Essays on fiscal sustainability in Europe

This item was submitted to Loughborough University's Institutional Repository by the/an author.

Additional Information:


Metadata Record: [https://dspace.lboro.ac.uk/2134/33690](https://dspace.lboro.ac.uk/2134/33690)

Publisher: © Ivaylo Alexandrov Nikolov

Rights: This work is made available according to the conditions of the Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International (CC BY-NC-ND 4.0) licence. Full details of this licence are available at: [https://creativecommons.org/licenses/by-nc-nd/4.0/](https://creativecommons.org/licenses/by-nc-nd/4.0/)

Please cite the published version.
ESSAYS ON FISCAL SUSTAINABILITY IN EUROPE

by

Ivaylo Alexandrov Nikolov

Doctoral Thesis
Submitted in partial fulfilment of the requirements
for the award of
Doctor of Philosophy of Loughborough University

September 2009

© by Ivaylo Alexandrov Nikolov (2009)
ABSTRACT

Fiscal sustainability is present when the current government debt equates to the present value of future budget surpluses or their excess over deficits but since 1970 the EU countries on average had a surplus budget only in one year. The first aim of the thesis is to see whether Europe has achieved fiscal sustainability, whereas the second aim is to analyse the effects of Maastricht and the Stability and Growth Pact to this end. Another research aim is to present a formal fiscal sustainability assessment for the EU accession countries. Finally, the thesis bridges fiscal and external sustainability and studies the economy-wide sustainability separately in ‘old’ Europe and the accession countries.

For ‘old’ Europe, sustainability seems an unrealised goal no matter if the fiscal balance is considered alone or in a unified analytical framework with the current account. Neither have Maastricht, the Stability and Growth Pact or the Euro been instrumental in shaping sustainable policies. The analysis of accession Europe broadly confirms the hypothesis of successful fiscal adjustment there but this conclusion is only valid for the group of accession countries as a whole, whereas the empirical evidence is less optimistic for each country individually. Finally, in the open-economy setting, the economies of Central and Eastern Europe do not exhibit any economy-wide sustainability.

The new fiscal sustainability analysis of fourteen ‘old’ EU members is the first contribution to the literature. Then the thesis proposes a way to assess fiscal sustainability convergence over time, in addition to the hypothetical Maastricht regime change. Another contribution is the most comprehensive so far assessment of fiscal sustainability in the accession countries, using a new set of data and some recent advances from the panel cointegration literature. Furthermore, the thesis puts forward a theoretical model relating the fiscal and external sustainability dimensions, as essentially an open-economy fiscal sustainability approach. That model is illustrated with separate empirical applications on ‘old’ Europe, including an adaptation of the convergence modelling, and accession Europe.

KEYWORDS: fiscal sustainability, convergence, current account sustainability, European Union, accession countries, panel cointegration.
ACKNOWLEDGEMENTS

First off, I would like to express my gratitude to my supervisor, Prof Christopher J. Green. His support dates back to my MSc programme at this Department and he was instrumental in motivating me to return to Loughborough to pursue the doctoral degree. I have relied on his overall guidance and his feedback has always been full of insights. Nevertheless, I am solely responsible for any faults remaining in this thesis.

My gratitude is extended to Dr Paul M. Turner who, as my second supervisor and Director of Research, shared his professional knowledge with me in several key stages during my research. I would also like to take this opportunity to thank Prof Eric J. Pentecost, Head of Department, for his encouraging comments and understanding. I am grateful to the support staff too, especially to Su Spencer, Denise Simpson and Lorraine Whittington. Certainly, I acknowledge the financial support from the Department of Economics of Loughborough University, which made this research possible in the first place.

I also thank Gerhard Kling for sharing his Stata codes, Bank of Greece’s Sophia Lazaretou and Alexandra Voutou for the private sector data for their country, and the participants at the PhD research seminars in our Department where I presented earlier excerpts from my work.

Among the fellow students, the discussions with Alex Kganetsano, Catarina Cardoso, Geetha Ravishankar, Juan Tao, Karligash Kenjegalieva, Marie Stack, Paul Alagidede, Simona Rasciute, Vasileios Zikos and Xiaoshan Chen have enhanced my understanding of economics and econometrics and eased an otherwise lonely research experience.

My parents Petya and Alexander have, as always, stood by me. But my wife Kalina deserves the deepest gratitude for her patience, continuously inspiring me to accomplish this task and never ceasing to care across the many miles that separated us for so long. And as I am finally to be reunited with my family in Bulgaria I hope that also my daughter Stephania, born while I did this research here, will one day forgive my absence and have her reasons to take pride in me.
CONTENTS

Chapter One  Introduction................................................................. 7

Chapter Two  Foundations of Fiscal Sustainability Analysis........... 14
  2.1. The IBC as the major building block ................................. 15
  2.2. The ‘constrained sustainability’ approach ......................... 26
    Gauging fiscal sustainability constraints ............................ 26
    Blanchard’s fiscal indicators ............................................ 27
    Buiter’s ‘permanent’ rules .............................................. 30
  2.3. The ‘statistical tests’ approach ......................................... 46
    Hamilton and Flavin’s (1986) basic framework ................... 48
    Seminal works in the ‘statistical tests’ approach ................. 51
    Bohn’s critique 1: modelling sustainability under uncertainty ... 62
    Bohn’s critique 2: the (un)necessity of stationarity and cointegration restrictions ... 66
    Nonlinear fiscal adjustments .......................................... 69
  2.4. Conclusion ........................................................................ 73

Appendix 2.A  European Fiscal Sustainability Studies ................. 80

Appendix 2.B  The ‘Permanent Balance’ Rule ............................. 84

Chapter Three  Fiscal Sustainability Convergence in ‘Old’ Europe .... 88
  3.1. Fiscal policy before and after the Euro ............................. 90
    General government fiscal balances .................................. 90
    General government debt ............................................... 94
  3.2. Between Maastricht and the long-run fiscal sustainability .... 97
    Econometrics background ............................................. 98
    The research strategy ................................................ 102
  3.3. Data and empirical results ............................................. 103
    Data ........................................................................ 103
    Unit root/stationarity results ....................................... 106
    Cointegration results ................................................ 109
  3.4. Conclusion ..................................................................... 119

Chapter Four  Fiscal Sustainability in EU Accession Countries: A Panel (Co)integration Perspective ................................. 121
  4.1. The fiscal experience of accession countries ..................... 124
    The transition and EU accession context ............................ 124
    The long-run fiscal sustainability criterion revisited ............ 129
  4.2. A panel fiscal sustainability analysis ............................... 131
    The implications of panel tests on the issue of sustainability ... 131
    The panel unit root and stationarity tests ......................... 133
    Panel cointegration tests ............................................. 134
    Panel cointegration estimation .................................... 135
  4.3. Data, methods and empirical results ............................... 137
    Data ........................................................................ 137
TABLES

Table 2.1. The statistical tests approach: summary of the founding theory ........................................ 61
Table 2.A.1. Some existing empirical evidence about fiscal sustainability in Europe ...................... 81
Table 3.1. Country fiscal data overview (EU14) .............................................................................. 105
Table 3.2. Unit root/stationarity tests: total expenditures and total revenues (levels) .................. 107
Table 3.3. Unit root/stationarity tests: total expenditures and total revenues (first differences) .................................................................................................................. 108
Table 3.4. Cointegration analysis without breaks ............................................................................ 110
Table 3.5. Cointegration analysis with a break ................................................................................ 118
Table 4.1. General government fiscal balance, percent of GDP ....................................................... 125
Table 4.2. General government consolidated gross debt, percent of GDP ..................................... 125
Table 4.3. Gross domestic product, constant prices, annual percent change .................................. 125
Table 4.4. Country fiscal data overview (accession countries) ....................................................... 138
Table 4.5a. Are country fiscal policies mutually independent? Correlation coefficients .............. 139
Table 4.5b. Are country fiscal policies mutually independent? Correlation coefficients .............. 139
Table 4.6. Panel unit root/stationarity results: total expenditures (levels) ..................................... 143
Table 4.7. Panel unit root/stationarity results: total revenues (levels) ............................................. 143
Table 4.8. Panel unit root/stationarity results: total expenditures (first differences) ..................... 143
Table 4.9. Panel unit root/stationarity results: total revenues (first differences) ......................... 143
Table 4.10. Panel cointegration (all twelve countries), Kao and Pedroni tests ............................... 148
Table 4.11. Panel cointegration (eleven countries), Kao and Pedroni tests ..................................... 149
Table 4.12. Accession countries fiscal sustainability bootstrapped critical values, W-E test .......... 151
Table 4.13. Panel cointegration, W-E test ....................................................................................... 152
Table 4.14. Panel cointegration estimation results ......................................................................... 155
Table 5.1. General government fiscal and current account balances, percent of GDP (EU14) ....... 163
Table 5.2. General government fiscal and current account balances, percent of GDP (accession countries) ................................................................. 164
Table 5.3. The schematic flow of funds ......................................................................................... 168
Table 5.4. Private sector savings and investment data (EU14) ....................................................... 175
Table 5.5. Unit root/stationarity tests: private investment and private savings (levels) ............... 177
Table 5.6. Unit root/stationarity tests: private investment and private savings (first differences) .... 178
Table 5.7. Cointegration analysis without breaks (private savings and private investment) ......... 181
Table 5.8. Cointegration analysis with a break (private savings and private investment) .......... 189
Table 5.9. Private sector savings and investment data (accession countries) ................................. 191
Table 5.10. Panel unit root/stationarity results: private savings (levels) ........................................ 192
Table 5.11. Panel unit root/stationarity results: private investment (levels) ................................. 192
Table 5.12. Panel unit root/stationarity results: private savings (first differences) ....................... 193
Table 5.13. Panel unit root/stationarity results: private investment (first differences) ................. 193
Table 4.11. Panel cointegration (all twelve countries), Kao and Pedroni tests ............................... 194
Table 5.15. Panel cointegration (eleven countries), Kao and Pedroni tests ..................................... 196
Table 5.16. Accession countries open-economy sustainability bootstrapped critical values, W-E test ........................................................................................................... 197
Table 5.17. Panel cointegration, W-E test ....................................................................................... 197
Table 5.18. Panel regression estimation results ............................................................................. 198
FIGURES

Figure 3.1. General government fiscal balance: EU15 non-Euro countries (percent of GDP) ................................................................. 91
Figure 3.2. General government fiscal balance: five biggest Euro area countries (percent of GDP) ......................................................... 91
Figure 3.3. General government fiscal balance: six smallest pre-2007 Euro area countries (percent of GDP) ................................................ 92
Figure 3.4. General government fiscal balance: unweighted ‘old’ Europe averages (percent of GDP) ......................................................... 92
Figure 3.5. Maastricht debt: EU15 non-Euro countries (percent of GDP) ................................................................. 95
Figure 3.6. Maastricht debt: five biggest Euro area countries (percent of GDP) ................................................................. 95
Figure 3.7. Maastricht debt: six smallest pre-2007 Euro area countries (percent of GDP) ................................................................. 96
Figure 3.8. Maastricht debt: unweighted ‘old’ Europe averages (percent of GDP) ................................................................. 96
Figure 3.9. The research strategy ................................................................................................................................. 103
Figure 3.10. Austria: convergence in fiscal sustainability ........................................................................................................... 112
Figure 3.11. Belgium: convergence in fiscal sustainability ........................................................................................................... 112
Figure 3.12. Denmark: convergence in fiscal sustainability ........................................................................................................... 113
Figure 3.13. Finland: convergence in fiscal sustainability ........................................................................................................... 113
Figure 3.14. France: convergence in fiscal sustainability ........................................................................................................... 113
Figure 3.15. Germany: convergence in fiscal sustainability ........................................................................................................... 114
Figure 3.16. Greece: convergence in fiscal sustainability ........................................................................................................... 114
Figure 3.17. Ireland: convergence in fiscal sustainability ........................................................................................................... 114
Figure 3.18. Italy: convergence in fiscal sustainability ........................................................................................................... 115
Figure 3.19. Netherlands: convergence in fiscal sustainability ........................................................................................................... 115
Figure 3.20. Portugal: convergence in fiscal sustainability ........................................................................................................... 115
Figure 3.21. Spain: convergence in fiscal sustainability ........................................................................................................... 116
Figure 3.22. Sweden: convergence in fiscal sustainability ........................................................................................................... 116
Figure 3.23. United Kingdom: convergence in fiscal sustainability ........................................................................................................... 116
Figure 4.1. Accession countries fiscal sustainability bootstrap distribution, W-E test statistic ................................................................................................................................. 152
Figure 5.1. Foreign vs. government debt ................................................................................................................................. 166
Figure 5.2. Austria: convergence in open-economy sustainability ........................................................................................................... 183
Figure 5.3. Belgium: convergence in open-economy sustainability ........................................................................................................... 183
Figure 5.4. Denmark: convergence in open-economy sustainability ........................................................................................................... 183
Figure 5.5. Finland: convergence in open-economy sustainability ........................................................................................................... 184
Figure 5.6. France: convergence in open-economy sustainability ........................................................................................................... 184
Figure 5.7. Germany: convergence in open-economy sustainability ........................................................................................................... 184
Figure 5.8. Greece: convergence in open-economy sustainability ........................................................................................................... 185
Figure 5.9. Ireland: convergence in open-economy sustainability ........................................................................................................... 185
Figure 5.10. Italy: convergence in open-economy sustainability ........................................................................................................... 185
Figure 5.11. Netherlands: convergence in open-economy sustainability ........................................................................................................... 186
Figure 5.12. Portugal: convergence in open-economy sustainability ........................................................................................................... 186
Figure 5.13. Spain: convergence in open-economy sustainability ........................................................................................................... 186
Figure 5.14. Sweden: convergence in open-economy sustainability ........................................................................................................... 186
Figure 5.15. United Kingdom: convergence in open-economy sustainability ........................................................................................................... 187
Figure 5.16. Accession countries open-economy sustainability bootstrap distribution, W-E test statistic ................................................................................................................................. 197
ACRONYMS

ADF  Augmented Dickey-Fuller Test
AMECO  The Annual Macro-Economic Database of EC's DG ECFIN
B  Breitung Test
BG  Bulgaria
CEE  Central and Eastern Europe
CY  Cyprus
CZ  Czech Republic
DFGLS  Dickey-Fuller Generalised Least Squares Test
DG ECFIN  European Commission's Directorate General for Economic and Financial Affairs
DGLS  Dynamic Generalised Least Squares
DOLS  Dynamic Ordinary Least Squares
EBRD  European Bank for Reconstruction and Development
EC  European Commission
ECB  European Central Bank
EDP  Excessive Deficit Procedure
EE  Estonia
EMU  Economic and Monetary Union
E(M)U  Economic and Monetary Union/European Union
ERM  Exchange Rate Mechanism
ESA  European System of Accounts
EU  European Union
EU12  European Union, Member States having adopted the single currency before 1 January 2007
EU14  EU15 without Luxembourg
EU15  European Union, 15 Member States before 1 May 2004 (EU12 plus Denmark, Sweden and the UK)
EUR  Euro
FMOLS  Fully-Modified Ordinary Least Squares
GB  Great Britain
GDP  Gross Domestic Product
GLS  Generalised Least Squares
GNP  Gross National Product
H  Hadri Test
HICP  Harmonised Index of Consumer Prices
HU  Hungary
IBC  Intertemporal Budget Constraint
IMF  International Monetary Fund
KPSS  Kwiatkowski-Phillips-Schmidt-Shin Test
LT  Lithuania
LV  Latvia
MT  Malta
OECD  Organisation for Economic Cooperation and Development
OLS  Ordinary Least Squares
PL  Poland
PPERRON  Phillips-Perron Test
PVBC  Present-value Budget Constraint
RO  Romania
<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>SGP</td>
<td>Stability and Growth Pact</td>
</tr>
<tr>
<td>SI</td>
<td>Slovenia</td>
</tr>
<tr>
<td>SK</td>
<td>Slovakia</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>US</td>
<td>United States</td>
</tr>
<tr>
<td>VAR</td>
<td>Vector Autoregression</td>
</tr>
<tr>
<td>VECM</td>
<td>Vector Error-Correction Model</td>
</tr>
<tr>
<td>W-E</td>
<td>Westerlund-Edgerton Test</td>
</tr>
</tbody>
</table>
CHAPTER ONE
INTRODUCTION

The budget should be balanced, the Treasury refilled, public debt reduced, the arrogance of officialdom tempered and controlled, and the assistance to foreign lands curtailed, lest Rome become bankrupt.

- Marcus Tullius Cicero (106 BC - 43 BC)

The bankruptcy of the Treasury of a country is a most visible sign of economic policy failure. The recent budget deficits in several of the world’s advanced economies are a daunting reminder that historically some states have failed to service their debt obligations. As the last decades of the twentieth century provided for a first time long and relatively reliable data records, and modern research methods have surged, both analysts and policymakers have sought new answers to the long-standing concerns about the sustainability of fiscal policy. Should governments have imposed limits on how much they can borrow and can continuing budget deficits be sustained?

In modern terms, fiscal sustainability is associated with the ability of a government to bear the costs of existing debt, that is to stay solvent, and with any constraints over time needed to keep or restore that solvency. The current fiscal stance is deemed sustainable when it does not lead to bankruptcy in the future, even if solvency is not an imminent issue. More technically, fiscal sustainability is present when the current government debt equals the present value of the future budget surpluses or their excess over deficits. The intertemporal budget constraint thus defined implies that in some periods a government can safely issue new debt to finance its deficits. Solvency of the Treasury remains the focal concern but there is no need to keep the budget balanced in every period, contrary to Cicero’s intuitive suggestion.

The theory of fiscal sustainability from the last two decades has correspondingly distilled a distinct strand of literature, where the statistical properties of various fiscal series are explored to yield empirically testable conditions. If the past data meet these conditions, the government will be able to pay out its debt and fiscal sustainability is in place. Two assumptions rest behind such methods: fiscal policies are assumed to remain
unchanged and the data from the past are regarded as representative of the long-run infinite future.

Practitioners and policymakers however may be less willing to rely on long-term outcomes. So another distinct strand in modern fiscal sustainability analysis advocates the need to confine current deficits and debts within straightforward numerical targets. The fiscal convergence criteria of the European Union exemplify that approach. Although requiring balanced budgets only over the economic cycles, the European fiscal rules are nevertheless closer to the spirit of the ancient Roman thinker.

So it is fascinating to note that two millennia after Cicero’s words the definitions of fiscal sustainability and the policy implications thereof have remained divergent, while the fear of insolvency has not ceased to plague the European economies. Since 1970, the European Union countries on average have had a surplus budget only in the year 2000. The Stability and Growth Pact was introduced over a decade ago to safeguard fiscal discipline and promote sound national public finances, particularly in the countries bound by the monetary union. Yet the advent of the common currency in 1999 spurred an ardent debate about the need to reform the Pact. Instead of ensuring fiscal discipline while at the same time facilitating growth and the smooth operation of the common market and the new monetary regime, the Pact was allegedly breached by important European economies. It was amended in mid-2005 but it is still debatable whether the countries are following fiscally sustainable paths. Recently the European Commission proposed the new Broad Economic Policy Guidelines, launching the last cycle (2008-2010) of the Lisbon Strategy, which in 2000 promised to make the EU the world’s most dynamic and competitive economy by the end of the decade. In the new guidelines, the Commission again admonished Member States to ‘pay particular attention to fiscal sustainability of their public finances in full compliance with the Stability and Growth Pact’ (EC, 2007).

It is intriguing therefore to embark on an analysis to see whether Europe has achieved fiscal sustainability or not, and this is the first aim of this thesis. The European Union’s multi-country experience, especially with the single currency, must be revealing for both the definition and practice of fiscal sustainability. Favoured the formal definition outlined above, the thesis analyses past data to uncover evidence whether the recent
fiscal practices in the European economies, if continued into the future, guarantee that existing debt will be repaid eventually.

This perspective clearly differs from simply checking compliance with the exact numerical rules introduced by the Maastricht Treaty and the Stability and Growth Pact. Yet fiscal sustainability concerns may be expected to be accented in the case of a monetary union where members, while retaining fiscal independence, transfer the conduct of monetary policy to a supranational independent authority. Fiscal policy is then elevated beyond maintaining the solvency of the Treasury: it remains the only tool for an independent national stabilisation policy. So the second aim of the thesis is to analyse in particular if the road to the Euro and its subsequent adoption have induced fiscal consolidations in line with the intertemporal budget constraint.

A thorough analysis of fiscal sustainability in Europe will be incomplete if it does not consider the last two waves of enlargement of the European Union. The new members from Central and Eastern Europe must comply with the Stability and Growth Pact rules and will eventually have to adopt the Euro. Four of them already joined the monetary union and others are scheduled to follow soon. Thus a third aim of the research agenda here is to apply the formal methods of long-run fiscal sustainability analysis to the accession countries. Data limitations usually explain why the region has so far received limited research attention. To fill that gap, novel applications from the recently growing field of panel time series econometrics are utilised to examine if the fiscal series satisfy the statistical conditions for fiscal sustainability.

Furthermore, and as a fourth major research question, the thesis extends the assessments for both pre-2004 ‘old’ Europe and accession Europe to incorporate the issue of current account sustainability. I explain why in an open-economy world both the fiscal and external constraints matter. A country’s fiscal policies may be defined as sustainable but if the current account is persistently in deficit, and so foreign debt is accumulated, the threat of external insolvency may require policymakers to resort to fiscal tightening. The latter, even if promoting fiscal consolidation in the short run, may slow economic growth and because of diminishing budget revenues in the future undermine long-term fiscal sustainability. The thesis proposes a new model to test for overall sustainability and applies it first to the European Union consisting of its pre-2004 members. There
again the focus is on the effects from the fiscal rules of Maastricht and the Stability and Growth Pact. The model is then applied separately to assess whether the dual pressures of transition and accession have resulted in overall sustainability in Central and Eastern Europe.

In summary, the thesis puts forward the following contributions to the literature:

- It analyses the historical fiscal sustainability in fourteen ‘old’ European Union members. Few European fiscal sustainability studies have covered such a comprehensive set of countries. The long data series, spanning almost four decades, bring new evidence to compare to the often contradictory findings from previous studies.
- It proposes a way to assess fiscal sustainability convergence over time, to reveal when and how countries have achieved or deviated from the fiscally sustainable path. Existing fiscal sustainability studies have come up with ways to model structural shifts in the data generating processes: but the exact timing of fiscal sustainability, conditioned on the intertemporal budget constraint, has remains unclear. The assessment of the evolution in fiscal sustainability is based on several complementary methods: cointegration regression analysis, recursive estimation of the cointegrating parameter, and Maastricht regime shift tests for disentangling any influences from Maastricht, the Stability and Growth Pact, and the Euro.
- It conducts one of the first and certainly the most comprehensive so far fiscal sustainability analysis for accession Europe. To that end, recent advances in panel unit root and panel cointegration tests, and panel cointegration estimators are reviewed and adapted from other areas of economics and finance. The thesis is among the first to employ a panel fiscal sustainability approach. To overcome a limitation common to the earlier panel cointegration tests, the assumption of cross-sectional independence is relaxed.
- It designs a theoretical model relating fiscal and external sustainability, as essentially an open-economy fiscal sustainability approach. A simple testable condition is derived to ascertain whether data respect the economy-wide intertemporal constraints. An interpretation of the different scenarios and possible policy implications are suggested.
- It illustrates the new overall sustainability model with an empirical application to the set of ‘old’ European economies. Furthermore, the fiscal sustainability
convergence approach is extended to produce the first evidence for any gradual changes in the overall sustainability in Europe, before and after the introduction of the Euro.

- It applies the overall sustainability analysis to the accession Europe panel to complement the findings from the assessment of fiscal sustainability alone.

The analyses of fiscal and overall sustainability in this thesis are based on original datasets compiled for the entire set of EU countries and these datasets are available upon request. The panel cointegration tests and estimators applied here have until now been unavailable in Stata and the research community using that software might benefit from the tailor-made codes written for the empirical applications in Chapter Four and Chapter Five.

The rest of the thesis is organised as follows. Chapter Two offers a unifying classification for the fiscal sustainability concepts in order to set the theoretical background, place the subsequent applications in a broader context of the literature and to justify the choice of methods. The original taxonomy presented intends to disentangle the theories and offer a straightforward guide for the rest of the analysis. It first presents the simple arithmetic of the intertemporal budget constraint, the building block of fiscal sustainability theory. Diverse approaches from the last two decades are reviewed and narrowed down to two broad groups. One major strand of literature advocates the imposition of additional fiscal constraints to keep or restore sustainability. Often these evolve into measurable indicators or even enforceable fiscal rules, and thus this strand seems attractive. A second strand is more backward-looking and deals with the statistical analysis of historical data. By definition limited in offering any ex ante policy prescriptions, this second 'statistical tests' approach is nevertheless shown to be theoretically robust in identifying the compliance of the recorded fiscal stance with the long-run notion of fiscal sustainability.

Chapter Three addresses the dynamic dimension of fiscal sustainability in Europe. The tools to indicate when an economy has achieved or lost sustainability over any particular time horizon are applied to the 'old' part of the EU where longer time series of data are available. The corollary research question which has, surprisingly, only been addressed in a few studies in the existing literature, is whether the Maastricht Treaty and the Stability and Growth Pact have contributed to sustainability. The chapter brings out
exhaustive evidence, which may be emphasised by some as confirming previous more limited studies while by others, as providing new arguments for criticising the fiscal regime in Europe.

Twelve nations from Central and Eastern Europe recently acceded to the EU and that group of countries are interesting for their unique transition and accession experience which shaped their fiscal practices. Chapter Four analyses the fiscal sustainability of accession Europe. Because the region has only rarely been studied with the formal tools for historical fiscal sustainability analysis, the chapter represents a comprehensive extension of the existing literature on Europe. The literature gap so far is presumably due to data limitations and filling it is made possible through the exploitation of recent advances in panel time series econometrics. The panel approach is enjoying rising popularity in other areas but Chapter Four contributes to an only emerging panel sub-strand of the literature in the fiscal sustainability field. Taking advantage of a new dataset, the evidence for the panel is also distinguished, within limits, from the true achievements of the individual countries.

Chapter Five tackles a related question: what does fiscal sustainability benefit an economy running persistent current account deficits? It is argued that the external and the fiscal sustainability dimensions need to be bridged and concurrently assessed, to overcome an implied closed-economy context. The chapter develops a model for that with a simple testable condition. The variables of interest turn out to be generated from outside the government sector, and original datasets from the entire EU are duly constructed. Two empirical applications are then presented mirroring the previous two chapters. For Western Europe, the hypothesis of convergence towards open-economy sustainability, with a possible Maastricht/Euro effect, is tested. For the accession Europe panel, the question is whether the recent large current account imbalances have affected the long-run economy-wide sustainability. The chapter findings may be of interest on their own or as complementary to those from Chapters Three and Four. The policy implications could be viewed as a first approximation to how open-economy sustainability should be interpreted.

The concluding chapter summarises the evidence from across the thesis to answer the concern which cuts through it: has Europe achieved fiscal sustainability or not? Key
points from the proposed models and empirical strategies are highlighted, some limitations are acknowledged, and first directions for future research are outlined.
CHAPTER TWO
FOUNDATIONS OF FISCAL SUSTAINABILITY ANALYSIS

A journey of a thousand miles begins with a single step.
-Lao Tzu (604 BC - 531 BC)

Out of the many ways to approach the fiscal sustainability area, a less expected but insightful one is to emphasize the monetary outcomes from certain fiscal stances of the economy. In the wake of an age of high inflation, Sargent and Wallace's (1981) 'unpleasant monetarist arithmetic' showed that monetary policy cannot permanently control inflation when the fiscal authorities set their budgets independently. Public sector borrowing then is constrained by the demand for government bonds, so seigniorage revenue from money creation may be needed to co-finance the budget deficits. Adjusting the stock of money may be incompatible with inflation targets; hence prudence on the side of fiscal policy is required. The purpose of this chapter is to present the theoretical framework for fiscal policy seeking to avoid insolvency in the absence of sources to finance the budget deficits other than government debt. In other words, the emphasis is on fiscal sustainability as defined through any particular long-run constraints in the relationship between fiscal deficit and debt.

Whereas persistently loose fiscal policies may be inflationary, price stability is the primary objective of the European Central Bank. Because most of the 'old' EU members belong to the Euro area and the new accession countries are all required to join eventually, a natural research question is whether public finances in Europe have so far been sustainable. The theory in this chapter aims to provide the main tools for the empirical assessment of European fiscal sustainability in the subsequent chapters.

Analyzing fiscal sustainability in Europe may also be motivated under the opposite fiscal-monetary policy regime: when the monetary authority is the first to set its targets, leaving the fiscal authority to adjust. The government then is constrained 'by the demand for bonds, since it must set its budgets so that any deficits can be financed by a combination of the seigniorage chosen by the monetary authority and bond sales to the
public' (ibid., p. 2). The monetary target may include setting the growth rate of the stock of money but Sargent and Wallace (1981, p. 7) also note the 'alternative monetary mechanisms that do impose fiscal discipline ... for example, fixed exchange rates'. On the national level, the E(M)U may be viewed as such a regime: without their own monetary powers, the individual countries face the stock of money and exchange rates as exogenously imposed. Fiscal discipline in each member of the monetary union is correspondingly a paramount requirement as set out in the Stability and Growth Pact to which the European Union must adhere.

With this in mind, politicians and academics may be expected to seek to define what constitutes a set of 'good' fiscal policies. Are budget deficits necessarily inflationary or how large must they be to be inflationary while keeping the Treasury of the government solvent? What are the optimal bounds for an economy's indebtedness and what, if any, stable debt paths should be targeted? Such and related queries are sometimes conveniently aggregated into the question of what defines the fiscal policy as 'sustainable'.

Sargent (1999) discusses the monetary effects from fiscal policies in the simple case where zero money growth is targeted. This requires that 'government expenditures plus interest payments equal tax collections plus the net proceeds from new issues of interest-bearing debt' (ibid., p. 1471). That there are intertemporal bonds constraining the sequences of fiscal deficits and debts is a recurring theme in fiscal sustainability theory. So it will be most instructive to commence from there as the first single step.

2.1. The IBC as the major building block

The intertemporal budget constraint (IBC) is the indispensable starting point for analysing fiscal sustainability. The IBC is also sometimes referred to as the present-value budget constraint, PVBC, or the life-time budget constraint. Among a multitude of theoretical and empirical texts on fiscal sustainability, Vieira (1999), Chalk and Hemming (2000), Ley (2003) and Burnside (2005) present conveniently concise treatments of the IBC arithmetic. With unavoidable adaptation, these are largely followed below.
The IBC has as its building block the ‘static’ (Chalk and Hemming, 2000) or ‘flow’ (Burnside, 2005) budget constraint, given by:

\[ (2.1) \quad B_t = R_t B_{t-1} + D_t, \]

where \( R_t \) is the real interest factor during period \( t \), \( B_{t-1} \) is the quantity of debt outstanding in the beginning of \( t \) (hence, bonds), and \( D_t \) is the primary fiscal deficit (i.e. excluding interest expenditures). Equally, (2.1) can be augmented by including seigniorage as a separate government revenue source:

\[ (2.2) \quad B_t = R_t B_{t-1} + D_t - \Delta M_t, \]

Above, \( \Delta M \) denotes the change in base money. Because \( R_t = 1 + r_t \) where \( r_t \) is the constant real interest rate on debt, (2.2) is equivalent to:

\[ (2.3) \quad B_t = (1 + r_t) B_{t-1} + D_t - \Delta M_t, \]

Above, \( r_t \) could also be an average rate, keeping the notation both simple and not too remote from reality. Similarly, a common assumption at this point is that all debt has a maturity of one period (year): an assumption seemingly acceptable under perfect foresight (Burnside, 2005, Chapter 2, Note 2, p. 30). Then (2.3) yields one of the popular representations of the ‘flow’ budget constraint:

\[ (2.4) \quad \Delta B_t = r_t B_{t-1} + D_t - \Delta M_t, \]

The latter represents an identity linking the net issuance of debt to interest payments during \( t \) for debt outstanding at the end of \( t-1 \), the primary deficit \( (D_t) \) and seigniorage revenues between \( t \) and \( t-1 \).

A few preliminary notes are worth making at this stage. There may be varied expressions and measures for debt and deficits in (2.1) - (2.4). Government expenditures and revenues may also differ in assumptions about the scope of the ‘government’ and the level of theoretical or observational decomposition to be considered plausible. A researcher may need to decide in advance on the use of real or nominal values. Finally,
the relevant interest rate in the constraint is often corrected for, or combined with, the output growth rate as shown further below.\(^1\)

The IBC arithmetic may be discussed against that background. Thus, (2.1) was given without any explicit reference to the degree of consolidation/size of the government sector. The question of whether to include, in addition to the central government, local governments and/or state-owned enterprises and even banks may have different relevance for different countries, depending on their economic structures. Buiter (2004) argues in favour of including the central bank’s assets and liabilities in the overall country’s fiscal-sustainability balance. Even if the central bank is operationally independent from the ‘government of the day, it is always an agent of the state’ (ibid., p. 5). The bank enters the boundaries of the public sector because ultimately the state is responsible for its debts and because the state appropriates its profits and covers its losses.

There may be a range of fiscal decentralisation schemes across countries and regions, and the consolidation of state-owned entities within the state budget may depend on both national accounting conventions and degrees of the entities’ de facto autonomy. The appropriate size and coverage of the public sector is discussed at length in IMF (2002).

As for the choice of real vs. nominal values, it could be argued that the flow government budget constraint of (2.4) is not entirely correct for empirical purposes since the fiscal–monetary variables are not observable directly in real terms. Assuming that \(B, D\) and \(M\) are nominal, equation (2.4) can be corrected as:

\[
\Delta B_t = i, B_{t-1} + D_t - \Delta M_t,
\]

with \(i\) being a nominal interest rate.

There are then two useful ways to proceed with the flow budget constraint equation: one is to normalise it and another is to solve it forward by recursive substitution. Normalisation is done ‘by some measure of the government’s ability to service and

\(^1\) For the time being, this discussion is abstracted from any continuous-time or stochastic settings. The open economy is also regarded as an extension only.
repay its debt' (Ley, 2003, p. 2). This is usually done by scaling (2.5) by GDP or other measure of the size of the economy. For example, if the sustainability analysis discriminates between the geographic sources of government revenues, then gross national product (GNP) may be used instead (Buitert and Grafe, 2004, fn. 15, p. 77). According to Bohn (1991a, p. 344): ‘Since the nation’s productive activity provides the basis for all taxation and since the government sector is presumably bounded by the size of the whole economy, it seems appropriate to use ratios of fiscal variables to GNP.’ To keep the exposition simple here, GDP will be used as it is the ‘most common choice used for normalising government debt’ (Ley, 2003, p. 2).

We can therefore rescale (2.5) by dividing by nominal GDP, i.e. by period \( t \) real GDP \( (Y_t) \) multiplied by its deflator \( (P_t) \):

\[
(2.6) \quad \frac{B_t}{P_t Y_t} = \frac{(1 + i_t) B_{t-1}}{P_t Y_t} + \frac{D_t}{P_t Y_t} - \frac{\Delta M_t}{P_t Y_t}
\]

In turn, (2.6) equals:

\[
(2.7) \quad \frac{B_t}{P_t Y_t} = \frac{(1 + i_t) B_{t-1}}{(1 + \theta_t)(1 + \pi_t) P_{t-1} Y_{t-1}} + \frac{D_t}{P_t Y_t} - \frac{\Delta M_t}{P_t Y_t}
\]

The denominator in the first right-hand side term of (2.7) ‘discounts’ nominal GDP one period back by taking account of real output growth rate \( \theta_t \) and the inflation rate \( \pi_t \), measured as the rate of change of the GDP deflator. The real interest rate could be expressed as \( r = i - \pi - i\pi \), so that \( (1 + i)/(1 + \pi) = (1 + r)/(1 - \pi^2) \). The latter approximates to \( (1 + i)/(1 + \pi) = (1 + r) \) when \( \pi \) is small, e.g. less than 0.1, and hence (2.7) reduces to \(^2\):

\[
(2.8) \quad b_t = \frac{(1 + r_t)}{1 + \theta_t} b_{t-1} + d_t - \Delta m_t
\]

where \( b_t = B_t/(P_t Y_t) \), \( d_t = D_t/(P_t Y_t) \) and \( \Delta m_t = \Delta M_t/(P_t Y_t) \). Substituting \( \rho_t \) for \( (1 + r_t)/(1 + \theta_t) \), (2.8) becomes:

\[
(2.9) \quad b_t = \rho_t b_{t-1} + d_t - \Delta m_t
\]

\(^2\) This note resembles Ley (2003, fn. 3, p. 2). There he terms (2.6) - (2.9) the ‘law of motion of the government debt-to-GDP ratio’.
This flow constraint can then be used to derive the final expression for the IBC. Solving the difference equation (2.9) forward by recursive substitution results in:

\begin{equation}
(2.10) \quad b_t = \rho^{-(j+1)} b_{t+j+1} - \sum_{j=0}^{\infty} \rho^{-(j+1)} (d_{t+j} - \Delta m_{t+j})
\end{equation}

Thus (2.10) relates the initial-period debt outstanding to the debt accumulated between periods \(t\) and \(t+(j+1)\) with \(j \in \{0, \ldots, \infty\}\), as well as to the future primary deficits, or surpluses when \(d < 0\), and seigniorage revenue. If the sequence of debt ratios is to be bounded in an infinite-horizon setting, then the present discounted value of terminal debt should be non-positive in the limit:

\begin{equation}
(2.11) \quad \lim_{j \to \infty} \rho^{-(j+1)} b_{t+j+1} \leq 0
\end{equation}

This is the transversality condition for the difference equation (2.9). Provided that (2.11) holds as equality, (2.10) turns into the intertemporal budget constraint of the form:

\begin{equation}
(2.12) \quad b_t = -\sum_{j=0}^{\infty} \rho^{-(j+1)} (d_{t+j} - \Delta m_{t+j})
\end{equation}

What the IBC thus states is that government debt in period \(t\) should be equalled by a corresponding, in present value terms, sequence of future primary surpluses (or at least an excess of surpluses over deficits) and seigniorage revenues. If taken as an accounting identity, the IBC of (2.10) - (2.12) may be considered to hold permanently, or somewhat more precisely \textit{ex post} (Blanchard, 1990, p. 13). That consideration is fundamental for the research approaches to fiscal sustainability, although interpretations may differ substantially. First, one may wish to focus on the specific changes envisaged \textit{ex ante} in order to satisfy the IBC, and to also sometimes ‘augment’ them by further collateral constraint(s). A second popular approach to study sustainability is to test empirically past fiscal performance: to see if the IBC has actually been observed, and if not whether some fiscal adjustments are inevitable in the future. Broadly speaking, those two approaches have inspired the two distinct categories of fiscal sustainability studies via the IBC, treated in detail further below.

Deriving the constraint’s arithmetic through forward recursive substitution might suggest applying it readily for forecasting purposes, i.e. to draw implications for future fiscal sustainability. That may, however, prove difficult in practice as the IBC variables
are supposedly uncertain and perhaps also endogenous. The simplifying assumptions before deriving the IBC above did assume perfect certainty and perfect foresight, and the relations were formalised in a seemingly rigid way: so after all implying that the IBC is an accounting identity. Therefore the simple IBC arithmetic in (2.10) - (2.12) should indeed be emphasized as an *ex post* appearance of the fiscal stance. Still, there remains ground not only for the backward-looking research but also for more normative endeavours to analyse sustainability: because ‘a most fertile source for insight is hindsight’ (Ley, 2003, p. 1). IBC applications in that regard, sometimes evolving into specific sustainability indicators, are reviewed later.

The exposition of the IBC is also at the core of a debate about the proper definition of the budget deficit/surplus. In a seminal contribution McCallum (1984) described how the IBC allows for a permanent sequence of primary, exclusive of interest, deficits only if the latter were financed by money creation. Conversely, McCallum showed that if the permanent deficits were defined as incorporating interest expenditures, the IBC will not be violated even if seigniorage was non-existent. Intuitively, such a scenario is illustrated with a government running in each period a primary surplus just sufficient to cover some of the debt-service costs (Chalk and Hemming, 2000, p. 5). Then there will be an overall deficit, but debt will grow less than the rate of interest: in the framework above, debt will grow at a rate less than \( r \) in (2.8), thus satisfying the transversality condition (2.11).³

McCallum’s (1984) analysis also contains an early perspective on the contentious *Ricardian* properties of the IBC. The ‘monetarist’ hypothesis tested by McCallum is whether bond-financed changes (reductions) in tax revenues ultimately have no effect on the price level. Such a ‘Ricardian’ regime implies that the monetary authority sets its targets independently, with the fiscal authority seeking a fiscal balance compatible with the demand for bonds by the public. Thus the ‘Ricardian equivalence theorem’ examined by McCallum (1984) essentially requires the government to observe its IBC in the absence of undesired inflation⁴. A similar example of policy sequences is when the monetary authority is to ‘move first and thereby impose discipline on the fiscal authority’ (Sargent and Wallace, 1981, p. 7).

³ Abstracting for a moment from the growth rate of the economy (\( \beta = 0 \)).
⁴ For a fairly recent literature review on the ‘Ricardian equivalence’ see Ricciuti (2003).
Afonso (2005a) confirms the Ricardian regime hypothesis for the EU countries between 1970 and 2003. As noted at the outset, the monetary policy dominance necessitating fiscal discipline is to be expected in the supranational monetary framework in Europe.

Although assessing European fiscal sustainability however, this thesis does not explicitly test which policy regime dominates. This is compatible with the theoretical caveat that the IBC can also allow for the opposite 'fiscal dominant' regime where monetary policy adjusts to fiscal policy rather than vice versa. The monetary adjustments occur through seigniorage, therefore affecting the price level to restore the IBC in cases when 'irresponsible' fiscal policies have led to a deterioration in the debt and deficit. So, with this argument one may go further to assume that it is in fact fiscal policy that determines prices: this is the message of the fiscal theory of the price level. Then the IBC may not even be regarded as a constraint but as a tool for valuing government debt.

That 'valuation equation' perspective gives the following alternative interpretation of the IBC. There is no constraint as such on the government to borrow more, but it is rather that the nominal government debt in combination with the (expected) present value of future surpluses determines the price level. In this regard an expression akin to (2.12) turns out to be 'the government valuation equation, formerly known as the government budget constraint' as Cochrane (2005, p. 526) asserts. Cochrane contends that the fiscal theory of the price level 'does not mistreat' the IBC exactly because the theory regards a relation such as (2.12) as a valuation equation without imposing an alternative constraint.

The reasoning behind condition (2.11) ought to be re-assessed then, for it is central to the IBC. Examining (2.11) further reveals how (2.12) creates a true constraint on fiscal policies.

The transversality condition (2.11) was imposed as a non-positive limit to terminal government debt, also known as the no-Ponzi game restriction for the government. In 1920 in Boston Mr Charles Ponzi set up a business of attracting public deposits with the promise to pay substantial interest. The promise was delivered upon by covering interest
and principal payments with newly-attracted public funds, until this ‘pyramid’ scheme eventually collapsed.

Without that restriction (2.10) shows that the government could roll its current debt over forever. Such an opportunity of continuously rolling over both principal and interest payments is also known as a ‘rational Ponzi game’ policy (O’Connell and Zeldes, 1988). It relies on the proposition that the government would always be able to sell its bonds, i.e. that in the infinite horizon the public, or at least one individual, will be willing to hold bonds. But that is deemed infeasible as long as lenders are of finite number and represent infinitely lived consumers with their wealth not growing at a rate faster than the rate of interest. O’Connell and Zeldes call the alternative of allowing individual wealth to grow faster than interest ‘consumption inefficiency’: then it is possible for an individual on the lending side in some period to raise consumption without lowering it in some other period(s) (ibid., pp. 435-436). To put it intuitively, without such ‘inefficiency’ for at least one period an agent on the lending side would be giving up consumption. For that individual, the ‘option of holding a debt that will be continuously rolled over is strictly dominated by that of holding no debt at all’ (Chalk and Hemming, 2000, p. 4). At the aggregate level the transversality condition can be left not satisfied, and so the government may play the Ponzi game, only if there is infinite number of individuals entering the economy and the lending market over time.

It should then be argued why (2.11) was taken to hold as an equality in order to derive the IBC in (2.12), since the transversality condition (2.11) required the discounted value of terminal debt to be only non-positive. The equality, as the ‘standard’ transversality condition, arises from a combination of two conditions: (a) that individuals rule out being on the lending side, i.e. (2.11) is non-positive, and (b) that individuals also rule out being on the borrowing side, i.e. (2.11) is also non-negative. The latter observation is again found in O’Connell and Zeldes (1988, p. 437): not ruling that option out would enable individuals themselves to run ‘rational Ponzi schemes’ against the government.

O’Connell and Zeldes contend that it is in a dynamically Pareto inefficient economy that the government might run a ‘rational Ponzi game’⁵. That is why a further important set of implications for the IBC in (2.12) is derived related to the dynamics of ρ.

Whenever the real growth rate of the economy is less than the real interest rate, $\rho$ exceeds unity and thus the system characterised by the first-order difference equation (2.9) becomes unstable (Hamilton, 1994, pp. 1-3). The debt-ratio $b$ path becomes explosive as a result of any single impulse change in the primary deficit less seigniorage. That provides another way of justifying why in order to have an upper bound on the debt ratio sequence the limit in (2.11) should be approaching zero. And as long as the sequence of future primary surpluses plus seigniorage revenue is also bounded, the IBC of (2.12) may also exist in its limit.

Opposite reasoning applies when the economy grows at a real pace faster than that of interest and so $\rho$ is less than 1. The system of (2.9) is stable, meaning that the sequence of debt ratios could to some extent be compatible even with permanent primary deficits minus seigniorage. Putting it less formally, when the economy grows faster than debt the denominators in the ratios of (2.9) adequately ‘support’ the whole of the rise in debt in period $t$ due to interest expenditures on previous-period debt, and some of the rise in debt in period $t$ due to primary deficits less seigniorage in period $t$. Viewed from another angle, when $\theta$ persistently exceeds $r$ the debt/GDP ratio $b$ may be declining because output growth exceeds debt growth: even though under those circumstances the inverse of the discount factor in (2.11) will be above unity and the ‘standard’ transversality condition necessary in the present-value model will not hold. The latter may be regarded as a ‘paradox’ of the IBC of (2.10) - (2.12): but that ‘paradox’ exists only as long as a negative interest-growth differential is plausible in reality.

An economy where the growth rate exceeds the interest rate is termed ‘dynamically inefficient’. Following Diamond (1965) that is an economy where the investment return is below the economy’s growth rate. The ‘IBC paradox’ above explains why O’Connell and Zeldes (1988) regarded dynamic inefficiency as allowing the government to run the ‘rational’ Ponzi game. Under such circumstances ‘an increase in current debt has no implications for future surpluses’ (Wilcox, 1989, p. 291).

It may therefore be concluded that, regardless of whether dynamic inefficiency is being ruled out or not, the transversality condition and the IBC alone do not rigorously impose an upper limit on government debt ratio. Neither is the debt ratio required to decline.

---

6 For the analogy of the ‘market fundamentals’ solution see Hamilton (1994, p. 39).
What sufficiently bounds a government’s fiscal policies under the IBC is for the debt/GDP ratio asymptotically to approach zero.

But the debt ratio may approach zero in the limit even with a rising debt level. The latter may happen in both of the following two cases: (a) imposing the transversality condition with dynamic efficiency, when the debt ratio discounted by the growth-corrected real interest rate declines in the long run; and (b) under dynamic inefficiency. In case (b), the system in (2.9) is stable but perpetual rollover of the debt level becomes possible and the transversality condition for ruling out Ponzi-type financing of continuous deficits cannot be imposed.

Even if a constraint similar to (2.10) - (2.12) is analogously derived when fiscal variables are not expressed as ratios to GDP, the IBC again imposes no bound on the level of debt. Then, transversality would only require that debt does not grow faster than the discounting factor.

The possibility of a rising level of debt casts a shadow regarding the fiscal sustainability concerns. The controversies surrounding the IBC translate into two essential questions. First, does adherence to the IBC imply any particular concept of fiscal sustainability? Second, to what extent is the IBC sufficient to impose fiscally sustainable behaviour, i.e. is there a need to complement the simple arithmetic above by additional (collateral) constraints?

The IBC is taken by and large as the cornerstone in nearly all forms and variations of fiscal sustainability analysis. Therefore the answer to the first question only requires drawing the subtle distinction between the two concepts often interchangeably used: fiscal sustainability and fiscal solvency.

The second question is addressed from section 2.2 onwards.

One common broad definition of fiscal sustainability is that current debt should be matched by the present value of future primary surpluses. This definition corresponds to the IBC of (2.12) above. From this perspective, as just discussed, sustainability does not either bound the debt level or require that debt decline over time. The debt ratio may
also vary and stay high over long periods, provided that it approaches zero in the limit following the transversality condition.

*Fiscal solvency*, on the other hand, is often used to apply to a government being capable of serving its debt without defaulting on it. Hence an informal alternative to defining fiscal sustainability is a fiscal policy stance which neither currently nor in the future if kept unchanged is to jeopardise solvency. Buiter (2004, p. 4, fn. 3) provides a somewhat weaker condition, re-stating the ‘sustainability criterion’ ‘in an uncertain world’ as when government policies do not ‘result in an unacceptable risk of insolvency’.

Burnside (2005, p. 12) contends that even when a government is ‘likely to remain solvent ... its fiscal policies may be costly’ and fiscal sustainability may refer to the ‘ongoing costs associated with a particular combination of fiscal and monetary policies’.

Such nuances in delineating fiscal sustainability and solvency may ultimately be amalgamated and reduced to much coarser pragmatic explanations. Thus Ley (2003, p. 5) states that fiscal policy is sustainable ‘if the government’s solvency condition is satisfied’, where the ‘solvency condition’ refers to a variant of the IBC in which the present values of government debts and surpluses are balanced. Ballabriga and Martinez-Mongay (2005, p. 5) presumably share a widespread practitioners’ belief that ‘a solvent government is one that satisfies its intertemporal budget constraint’.

In what follows, notions of fiscal sustainability that are as closely as possible associated with the IBC will be discussed. It might be noted in advance that defining sustainability distinct from solvency echoes the more profound discrepancies that mark the theory and practice of fiscal sustainability analysis. On theoretical grounds, one may argue that solvency would be ensured through the inevitable *ex post* fiscal adjustments: because the IBC always holds. Even sometimes those adjustments could, or should, be estimated in advance. However, satisfying the long-run IBC may not in the real, short-term, world suffice for fiscal policies to score as sustainable: e.g. some limitations on the government debt or deficit should be imposed. The latter may also turn into indicators for benchmarking a sustainable fiscal stance. Those concerns explain why ‘there is something of disconnect between the theoretical work that has been done on fiscal
sustainability and assessment of fiscal sustainability in practice' (Chalk and Hemming, 2000, p. 24). The differing attitudes towards sustainability have also shaped the distinct strands of the theoretical literature, as shown next.

2.2. The 'constrained sustainability' approach

The theoretical and practical controversies around the fiscal sustainability concept(s) have given rise to a multiplicity of approaches. Those may be classified into two broad categories. One such category has evolved a diverse area of formal backward-looking statistical tests employed to study fiscal sustainability. They are discussed in section 2.3.

Gauging fiscal sustainability constraints

A second strand in the literature may be defined to comprise all works that stem from the understanding that 'just waiting' for an ex post realisation of the IBC is by itself not sufficient to assess a past, existing or expected policy mix as 'sustainable'. That attitude is rooted in at least two propositions: one of a more positive and one of a more normative nature. First, allowing government debt (or debt ratio) to grow without bounds as long as its discounted value asymptotically converges to zero (as implied by an IBC's transversality condition) may be unrealistic in practice. There may be limitations either to a government's capacity to tax (Kremers, 1989) or to the willingness of the public to buy and hold government debt (Sargent and Wallace, 1981), or to both. In a 'dynamically inefficient' economy, the debt ratio may be declining and yet still be unable to satisfy the transversality condition. In that case the fiscal stance would still be classified as 'unsustainable'. Hence, there is a need to derive special fiscal sustainability rules based on indicators used to 'strengthen' the basic IBC arithmetic.

Second, even if the IBC is satisfied, policies and external conditions may change in the future. A focus only on past performance and whether the borrowing constraint has been satisfied, though convenient for empirical purposes, may prove of little value for assessing the future evolution of sustainability. Moreover, the 'trivial' IBC approach may not readily be employed to yield concrete quantitative recommendations about policy changes ex ante. But it is desirable to analyse past and current fiscal performance
so as to spot indications for future adjustments needed to restore any deviations from the IBC. An alternative would be to introduce simple rules to constrain fiscal policies even beyond the IBC (a low ceiling on permissible debt would be an example). In both latter cases, the fiscal authority would be motivated to impose some constraints today, and to act pro-actively notwithstanding the positive belief that the IBC would always hold in the end.

The arguable limitations of backward-looking-only fiscal sustainability analysis have thus justified the need either to calculate \textit{ex ante} the \textit{ex post} adjustments that will occur, or to augment the IBC of the (2.12) type by further (stronger) sustainability criteria. That constitutes a popular divergent strand of the fiscal sustainability literature in the last two decades. In more practical terms, the emphasis there is on the need to adhere to (or achieve) fiscal sustainability through certain sustainability indicators or rules. Somewhat loosely terming it the 'constrained sustainability' approach, a selection of literature examples that are best acknowledged or most expressive are presented now.

**Blanchard's fiscal indicators**

In an influential contribution, Blanchard (1990) put forward a set of indicators for fiscal sustainability. His intent was to address sustainability as one of the aspects of fiscal policy, expressed by the questions 'Can the current course of fiscal policy be sustained, without exploding - or imploding - debt? Or will the government have to increase taxes, decrease spending, have recourse to monetisation, or even repudiation?' (ibid, p. 10). That set of adjustment options are the possible scenarios in order for the IBC to be satisfied \textit{ex post} always: the indicators are essential for giving a measure of the adjustments required.

The first indicator is based on a rule that keeps the current debt/GDP ratio constant, thus imposing directly the non-increasing debt (ratio) as a fiscal sustainability criterion. The emphasis is put on the primary deficit needed to achieve that. Resembling the expression in (2.9) above, Blanchard's first indicator looks like:

\begin{equation}
\ddot{d} - d_t = -\left[ (r_t - \theta_t) b_t + d_t \right]
\end{equation}
This time \( \bar{d} \) denotes the primary deficit needed to stabilise the debt ratio, \( \bar{d} = -(r, -\theta,)b, \). For \( r \) and \( \theta \), one possibility suggested by Blanchard was to use their actual values or their averages for some period back.

This first 'primary gap indicator' of fiscal sustainability could not easily be used for assessing sustainability \textit{ex ante}, because no future changes are envisaged for the government revenues and expenditures or the economy as a whole. That is why two further indicators are proposed.

Looking at the tax-to-output ratio, rather than the deficit (surplus), needed to stabilise the current debt ratio, Blanchard derives the 'sustainable tax rate'. That is the tax/GDP ratio that for some years ahead keeps debt unchanged, given a future sequence of government expenditures (G) as a share of output:

\[
(2.14) \quad \bar{t}_i = \frac{1}{n} \sum_{t+1}^n g_{t+1} + (r - \theta) b_0
\]

where \( g_t = G_t/T_t \). The first term in the right-hand side of (2.14) shows the average over the current and the next \( (n+1) \) years, and \( r \) and \( \theta \) are assumed not to be large. Blanchard's second indicator is the 'medium-term tax gap'. It measures the difference between the 'sustainable' tax rate for the next three years and the current tax/GDP ratio:

\[
(2.15) \quad \bar{t}_3 - t_i = \frac{1}{3} \sum_{t=0}^{3} g_{t+1} + (r - \theta) b_0 - t_i
\]

Blanchard (\textit{ibid.}, p. 15) admits that the choice of three years is arbitrary, depending ultimately on the period for which projections for government expenditures are available before averaging them as in (2.15). That is how the third, 'long-term tax gap' indicator is suggested:

\[
(2.16) \quad \bar{t}_{50} - t_i = \frac{1}{50} \sum_{t=0}^{50} g_{t+1} + (r - \theta) b_0 - t_i
\]

\footnote{Blanchard's original expressions differ slightly from here, in that the tax indicators are derived from a continuous-time setting and government transfers are added to expenditures}
That indicator is similar to (2.15) but the 'sustainable' tax rate over a longer time period, say fifty years, is used instead. Such a forward projection is admittedly hard to construct, as it would have to account for possibly significant future changes in expenditures, transfers and other likely fiscal or fiscal-related government expenditures.

Blanchard’s fiscal sustainability indicators are elaborated on in a subsequent paper by Blanchard, Chouraqui, Hagemann and Sartor (1990). Two important points are made about the tax-related second and third indicators. First, it is affirmed that despite the ‘symmetry of treatment’ between the components of primary deficit the indicators are inspired by an assumption that a government is more likely to be committed to the current expenditures programmes, hence taxes are more likely to be used for adjustment. Still, a positive value of tax gap indicators does not imply that taxes should be increased: 'the index is agnostic as to whether the adjustment should come from increased taxes, or decreased spending and transfers' (ibid., p. 13).

Two assumptions central to those indicators are also acknowledged (ibid., p. 14): that the interest-growth rates differential is positive, and that the debt/output ratio is bounded to converge to a certain value in the long run. The latter suggests imposing the familiar transversality condition, and not totally ruling out an increasing debt (ratio).

Imposing the assumption of a non-increasing debt/GDP ratio, or one which converges to some particular value, confirms the rationale for classifying Blanchard’s fiscal sustainability indicators into the ‘constrained sustainability’ group. Taken against the afore-mentioned controversies regarding both the ex ante assessment of fiscal sustainability and the sufficiency of the IBC to define deviations from fiscal sustainability, Blanchard’s indicators reveal an approach which is intuitively appealing and in line with the IBC. Still, the approach has clear limitations. First, it is not entirely conclusive about the sustainable debt ratio path: as acknowledged by the author(s), the debt ratio could grow as long as it is bounded by a form of transversality condition to converge to some limit value. This collateral constraint may not be plausible in reality for at least two reasons. The debt growth as earlier discussed may be limited because of the economy’s capacity to service it or the public’s willingness to buy and hold government debt. Also the interest-growth rate differential may not sometime be positive and then ‘the discussion of sustainability would be very different' (ibid., p. 15).
Furthermore, Blanchard’s indicators alone may not yield uniform conclusions across different countries. Positive values of the indicators may have different policy implications: in one country the current tax ratio may already be relatively high or in another the initial debt ratio may already be relatively high. The former would make it both economically and politically harder to raise taxes further; the latter implies a need for a larger and/or faster primary surplus adjustment.

Blanchard’s fiscal sustainability indicators may require projections of key variables, sometimes far into the future, which are often unavailable or highly uncertain. Finally, they are indicative of what is required for policies to stay, or to become, sustainable but it is worth noting that when the time for adjustment actually arrives, the constraints faced by the government may look different. For instance the indicators give the taxation adjustment needed to achieve fiscal sustainability today but if delayed, the required adjustment may be higher if debt ratio has increased, i.e. $b_0$ changes in (2.14) above.

Some of those limitations are grasped and accounted for by the author(s), and some of the limitations are also generic among the whole family of fiscal ‘constrained sustainability’ approaches. It is therefore revealing to stress Blanchard’s own interpretation that the indicators reflect a belief that the ‘issues of sustainability basically involve only accounting identities and the use of forecasts’ (Blanchard, 1990, p. 7).

**Buiter’s ‘permanent’ rules**

In a series of papers Willem H. Buiter developed a distinct method for fiscal sustainability analysis, which yet markedly belongs to the ‘constrained sustainability’ category. Many aspects of the fiscal stance are taken into account, so the resulting indicators reflect further-reaching concepts about a government’s policy mix. Yet it is the IBC, the deviations from it or the need to impose additional benchmark conditions that allow for Buiter’s indicators to be taken as exemplifying the more normative ‘fiscal constraints’ approach. The following discussion is based on Buiter (1990), Buiter (2003), Buiter (2004) and Buiter and Grafe (2004).
An intertemporal budget identity similar to the one specified in (2.10) above is arrived at in Buiter (1990). To turn that identity into a constraint, the familiar transversality condition of a zero terminal (net) debt is assumed. Buiter interprets that to be the constraint on solvency which the feasible fiscal, financial and monetary plans should satisfy.

The government may ex ante plan or project a sequence of policies which, if pursued effectively, will violate the solvency constraint: and then debt repudiation would have to restore the constraint ex post. Such a hypothetical deviation from the IBC is therefore to be the subject of fiscal sustainability assessment, and that has inspired Buiter’s ‘constrained sustainability’ approach. In Buiter’s framework, the role of the permanent fiscal indicators/variables becomes central.

The first such measure is about the ‘permanent deficit’, defined as a share of trend output as:

\[(2.17) \quad d^p = (r - \theta) (PVS - NW)\]

where \(r\) denotes the real interest rate and \(\theta\) is a notation for the real output growth rate as before, both currently expected/constant. \(PVS\) stands for the present value of the spending plans of the government (ibid., p. 68) and \(NW\) is the net worth of the public sector (ibid., p. 63). Buiter’s permanent deficit notion emphasises its measure as a ‘perpetuity equivalent or annuity value’ (ibid, p. 68) of the ex ante fiscal divergence: so (2.17) reveals an implicit recommendation to measure deficit in market-value terms. The concern of whether to value debt and deficits nominally or at some market price is an important issue in much of the fiscal sustainability literature, as will be seen later.

While Buiter admits that the permanent deficit will never materialise in reality and not even be ‘permanent’ per se, a constraint like (2.17) depicts the ‘permanent adjustment’ that must be made, to spending, to receipts, or to seigniorage, in order to achieve solvency’ (ibid, p. 68). Similar reasoning could be applied to the next two permanent fiscal sustainability indicators.

The first one defines the ‘constant net worth’ deficit as a share of trend output:
\[ d^* = G' - (r' - \theta)NW \]

whereas the second one defines the 'permanent income' deficit as a share of trend output:

\[ d^{**} = G - (r' - \theta)NW \]

Above, (2.19) differs from (2.18) only in that the long real rate, \( r' \), rather than the short one, \( r' \), is used. One of Buiter's interpretations of (2.19) is that it is constructed in an effort to smooth out expected time fluctuations of a varying short rate. But the ultimate argument behind the 'permanent income deficit' measure is that it concerns a current spending programme which mirrors the way households' consumption relates to households' permanent income. Thus basically the 'permanent income' deficit represents the deviation of government current spending from the constant highest possible sustainable spending\(^8\).

The deficit in both latter cases is again expressed as a ratio to output, and is priced as a perpetuity with the growth-corrected real interest rate. Unlike the 'permanent deficit' measure of (2.17), which merely reiterates the IBC and the permanent ex post consistency with it of public sector spending and revenues, the 'constant net worth' and the 'permanent income' fiscal deficits centre around additional constraints. These constraints are the following: either the net worth is kept constant (2.18) or the net worth is associated with the public sector's 'permanent income' (2.19). Unlike the 'permanent deficit' measure, the latter two rule out any changes in net worth that are expected to adjust the ex ante discrepancy in the intertemporal budget identity. Regardless of whether extra constraints are imposed or whether the inevitable future fiscal adjustments are stressed as in (2.17), the approach calls for a forward-looking and pro-active fiscal policy by the authorities. That is what justifies labelling Buiter's (1990) definitions 'constrained sustainability' ones.

Drawing on some of Buiter's earlier ideas, a 'permanent balance' rule is outlined in detail by Buiter and Grafe (2004). Initially appearing within the E(M)U context, its more general relevance and instructive features call for a separate discussion. Somewhat

---

\(^8\) Miller (1983) and Miller and Babbs (1983) are acknowledged to have proposed the application of the (familiar) permanent income approach to public-sector fiscal sustainability.
contrary to Buiter’s previous *permanent* measures, especially (2.18) and (2.19) above, which are implicitly rooted in a requirement to smooth out the *ex ante* IBC discrepancies through adjustments on the spending side, the ‘permanent balance’ rule allows for a much more flexible and rich set of adjustment paths.

A ‘permanent’ primary surplus-to-GDP ratio is defined first as ‘that constant primary ... ratio whose present discounted value is the same as the present discounted value of the actual (or anticipated) future sequence of primary surplus-GDP ratios’ (*ibid.*, p. 73). ‘Permanent’ counterparts to other indicators are then defined analogously: they are given as constants whose present discounted values equal the present discounted values of the actual/anticipated future sequences of revenues, expenditures, etc. So a ‘permanent’ version of an IBC is arrived at:

\[
(2.20) \quad b \leq \frac{s^p}{r^p - \theta^p} = \frac{\tau^p + \psi^p k^p - g^p_T - g^p_C + g^p_I}{r^p - \theta^p}
\]

The variables are expressed as ratios to GDP and the superscripts denote their ‘permanent’ nature. Correspondingly, \(s^p\) is the permanent primary surplus, \(r^p\) is the permanent long-run real interest rate and \(\theta^p\) is the permanent long-run output growth rate. Then \(\tau^p\) stands for the permanent total current revenues and is decomposed into the ‘permanent’ expressions for the gross financial returns on the public sector ‘capital stock’ (\(\psi^p k^p\)) and for other current revenues (\(\tau^p_C\)). Total permanent public spending is denoted by \(g^p\), which is in its turn decomposed into permanent transfers and subsidies (\(g^p_T\)), consumption (\(g^p_C\)) and capital formation (\(g^p_I\)). Essentially (2.20) sets the upper limit for the sustainable outstanding debt/GDP ratio, and as such it is a truly constraining fiscal rule.

Further manipulations of (2.20) yield a ‘permanent balance’ rule for the non-primary government deficit, again as a share of GDP (\(d^p\)):

\[
(2.21) \quad d^p \leq (\theta^p + \pi) + \psi^p k^p - v k + g^p_T - g^p_C + g^p_I + \tau^p + (\tau^p - r^p) - \theta^p]
\]

---

9 Appendix 2.B provides details about the derivation of equations 2.20 and 2.21.
where \( r' \) and \( \theta' \) are the short rates of interest and GDP growth, respectively, and \( \pi \) is as before the inflation rate. Pairs of variables in (2.21) denote deviations of actual from 'permanent' values. At first glance this 'permanent balance rule' seems to highlight the constraints for the general deficit, but looking at all possible dynamic combinations in (2.21) a great flexibility of this version of the IBC is revealed. The 'permanent balance rule' for the deficit clearly manifests that a higher debt/GDP ratio permits higher deficit: by which the rule is somewhat distinct from the family of rule-based fiscal sustainability indicators where the constraint takes a static form. In this sense, (2.21) contains a host of dynamic fiscal constraints.

The flexibility of (2.21) is due to the fact that it accommodates a number of different adjustment paths for the fiscal variables. Thus, the debt ratio may be reduced with output growth, but also the public sector deficit may safely without threatening solvency be increased with the size of the deviation of any component of public spending from its permanent level\(^{10}\).

The 'permanent balance' rule has the appealing facet to be fully compatible with the intertemporal dimensions of solvency constraints without sacrificing the options for more diverse financing and spending patterns. As seen from (2.21), a government may resort both to expenditures in excess of their permanent level and to raising the debt/GDP ratio without violating the 'permanent' version of the IBC. Additional collateral conditionality may always be imposed though.

The rule also allows the anti-cyclical automatic stabilisers to operate unrestrictedly. This point should be noted because fiscal rules per se may not necessarily induce counter-cyclical fiscal behaviour. Fiscal constraints limiting the size of debt and deficit may disallow public spending and transfer outlays intended to stimulate recovery, while at the same time being irrelevant to pressures during economic upturns for excessively expansionary fiscal policies eventually eroding public finances\(^{11}\). This seems not to be the case with the 'permanent balance' rule in (2.21).

\(^{10}\) To limit the risk of default which increases with the debt/GDP ratio, Buiter and Grafe (2004) further 'augment' the 'permanent balance' rule.

The ‘permanent balance’ rule represents a coherent and more meticulous endeavour to reconcile the IBC-rooted solvency and fiscal *prudence* with flexibility. Yet its conceptual attractiveness does not conceal the practical difficulties in applying the rule. Like the first of Buiter’s ‘permanent’ rules, it requires projections and/or long-term counterparts for a whole set of fiscal and other variables. The ‘permanent’ fiscal values are not directly empirically observable, hence constructing quantitative indicators based on Buiter’s rules may require not merely projections but also some form of public commitments to follow certain policies, e.g. about expenditures.

*From theory to practice: Maastricht and Stability and Growth Pact rules*

The rules of Blanchard and Buiter are based on the IBC framework augmented by various auxiliary conditions. They focus on the specific adjustments advocated *ex ante*, hence their classification within the ‘constrained sustainability’ strand of literature.

Independently, there have emerged important practical examples of ‘constrained sustainability’ in the fiscal area. The following discussion aims to address neither the controversies around the existing fiscal rules in Europe nor the vast literature and practices of fiscal rules in general. The intent is rather to relate them to the fundamental logic of the IBC and the notion(s) of fiscal solvency and sustainability.

The Stability and Growth Pact (SGP) was adopted in 1997 by the European Council to underline ‘the importance of safeguarding sound government finances’. Legally, the SGP consists of three ‘pillars’. The first one, concerning the political commitments, is in the Resolution of the European Council on the Stability and Growth Pact signed in Amsterdam on 17 June 1997 (Resolution 97/C 236/01). The second and third ‘pillars’ concern the preventive and the dissuasive elements respectively and are in two further Council regulations: Council Regulation 1466/97 on the strengthening of the surveillance of budgetary positions and the surveillance and coordination of economic policies, and Council Regulation 1467/97 on speeding up and clarifying the

---

12 The area of *fiscal rules*, including those not originating directly from an IBC, calls for research on its own. For an extensive overview of the reasoning behind and the practical performance of fiscal rules see Kennedy and Robbins (2001), OECD (2002), and more recently Debrun, Moulin, Turrini, Ayuso-i-Casals and Kumar (2008). More examples of fiscal rules in practice are presented below.
implementation of the excessive deficit procedure. The two regulations were amended in mid-2005 (by Regulation 1055/2005 and Regulation 1056/2005).

The major SGP fiscal constraint is summed up by the Council in the statement that ‘adherence to the objective of sound budgetary positions close to balance or in surplus will allow all Member States to deal with normal cyclical fluctuations while keeping the government deficit within the reference value of 3 percent of GDP’ (Resolution 97/C 236/01). The Resolution makes it clear that the provisions of the SGP do not amend the requirements laid down in the Maastricht Treaty regarding participation in the third stage of the EMU but try to enhance the budget discipline in that final stage of the monetary union through the avoidance of excessive deficits.\(^\text{13}\)

Not amending the Maastricht Treaty means adhering to the two reference values described in the Protocol on the excessive deficit procedure annexed to the Treaty: the 3 percent for the ratio of planned or actual government general deficit to gross domestic product at market prices, and the 60 percent for the ratio of government debt to GDP at market prices. It is gross rather than net debt that is referred to in Article 2 of the Protocol on the excessive deficit procedure. Inasmuch as the SGP is focused on the deficit and not on the debt criterion, it may be argued that the former plays a dominant role in EU’s perception of fiscal sustainability once the monetary union starts to function (Article 1 of Regulation 1467/97). Buiter and Grafe (2004, p. 89) also infer that the debt criterion applies to full-EMU candidates (i.e. those in stages one and two), but does not apply to existing EMU members or EU members with the ‘EMU-opt-out clause’ (the United Kingdom and Denmark)

Thus the Maastricht Treaty and the SGP taken together contain two clear-cut fiscal rules or legislated fiscal constraints. Two sets of arguments could be put forward to assess the relevance of E(M)U’s rules to the conceptual framework for fiscal sustainability as discussed here. First, a review of the historical ‘heritage’ for the rules may yield an indirect clue about the extent to which they are intended to safeguard fiscal sustainability. Second, a formalisation of the rules and their direct comparison to some IBC-compatible representation used above may provide further insights.

\(^{13}\) The Maastricht Treaty is more formally known as the Treaty on European Union, signed on 7 February 1992.
As contended by Buiter and Grafe (2004), the Maastricht Treaty and the SGP do not expressly explain why those exact fiscal targets were selected. Historical data and comparisons are often taken as an informal explanation for the concrete values. Starting with deficits, the initial 12 full-member Euro area had an average deficit exceeding the 3 percent reference value for over a decade prior to 1992, the year of the Treaty (HM Treasury, 2004, p. 14, chart 3.1). The EU12 and EU15 average public deficits were below 3 percent for the first time in 1997, the year of the adoption of the SGP, and have remained below 3 percent ever since, though with a deteriorating trend since the year 2000\textsuperscript{14}. The latter fact is sometimes interpreted as a sign of the fiscal discipline imposed by the Pact. Nevertheless, no historical reference for the 3 percent deficit ceiling, prior to its formulation, exists.

Another explanation relates the deficit criterion to the ‘golden rule’ featuring in the German constitution, according to which public deficit should not go over public sector investment. For the twenty years before the Maastricht Treaty, public sector investment averaged 2.3 percent of GDP in Germany (Buiter and Grafe, 2004, p. 90). Considering that country’s reputation for sound fiscal performance and its role in shaping up the EMU, such explanation may be plausible yet it does not reveal any more formalised theoretical foundation for the deficit constraint.

Similarly, the question of why an exactly 60 percent reference value for the general government gross debt/GDP ratio has been imposed does not elucidate much the fiscal sustainability implications of the debt constraint. For the years just preceding the Maastricht Treaty the average debt/GDP ratio for the Euro area was below 60 percent (HM Treasury, 2004, p. 14, chart 3.1). For the debt ratio it does not appear this time that the Treaty and SGP have performed a stabilising and disciplining role. In fact, the debt ratio was going up starting from 1992 and subsequently breached the reference value of 60 percent. Gross debt to GDP in the Euro area was 70.8 percent in 2003 and 71.3 percent in 2004 (EC, 2005, Table I.3, p. 24). The EU as a whole performed only slightly better (see Table 4.2 in Chapter Four).

While ‘historical’ explanations for the Maastricht Treaty/SGP fiscal targets are of little value in justifying how they improve fiscal sustainability, some credit could be given if

\textsuperscript{14} The Euro area had a public balance of -2.8 percent in 2003 and -2.7 percent in 2004 (not cyclically adjusted numbers; source: EC, 2005, Table I.2, p. 23; also see Table 4.1 in Chapter Four).
the rules can possibly be related to the solvency/sustainability constraints outlined earlier. One such instance may be sought in the constraint of (2.8) above. Assuming stabilisation of debts (i.e. \( b_t = b_{t-1} \)) and deficits (i.e. \( d_t(1+\theta) = d_t \)), with output level in every next period equal to initial output times \((1+\theta)\), and if as in (2.7) \( r \approx i - \pi \) when both \( i \) and \( \pi \) are small, (2.8) results in:

\[
(2.22) \quad b = \frac{d + ib}{(\pi + \theta)}
\]

if the seigniorage term \((dm_t)\) in (2.8) is omitted for simplicity. In (2.22) there are no time subscripts under the assumptions for stable debt and deficit ratios and constant rates of inflation, nominal interest and output growth. Thus if one expects an E(M)U member country to have a debt ratio of 60 percent, an inflation rate of 2 percent (the annual target ceiling of the ECB) and a real growth rate of 3 percent, then the identity in (2.22) requires a non-primary deficit of 3 percent. Such a steady-state relationship may over-optimistically rely on a real average and constant growth rate of as high as 3 percent per annum but is surely compatible with a solvency budget constraint.

A more direct assessment of the extent to which the constraints of Maastricht/SGP comply with fiscal sustainability criteria is obtained when they are formalised algebraically. As in Buiter (2003), the deficit rule is decomposed into:

\[
(2.23) \text{General deficit rule} \quad d^F = d + ib \leq 0.03
\]

\[
(2.24) \text{Medium-term balance rule} \quad d^M = d + i\pi b \leq 0
\]

where the subscripts denote cyclically adjusted variables and \( d^F \) is the total deficit. (2.23) is to capture the 'cyclical fluctuations while keeping the government deficit within the reference value of 3 percent of GDP' and (2.24) corresponds to the notion of 'close to balance or in surplus'.

From (2.22) it follows that \( \Delta b = 0 = d + ib - (\pi + \theta)\), hence from (2.24) Buiter's (2003) expression for the medium-term change in the debt ratio is:

\[
(2.25) \quad \Delta b_c = d^M - (\pi_c + \theta_c)b
\]
with the subscripts denoting cyclically adjusted variables as before. The cyclically adjusted change in debt over some period equals the cyclically adjusted general deficit for that period minus the decline of the debt ratio caused by the cyclically adjusted nominal GDP growth.\footnote{(2.25) corresponds exactly to equation 12 in Buiter (2003, p. 88).}

As the deficit from (2.24) is used, and with a positive real rate of output growth $\theta$ and positive initial value of debt, in (2.25) the debt/GDP ratio will fall steadily in the medium term. That is why the Maastricht Treaty/SGP deficit rule ‘virtually ensures government solvency’ (Buiter, 2003, p. 88). A medium-term non-increasing, and indeed falling, debt ratio is also compatible with the asymptotical convergence towards zero from the transversality condition for fiscal sustainability in (2.11).

Moreover, the non-increasing debt ratio poses an extra constraint on fiscal policy. It is revealing to underline at this point that the falling debt ratio implied by (2.25) is an even more rigid policy requirement than the nominal debt rule, algebraically expressed as $b \leq 0.6$. Hence, this would suggest that it is reasonable to classify the Maastricht/SGP fiscal criteria within the family of ‘constrained sustainability’ rules.

The UK budgetary rules

UK fiscal policy in the last decade has evolved along the lines of the two fiscal rules which the Chancellor of the Exchequer self-imposed in June 1998 in the Code for Fiscal Stability: the ‘golden rule’ and the sustainable investment rule. Under the first rule, the government is allowed to borrow only to fund investment, but not current spending. That means that tax revenues should at least equal current (non-investment) expenditures. Under the second rule, government’s net debt should not exceed a ‘stable and prudent’ ceiling. Currently that ceiling is set at 40 percent of GDP.

The golden rule concerns cyclically adjusted borrowing, i.e. it should be observed as an average over the economic cycle. That allows for more flexibility: namely, that makes the rule compatible with the operation of automatic fiscal stabilisers. If the rule were to be met uniformly with every budget, the government may for example need to raise taxes in economic downturns when the deficit could have widened up due to lower tax
revenues and higher fiscal spending on unemployment benefits. But by doing so the government would aggravate the deterioration in the fiscal stance and in the economy as a whole. The flexibility of the golden rule and the fact that it does not interfere with automatic fiscal stabilisers are praised as its major advantages (Chote and Emmerson, 2005, and the ‘fifth commandment’ in Buiter, 2003).

Another positive feature of the golden rule is that it aims to limit the tax burden on future generations. The government may incur additional public debt only as long as it finances investments from which future as well as current generations are likely to benefit. That was emphasised by its authors as the ‘principle of fairness’: one of the formal principles laid down in the Finance Act of 1998 and in the Code for Fiscal Stability, approved by the House of Commons in December 1998. But it is important to distinguish between current and capital spending (HM Treasury, 1998). The golden rule is intended to curb the frequent proclivity for cutting public investment spending first (Servén, 2005) when fiscal tightening is undertaken: a practice eroding an economy’s growth potential and jeopardising future fiscal sustainability.

The sustainable investment rule is also to be met over the economic cycle, thus allowing for a breach of the 40 percent ceiling net debt ratio during cyclical downturn. The cyclically adjusted allowance for higher debt represents, similarly to the golden rule, an opportunity for the smooth operation of automatic fiscal stabilisers. Without cyclical adjustment, a forced reduction of public debt would engineer an overall deficit reduction as hinted by (2.22) above, which might further exacerbate an economic decline.

The sustainable investment rule imposes a straightforward bound on government debt and therefore seems fully compliant with a solvency constraint: hence, ensuring fiscal sustainability. Moreover, as the criterion involves net debt, the rule is more binding than the SGP debt rule: 40 percent net debt ratio may be lower than 60 percent gross ratio (Emmerson, Frayne and Love, 2001, p. 2). Imposing an extra constraint on the path of debt also justifies the discussion of the sustainable investment rule as further illustrating the ‘constrained sustainability’ approach to fiscal policy.
Whether the UK golden rule also guarantees solvency and the extent to which it imposes any further limitations to the IBC, is less clear intuitively. Using previous notation, the golden rule may be given as:

\[(2.26)\]
\[d^c_e - g^c_e = d_e + i_e b_e - g_e \leq 0\]

where \(g^c_e\) stands for cyclically adjusted public sector capital spending. If the government is allowed to borrow only to fund investment expenditures, then over the cycle the current general budget should be balanced or in surplus. Now applying (2.26) to (2.24) and (2.25) results in:

\[(2.27)\]
\[\Delta b_e = d_e + i_e b_e - (\pi + \theta) b_e \leq g^c_e - (\pi + \theta) b_e\]

That is, the cyclically adjusted increase in the debt ratio is bounded by the difference between the capital spending ratio and the reduction effect of inflation and real growth rates on the debt ratio. As long as \(\pi\) and \(\theta\) remain positive, public sector capital spending becomes the variable to watch: if it is too high, the debt ratio may correspondingly grow too much and thus, other things being equal, the risk of future unsustainability will be higher. In practice, however, the share of government investment in GDP will hardly be kept too high. Thus in practice (2.27) implies that debt is again constrained by some upper ceiling; hence solvency is secured. As with the SGP deficit criterion, a conclusion could be drawn that the UK golden rule imposes an additional constraint on public finances. Regardless of whether it asymptotically converges to zero, or some other limit value, the cyclically adjusted debt ratio is bounded not to increase much even in the medium term. Although the precise limit to debt increase is not revealed directly by (2.27) because it is contingent on \(g^c_e\), its existence could be interpreted as strengthening the IBC. Hence the UK golden rule also exemplifies the ‘constrained sustainability’ approach.

The UK fiscal rules are subject to criticism too. Buiter and Grafe (2004) indicate that a representation like (2.27) disguises the fact that more capital investment is required with the higher GDP growth rate, if the capital/output ratio is to be sustained. The latter will partly offset the otherwise (with \(\theta\) going up) increased permissible debt level. Buiter and Grafe alternatively propose an inflation-and-real-growth-adjustment restatement of the cyclically adjusted golden rule.

\[16\] This discussion is partly inspired by Buiter (2003).
Emmerson et al. (2001) suggest more basic reasons to doubt the precision of the UK fiscal rules. They are concerned with the arbitrariness of selecting the exact limit value of 40 percent in the sustainable investment rule: the government 'could just as easily have chosen 38% or 42%' (ibid., p. 2). More recently public attention was alerted to the controversies surrounding the very definition of public sector debt, after the government decided to exclude the liabilities of the nationalised Northern Rock from the calculation of debt in the 2007/08 budget. As for the golden rule, doubt is cast about the economic rationale when distinguishing between current and capital spending in the way currently done under the National Accounts conventions. A further critique of the UK fiscal rules is contained in Buiter (2001), Calmfors and Corsetti (2003) who object to 'golden rules' in general, and Servén (2005). Thus the UK fiscal rules are not the perfect tool for assessing the fiscal stance in general and fiscal sustainability in particular.

*Further examples of fiscal rules*

The literature on fiscal rules is vast and growing. Whereas a complete review of fiscal rules in both theory and practice is certainly outside the scope of the current research, a brief outline of more currently existing rules and their relation to the concept of fiscal sustainability will facilitate the concluding assessment and provide more insights into what was termed the 'constrained sustainability' group.

Examples of fiscal rules are found in Germany, Sweden, Poland, the United Stated, Canada, Chile, Japan, New Zealand and other countries (Kennedy and Robbins, 2001, and OECD, 2002, especially Appendix table IV.A.1). Fiscal rules may relate to practically manageable concrete indicators or to more general guidelines or regulations (Fiess, 2004).

A common characteristic is that the rules constrain certain fiscal variables, such as the budget balance, the public sector net worth or debt, in an effort to boost fiscal stability, ensure longer-term fiscal sustainability and enhance the credibility of the government. Some of the rules are explicitly aimed at curbing the procyclical bias of fiscal policy by being defined in structural terms, as in Chile. The exact numerical targets, where
existing, may be legislated or determined on an *ad hoc* basis according to pre-legislated or publicly committed policy principles, as in New Zealand.

While the rules are enforced in countries where medium-term fiscal solvency is not necessarily a concern, and while the IBC is always satisfied *ex post*, a common denominator for the fiscal rules in question here is the introduction of verifiable indicators *constraining* the sustainable policy options. Such indicators are derived either directly from fixed numerical targets (Poland’s 60 percent limit of total public debt/GDP ratio), or from commitments that may easily be expressed as algebraic fiscal relations (Germany’s golden-type rule for balanced current federal budget).

Recently Debrun *et al.* (2008) review the national fiscal rules in the EU countries with a focus on such rules which ‘fix targets or ceilings to budgetary aggregates expressed in numerical terms’ (*ibid.*, p. 301). The operational definition of numerical fiscal rules is adopted from Kopits and Symansky (1998, p. 2): ‘a permanent constraint on fiscal policy, typically defined in terms of an indicator of overall fiscal performance’. Following this definition Debrun *et al.* (2008) identify a growing number of fiscal rules in the EU: from 13 in 1990 to 57 in 2005. Out of the 25 EU members surveyed only Greece, Cyprus and Malta have no rules conforming to the above definition.

In the year 2005, thirty-three of those rules were stipulated in law or constitution while twenty-four were based on political commitment. According to Debrun *et al.* (2008, p. 342) ‘in the early 1990s, most numerical fiscal rules were applied at local or regional levels of government, while rules at the general and central government sector were introduced more recently’. Twelve numerical rules are documented at the general government level in 2005 and five of them are provided for in a legal act or constitution. The national numerical fiscal rules in the EU are shown to have encouraged higher cyclically adjusted primary balances. The effect is weaker when the change in debt rather than the fiscal balance is the variable to be explained by the fiscal rules in the econometric tests performed by Debrun *et al.* (2008).

In summary, the fiscal rules imply that some additional fiscal constraint is deemed necessary to guide policy-makers through the indispensable fiscal adjustments, if any. Those constraints justify defining all existing fiscal rules as pertaining to this more
forward-looking and normative approach to fiscal sustainability: diverse as they are, with or without numerical targets, legislated or not.

**Back to theory: recent quests for fiscal sustainability indicators**

Parallel to existing fiscal rules in practice, there are further theoretical proposals for fiscal sustainability indicators, besides the seminal ones of Blanchard and Buiter. Such proposals are again united by a desire to have fiscal targets which are not only easily verifiable and enforceable, but are more rigid than what believing in some ‘self-fulfilling’ fiscal solvency implies. The ‘constrained sustainability’ strand may be illustrated by more recent examples of specially constructed, and sometimes empirically tested, indicators.

Sustainability is at the core of much of IMF’s work particularly with respect to emerging markets. The broad experience of the IMF staff in dealing with various aspects of fiscal, but also external and financial-sector, sustainability is outlined in IMF (2002), where suggestions for a more unified cross-country assessment framework are put forward. This framework comprises two sets of indicators: one for external sustainability and one for public-sector debt sustainability. They partly relate to the concepts of fiscal sustainability broadly defined so far, like for instance the ‘indicative threshold’ approach presented about the level of debt at which stabilisation is required (IMF, 2002, Appendix 1).

Whereas IMF (2002) focuses on selected indicators concerned primarily with debt, IMF (2003) contains somewhat more comprehensive approaches to fiscal sustainability, particularly for emerging economies. The result is again, generally speaking, ‘threshold’ indicators. Three methods are applied in the IMF (2003) study. First, calculations about a debt-stabilising primary balance are done. This approach is close to the ideas of Blanchard and Buiter. Second, based on more formal statistical modelling, the relationships between fiscal policy instruments and fiscal targets are explored. Thus, setting the primary balance as an operational target, the study estimates fiscal policy reaction functions on past performance to conclude that the sustainable debt/GDP ratio for a typical emerging market economy is only about 25 percent. Third and perhaps most evidently related to the IBC concept, the study deals with the issue of whether
current debt stocks exceed the present discounted values of future primary surpluses: that is, whether governments over-borrow. The latter involves calculating a benchmark level of debt and then comparing it to the actual debt. That justifies the inclusion of IMF (2003) in the group of ‘constrained sustainability’ works as it recommends specific fiscal adjustments.

Mendoza and Oviedo (2004) propose a complete probabilistic model of sustainability. The model evolves around the ‘credible repayment commitment’: that the government is able to repay its debt in every state of nature. The debt limit (the ‘natural debt limit’), over which borrowing is not allowed, is self-imposed by the government. The ‘natural debt limit’ as the authors point out is similar to the trivial long-run transversality condition (ibid., p. 15) but it also accounts for uncertainty in the determinants of the fiscal balance and of debt. The model considers the volatilities in the revenues and GDP growth series. The debt limit implicitly acknowledges the practical limitations a government faces in servicing its debt, as opposed to relying on debt only asymptotically converging to zero; and the very fact of proposing debt limits is a feature of the constraints-related fiscal sustainability literature. The ‘constrained sustainability’ approaches may be about limits as well as about values on which fiscal variables are targeted to converge.

Recently Polito and Wickens (2005) proposed an index of fiscal sustainability derived directly from the IBC. The index basically computes the ratio between the forecast present values of future primary balances and existing debt. For the forecast, a VAR model of the economy is constructed, allowing also for changes in policy. If the index is less than unity, a change in the fiscal stance is required, hence the ‘constrained sustainability’ emphasis. The comprehensiveness of the model, like the opportunity to incorporate changes in the policy regime, and finite as well as infinite horizons, do not preclude drawing certain relatedness to Blanchard’s and Buiter’s rules presented earlier.

Such succinct outline of some sustainability indicators far from exhausts the ever-growing appetite for constructing a wide range of sustainability indicators. Different indicators are designed to address specific aspects of fiscal sustainability and/or to overcome existing deficiencies in areas of fiscal sustainability analysis. A limited selection of more examples would include the debt-relief and concessional-lending
effects on debt sustainability in Edwards (2003), the value-at-risk approach in Barnhill and Kopits (2004), the recursive fiscal sustainability indicator in Croce and Juan-Ramón (2003), the choice of indicative debt-burden thresholds within an operational framework for assessing debt sustainability in low income countries in IMF and IDA (2005), and the alternative dynamic-stability sustainability indicators in Bagnai (2004). It is fair to note, however, that the analysis of fiscal sustainability in emerging markets and low-income countries is usually equivalent to an analysis of debt, and especially external debt, sustainability, often without explicitly referring to any IBC.

The examples until now are meant to highlight a common feature: that they essentially try to introduce additional, and quantifiable, fiscal sustainability points of reference, or targets. Those are meant to guide government policies towards achieving fiscal sustainability, instead of ‘passively awaiting’ the ex post inevitable realisation of the IBC.

Some of the sustainability indicators just discussed have been justified through a number of formal statistical tests, unlike many of the fiscal ‘rules of thumb’. This discussion, therefore, is a convenient starting point before proceeding towards the second major approach to fiscal sustainability analysis: the more backward-looking ‘statistical tests’ approach. Not necessarily yielding additional rules or constraints, and so fundamentally differing from the ‘constrained sustainability’ strand, the statistical tests approach is reviewed in section 2.3.

2.3. The ‘statistical tests’ approach

Besides the various methods grouped as ‘constrained sustainability’ in section 2.2., the fiscal sustainability theory and empirical literature have evolved since the mid-1980s into a second and quite distinct strand of their own. The core feature of that body of literature is that it utilises a number of econometric tools to develop a purely statistical framework for testing sustainability, drawing inferences about past fiscal performance in an essentially backward-looking way. Unlike the fiscal sustainability notions above, even in those cases where formal statistical tests are employed, this second approach does not impose extra constraints on the IBC. Neither does it yield specific policy recommendations regarding adjustments about the future evolution of the fiscal stance.
Based on historical data and focusing explicitly on assessing the past fiscal stance, the normative forward-looking implications of the 'statistical tests' approach are negligible, in sharp contrast to the 'constrained sustainability' framework.

**The rationale behind statistical tests for sustainability**

A recurring theme in fiscal sustainability analysis is that the IBC is always satisfied *ex post*. Buiter (1990, pp. 67-68) asserts that either changes in spending, in revenues, in seigniorage, or debt repudiation (insolvency), would necessarily occur in order to satisfy the government’s intertemporal constraint. Then the first question to ask is: what is the meaning and the purpose of statistically assessing fiscal sustainability? What is the rationale of testing a constraint which always holds in the end, and even not necessarily through debt repudiation? A constructive answer would highlight the essence of the 'statistical tests' method.

Cuddington (1997, p. 10) touches upon this question. He tries to set the subtle delineation between sustainability and solvency, the latter related to the ‘given value of current debt’. Cuddington (1997) in the end concludes that the statistical tests should be viewed as tests of sustainability, not as solvency tests.

If as previously defined, fiscal sustainability amounts to the government being capable of continuing its current policy mix in the indefinite future without threatening solvency, the statistical tests are used to prove whether that is indeed the case. When the sequence of fiscal variables from the past, if supposed to be continued into the future, suggests to be satisfying an intertemporal present-value constraint regarding current debt as literally in (2.12) above, then fiscal policy is deemed sustainable and no changes in it are needed.

However, because the statistical tests are all based on past time series of debts and fiscal balances or their components, the focus on *current* debt may not matter much for empirical purposes. The ‘statistical tests’ approach acknowledges that, based on past performance, *generally* fiscal changes may in the future be required to keep solvency
No targets are designed or implied for debts or deficits, unlike in the 'constrained sustainability' approach. Future debt may not be stabilised, just like it has not been stabilised in the past, and fiscal policy may still be sustainable.

Though signalling the need for changes, the *backward-looking* statistical tests do not provide key policy guidance such as about the size of the fiscal adjustments required, their timing, or the degree of associated economic, social or political costs if default is to be avoided. That contrasts this approach with methods akin to the previous literature strand where even statistical forecasts could be made to derive sustainability targets, as for Blanchard's indicators and in Polito and Wickens (2005).

Similar reasoning can be applied to the earlier statistical tests. The research methods there invariably reflect a form of understanding of fiscal sustainability resembling the one just described. For instance, Ahmed and Rogers (1995, p. 352) admit both that the IBC should always hold *ex post* and that for shorter time series there may be deviations from the IBC: so 'using a long span of data is appropriate in assessing whether the conditions implied by intertemporal budget constraints are met, because these conditions are only required to hold in the long run'. But any past time series may be *shorter* than 'the long run'. That indirectly confirms the rationale behind the 'statistical tests' approach: assessing fiscal sustainability on the assumption that past policies are kept unchanged and the fiscal sequences are continued into the future.

**Hamilton and Flavin's (1986) basic framework**

The work of Hamilton and Flavin (1986) is generally recognized as the genesis of what is termed for the purposes here the 'statistical tests' approach. Their seminal paper is widely cited in that body of literature where the time series properties of past fiscal data are tested. Their approach has inspired theoretical extensions, key examples of which are presented further below.

Hamilton and Flavin's (1986) pioneering contribution is at the same time quite revealing as an interpretation of what 'testing' the IBC means. Interestingly, Hamilton

---

17 Statistically analysing the distinctive 'responsibility' of decreased revenue or increased spending for past fiscal deficits and adjustments is another concern: see Bohn (1991a) or Crowder (1997) among the early literature.
and Flavin (1986), while proposing an empirical framework for testing the intertemporal constraint, do not rule out a possibility that 'government deficits ... need not be balanced with future surpluses' (ibid., p. 811) but may be balanced with continually issuing new debt. It is that alternative hypothesis they test: for them a violation of the IBC from historical data would just mean that the government has chosen the alternative fiscal path, leading to perpetual debt financing. That has motivated some analysts to claim that, 'paradoxically', Hamilton and Flavin (1986) never regarded their own tests as sustainability tests (Vieira, 1999, p. 30, fn. 27). Later Wilcox (1989, p. 294) patently opposes such a view, stating: 'By contrast, I regard the necessity of the present-value borrowing constraint in a dynamically efficient economy as established on theoretical grounds'.

Hamilton and Flavin (1986) begin with the following formalisation:

\[(2.28)\]
\[B_t = (1+r)B_{t-1} + D_t + V_t\]

where, in addition to the familiar notation, \(V_t\) comprises one term for the effect of government bonds excess returns and two error terms accounting for 'the issue of intraperiod timing' (ibid., p. 810). Seigniorage is incorporated into the deficit this time. In (2.28) \(r\) is the \textit{ex post} average real interest rate on one-period government bonds. By forward recursive substitution of this specification of the familiar \textit{flow} budget constraint the following \textit{life-time} budget constraint is derived:

\[(2.29)\]
\[B_t = \sum_{i=t}^{\infty} \frac{D_i + V_i}{(1+r)^i} + \frac{(1+r)^t B_N}{(1+r)^N}\]

Clearly (2.29) resembles (2.10) above, in that the current debt is related to sequences of future debts and fiscal balances. The important distinction now is that variables are not scaled in terms of GDP. Hence the no-Ponzi game condition is equivalent to:

\[(2.30)\]
\[E_t\left[\lim_{N \to \infty} \frac{B_N}{(1+r)^N}\right] = 0\]

where \(E_t[\cdot]\) denotes creditors', i.e. government debt buyers', expectations based on information available at \(t\). Hamilton and Flavin view (2.30) as the null hypothesis to test for an IBC, whereas the alternative hypothesis is equivalent to:
where \( A_0 \) is a constant. Thus (2.29) is transformed as:

\[
B_t = E_t \left[ - \sum_{i=1}^{\infty} \frac{D_i + V_i}{(1+r)^i} \right] + A_0 (1+r)^t
\]

which makes it possible to re-state the null hypothesis of no-Ponzi debt financing as the restriction \( A_0 = 0 \), thus conveniently yielding it to statistical testing. That is the approach by Hamilton and Flavin who, inspired by an analogous modelling of speculative asset bubbles in Flood and Garber (1980), use an empirically testable counterpart to (2.32):

\[
B_t = E_t \left[ - \sum_{i=1}^{\infty} \frac{D_i}{(1+r)^i} \right] + A_0 (1+r)^t + \varepsilon_t
\]

Above, \( \varepsilon_t \) stands for a regression disturbance term. The authors adjust the officially reported debt and deficit series prior to applying the Dickey and Fuller (1979) test for unit roots. The key idea is that if the disturbance term and the sequence of the first term in the right-hand side of (2.33) are stationary processes, \( B_t \) will also be stationary when the null hypothesis of \( A_0 = 0 \) above is not rejected: whereas \( B_t \) will not be stationary if \( A_0 > 0 \) cannot be rejected. Following such a test, Hamilton and Flavin conclude that the hypothesis of non-stationarity of debts and deficits (surpluses) can be rejected, and therefore the budget in 1960-1984 has been balanced in keeping with a present-value constraint.

Hamilton and Flavin (1986, p. 816) propose a complementary statistical test for \( A_0 \). They start with focusing on the first term in the right-hand side of (2.33). Assuming that expectations of future deficits are partly conditioned on past deficits and if lagged debt is also included ‘to eliminate the serial correlation of the resulting error term’ the testable equation becomes:

\[
B_t = c_0 + A_0 (1+r)^t + c_1 B_{t-1} + \ldots + c_p B_{t-p} - b_0 D_t - b_1 D_{t-1} - \ldots - b_{p-1} D_{t-p+1} + \varepsilon_t
\]

where \( \varepsilon_t \) is a residual from the projection of the error term plus the first term on the right-hand side of (2.33) on past levels of surplus and debt, and on a constant. OLS estimation is done on (2.34) for Hamilton and Flavin’s data and the estimate for the
coefficient $A_0$ turns out not to be statistically significant (and is even negative). The no-
Ponzi condition of (2.30) is empirically supported, hence fiscal policy over the observed period is found to be sustainable.

That pioneering approach to test fiscal sustainability statistically has later been challenged. Thus Kremers (1988) argued that the original test was invalid because of significant first-order autocorrelation and he re-specified the nonstationarity test by adding a second lagged dependent variable. Wilcox (1989) pointed out that the tests of Hamilton and Flavin (1986) are limited in their assumptions of a constant real interest rate, a constant for the violation of the IBC (the $A_0$ above) and the condition that the surplus series be stationary. Kremers (1989) suggested that the time span of Hamilton and Flavin's empirical tests may have been too short to yield plausible long-run stationarity implications for the debt and deficit/surplus series. Kremers (1989) also went further to propose an alternative dynamic econometric modelling, based on Barro (1979), with a supposedly better power to assess sustainability; a similar alternative was later taken by Bohn (1998). And the question of the need to model breaks endogenously has been raised too (Tanner and Liu, 1994, and Quintos, 1995).

Nevertheless, the empirical framework proposed in 1986 by Hamilton and Flavin has boosted the empirical research into fiscal sustainability. Their model, and sometimes their data measurement conventions and the data set, benchmarked the subsequent extensions of the statistical tests. Alternative yet invariably related time-series approaches have come up. The following sections briefly present the theoretical findings from some landmark papers that have contributed most to the design of the 'statistical tests' approach to fiscal sustainability. Those papers remain seminal among even the most recent empirical studies summarised in the first appendix to this chapter.

**Seminal works in the 'statistical tests' approach**

Trehan and Walsh (1988), using a much longer data span of US annual observations from 1890 to 1986, provide an early extension of empirical work to incorporate the then recent breakthroughs in the theory of cointegration. Another distinction from Hamilton and Flavin's approach is the focus on the deficit process *inclusive* of interest payments. The one-period budget constraint equation, used as the building-block for the model by
Trehan and Walsh (1988), resembles the levels specification of (2.3) above. Taking expected values for the variables, it is solved forward to result in:

\[(2.35)\]

\[B_t = -E_t \left[ \sum_{j=0}^{\infty} (1+r)^{-j-1} (G_{t+j} - T_{t+j} - \varphi_{t+j}) \right] + \lim_{j \to \infty} E_t [(1+r)^{-j} B_{t+j}]\]

In (2.35) the familiar notation is followed for denoting debt, whereas \(G\), \(T\) and \(\varphi\) respectively stand for government expenditures net of interest, tax revenues and one-period seigniorage proceeds. All variables are real and in levels and subscripts denote time. The real rate of interest \(r\) is assumed to be constant. The no-Ponzi game condition, constraining a government trying to roll-over debt continuously, is thus:

\[(2.36)\]

\[\lim_{j \to \infty} E_t [(1+r)^{-j} B_{t+j}] = 0\]

so that the currently outstanding stock of debt would have to be financed fully by the expected discounted value of future primary surpluses including seigniorage. Trehan and Walsh (1988) then proceed to derive the restrictions on \(G\), \(T\) and \(\varphi\) necessary in order to satisfy the IBC with (2.36), by specifying the dynamics of a vector \(X'_t = (G'_t, T'_t, \varphi'_t)\) so that:

\[(2.37)\]

\[
\begin{bmatrix}
(1-L)G'_t \\
(1-L)T'_t \\
(1-L)\varphi'_t
\end{bmatrix} = (1-L)X'_t = \mu + C(L)e_i
\]

Above, \(L\) is the lag operator, \(\mu\) is a 3x1 vector of constants, \(C(L)\) is a 3x3 matrix of polynomials in \(L\), and \(e_i\) is a 3x1 white-noise sequence vector. The matrix \(C(L) = \sum_{j=0}^{\infty} C_j L^j\) is assumed to be square summable and normalised, so that the first-differenced process \(X'_t\) is covariance stationary (following Hamilton, 1994, Appendix 3.A.). Indeed, the model assumes that tax revenues, seigniorage and expenditures are nonstationary in levels but their first differences are stationary.

If a new vector \(a' = (1-1-1)\) is defined, then \(a'X'_t\) describes exactly the primary deficit process, the first-difference dynamics of which following (2.37) is given by:
Trehan and Walsh (1988) use (2.38) to derive the restrictions on \( G, T \) and \( \varphi \) necessary for (2.36). Those restrictions are in their turn proved to imply stationarity of the first difference of the stock of debt, \((1 - L)B_0\). Because the converse also holds, i.e. stationarity of the first-differenced debt implies that (2.36) is satisfied, then stationarity of the first difference of the debt stock turns out to be both necessary and sufficient for a sustainable fiscal process.

But the flow budget constraint (2.4) shows that the first difference of debt equals primary deficit, inclusive of seigniorage in the framework of Trehan and Walsh, plus interest payments on previous-period debt. That makes it possible to end up with four equivalent necessary and sufficient conditions for fiscal sustainability:

- When the first difference of the stock of debt is stationary.
- When the deficit (inclusive of interest payments) is stationary.
- When the stock of debt and the primary deficit are cointegrated with a cointegrating vector \((r, 1)\).
- When the expenditures (but including interest payments), tax revenues and seigniorage are cointegrated with a cointegrating vector \((1, -1, -1)\).

Trehan and Walsh (1988) applied that theoretical framework to assess fiscal sustainability over their sample period for the US. The tests showed that the necessary and sufficient conditions were satisfied empirically.

The possibility of cointegrating debt, net-of-interest expenditures, tax revenues and seigniorage was theoretically researched further by Trehan and Walsh (1991). Two of their previous assumptions were relaxed: government revenues and expenditures were not required to be first-difference stationary and the real rate of interest was allowed to vary.

Regarding the first set of extensions of their earlier model, Trehan and Walsh (1991) first keep the assumption of constant expected real rate of interest. The left-hand side of (2.38) is there expressed in a quasi-difference form as \((1-\lambda L)D\), where \(0 \leq \lambda < 1 + r\). In a similar fashion to the previous dynamic relationship in (2.38), \((1-\lambda L)D\) is assumed to be
zero-mean stationary (ibid., p. 209). The latter is a slightly stronger assumption than Trehan and Walsh (1988), where as seen from (2.38) \((1-L)D_t\) is not necessarily stationary with a mean of zero because the elements in the vector \(\mu\) may differ from zero.

Then a necessary and sufficient condition for (2.36) to hold, hence for an IBC to be satisfied and the fiscal stance to be deemed sustainable, is the stationary linear combination of the primary deficit and debt. The latter means that cointegration between debt and primary deficit remains a necessary and sufficient condition for sustainability.

That sustainability condition 'provides a simple test of intertemporal budget balance' (Trehan and Walsh, 1991, p. 211): if \(0 \leq \lambda < 1\), and so the primary deficit \(D_t\) is a stationary process, the debt process should also be stationary to have sustainability; if \(1 \leq \lambda < 1 + r\), and so the primary deficit \(D_t\) is a nonstationary process but \((I-\lambda L)D_t\) remains stationary, the debt process should also be nonstationary and should be cointegrated with the primary deficit.

When \(\lambda\) equals unity, the case of Trehan and Walsh (1988) correspondingly applies, whereas \(\lambda = 0\) is exactly the hypothesis tested by Hamilton and Flavin (1986).

Regarding the second set of extensions of their earlier model, Trehan and Walsh (1991) relax the assumption of constant expected real interest rate. The no-Ponzi game condition becomes:

\[
(2.39) \quad \lim_{T \to \infty} E_t \left[ (\rho_{r,s})^{T} B_{r,s} \right] = 0
\]

where \(\rho_{r,s} = \prod_{i=0}^{T} (1 + r_{i+s})\), as the real interest rate is now assumed to be strictly positive but stochastic. The stochastic nature of the interest rate prevents deriving a constant vector relating the processes of debt and primary deficit, hence unlike previously the cointegration test for sustainability is not valid anymore.

The condition (2.39) where the rate is allowed to vary remains the criterion to test, although it differs from (2.36) and certainly from (2.11) earlier where the discount
factor was corrected for economic growth. Trehan and Walsh (1991) claim that if the first difference of the stock of debt is stationary, (2.39) is satisfied because debt would grow at a linear trend rate at most while the interest factor used for discounting grows exponentially. Therefore the conclusion is that when the rate of interest is not constant, but is only positive, the necessary and sufficient condition for satisfying the IBC is that the first difference of the stock of debt is stationary. The latter is equivalent to a deficit inclusive of interest payments being stationary. Trehan and Walsh (1991, p. 215) emphasize that 'this last result does not rely on any assumptions about the individual ... [debt and primary deficit] ... processes'.

Trehan and Walsh (1991) applied their framework to test fiscal sustainability on the same data set used by Hamilton and Flavin, and concluded that fiscal policy has been sustainable but the variable interest rate assumption better fits the empirical data.

The contribution by Wilcox (1989) is also inspired by an effort to extend Hamilton and Flavin's approach further, relaxing their earlier assumptions in three directions. First, Wilcox allows for a varying real rate of interest. Second, the stationarity of primary surpluses is no longer a necessary condition. Third, the limiting value of expected discounted debt (the \( A_\theta \) above) could be a stochastic variable.

The life-time budget constraint in Wilcox (1989) has the following expression:

\[
B_t = E_t \left[ - \sum_{i=1}^{\infty} (\rho_{t+i})^{-1} D_t \right] + \lim_{j \to \infty} E_t \left[ (\rho_{t+j})^{-1} B_{t+j} \right]
\]

where the original notation is adapted to be uniform to both Hamilton and Flavin's (2.33) above and the later Trehan and Walsh's variable real rate assumption as in (2.39). The present-value borrowing constraint implies that the second term in the right-hand side of (2.40) equals zero. The latter is always satisfied under the following condition: if and only if the process of the discounted debt is stationary with a mean of zero.

The above translates into the following claim: 'the test for sustainability amounts to a judgement whether a reasonable forecast trajectory for the discounted debt ... would converge to zero' (Wilcox, 1989, p. 300). And, as long as such a 'forecast trajectory' is for empirical purposes assumed just to mean that past fiscal policies are kept
unchanged, this statistical tests approach to fiscal sustainability as usual relies on historical data. Testing Hamilton and Flavin's data for nonstationarity of discounted debt, Wilcox (1989) concluded that, contrary to their earlier result, recent U.S. fiscal policy has not been sustainable.

Sustainability notions related to certain patterns of cointegration between fiscal variables, but differing from Trehan and Walsh outlined above, were proposed by Hakkio and Rush (1991a). Two of their key extensions are the use of sample subperiods, as well as the normalisation of expenditures and revenues to GNP and population. Hakkio and Rush (1991a, p. 430) motivate the latter with McCallum's (1984) assertion that those ratios are more pertinent for a growing economy. The collateral constraint of the 'taxing capacity' pointed out by Kremers (1988, 1989) also bears upon such an approach. Similar arguments justified the expression in (2.6) at the outset of the current discussion.

Hakkio and Rush's model starts with an intertemporal budget equation of the form:

\[
B_i = \sum_{n=1}^{N} \left( \rho_{i+n}^{'} \right)^{n} (T_i - G_i) + \lim_{j \to \infty} \left( \rho_{i+n}^{'} \right)^{n} B_{i+n}
\]

where the original notation is adapted to stay uniform with previous representations. The authors note that their government expenditures \( (G_i) \), though excluding interest payments, include transfer payments. \( T \) in their notation stands for total revenue rather than tax revenue only. The interest rate is allowed to vary and the discount factor is as described about (2.39). Hakkio and Rush (1991a, p. 430, fn. 2) state that the interest rate used in the model may sometimes not be real. The subsequent assumption of stationarity for the interest rate, however, rules out nominal magnitudes since nominal rates are not stationary (ibid., p. 435). An IBC implies as usual that the limit term in (2.41) equals zero.

Hakkio and Rush (1991a) focus their attention on the stochastic properties of the processes of primary balance components (i.e. the revenues and expenditures) that would condition the expected value of the limiting discounted debt in (2.41) to be zero. In the beginning they admit a generic shortcoming of the statistical tests approach to fiscal sustainability analysis: "...we often know things about the future that are not
included in the historical record ... [and] ... this drawback exists in all work that focuses on the time series behavior of data' (ibid., p. 431).

They first assume that the interest rate is stationary around an unconditional mean $r$. Then a new relationship is constructed:

$$E_t = G_t + (r_t - r)B_{r,t}$$

which represents government expenditures plus that part of interest payments on previous-period debt that corresponds to the deviation of current interest rate from its mean value. Total government expenditures (denoted $GG_t = G_t + r_tB_{r,t}$) are then shown to form the following intertemporal counterpart to (2.41):

$$GG_t = T_t + \sum_{j=0}^{\infty} (1+r)^{-j}(\Delta T_{t+j} - \Delta E_{t+j}) + \lim(1+r)^{-j}B_{r,t}$$

An IBC, i.e. ruling out a Ponzi scheme to issue new debt continuously in order to finance deficits, would in (2.43) be satisfied if the limit term there equals zero. That equation is central to Hakkio and Rush's derivation of their statistical test. They assume that $T$ and $E$ are nonstationary in levels but are stationary in their first differences so as to follow random walks with a drift: $T_t = \alpha T_{t-1} + \epsilon_{1t}$, and $E_t = \alpha E_{t-1} + \epsilon_{2t}$. Those random-walk representations are used to rewrite (2.43) as:

$$GG_t = \alpha + T_t + \lim(1+r)^{-j}(\Delta T_{t+j} - \Delta E_{t+j}) + B_{r,t}$$

where $\alpha = \sum(1+r)^{-j}(\alpha_1 - \alpha_2)$ and $\epsilon_t = \sum(1+r)^{-j}(\epsilon_{1t} - \epsilon_{2t})$. Equation (2.44) is used to regress $T_t$ on $GG_t$, provided that the limit term equals zero:

$$T_t = a + bGG_t + \eta_t$$

Due to the definitions of $\alpha$ in (2.44), in the regression now $a$ is a constant. As long as the limit term in (2.44) is zero and hence fiscal policy is sustainable, the null hypothesis is that $b$ equals 1 and $T$ and $GG$ are cointegrated.

Hakkio and Rush (1991a) alternatively prove that the regression estimate of $b$ could also lie between 0 and 1, and IBC would still be satisfied. In that case, however, the undiscounted value of debt would explode over time, and this would create problems.
for a government trying to service its debt against a potentially limited output or population growth. The government would find it harder to market new debt. Therefore $b=1$ remains strictly necessary for sustainability, along with cointegration between revenues and total expenditures.

Applying their model to a sample of U.S. quarterly data from the second quarter of 1950 till the end of 1988, and also analysing separately two sub-samples within that time range, the authors concluded that fiscal policy has not been sustainable. In spite of the fact that their revenues and expenditures are cointegrated, the former seem to have grown more slowly than the latter with $b$ estimated below unity.

Haug (1991) also employs cointegration in order to derive statistically testable hypotheses for fiscal sustainability. His method again draws on Hamilton and Flavin (1986) but is more akin to the constant-rate versions of Trehan and Walsh (1988, 1991). Haug's starting one-period budget constraint looks like:

$$(2.46) \quad \Delta B_t = rB_{t-1} + D_t + \epsilon_t$$

and his life-time budget constraint is:

$$(2.47) \quad B_t = -\sum_{i=t}^{\infty} \frac{D_i + \epsilon_i}{(1+r)^i} + (1+r)^t \lim_{N \to \infty} \frac{B_N}{(1+r)^N}$$

The two expressions strongly resemble Hamilton and Flavin's (2.28) and (2.29) presented earlier, with a measurement error term added. It is assumed that the expected value of the error term is zero for all $t$ (Haug, 1991, p. 98). The null and the alternative hypotheses for sustainability correspond to (2.30) and (2.31), respectively. Taking expectations of the right-hand side of (2.47) and under the alternative hypothesis, i.e. Ponzi-type financing not ruled out, (2.47) and (2.31) yield:

$$(2.48) \quad B_t = E_t \left[ -\sum_{i=t}^{\infty} \frac{D_i}{(1+r)^{i-t}} \right] + A_0 (1+r)^t$$

which resembles (2.32) above. Hamilton and Flavin would have claimed that the 'bubble term' $A_0$ in (2.48) equals zero, and thus sustainability is restored, when both debt and primary surpluses are stationary series. Haug (1991), however, is interested to explore sustainability conditions when debt and primary surpluses are not stationary: his
assumption is that they are nonstationary in levels but their first differences are stationary. Rewriting (2.46) one period forward and importing (2.48) into (2.46), Haug gets:

\[ (2.49) \]
\[ \Delta B_{t+1} - (1 + r) E \sum_{t=1}^{\infty} \frac{\Delta D_{t}}{(1 + r)^{t}} - \Delta D_{t} - \varepsilon_{t+1} = r(1 + r)'A_{o} \]

Because by assumption the first differences in debt and primary surplus are stationary, then the no-Ponzi condition \( A_{0} = 0 \) in (2.49) would require that the error term \( \varepsilon \) be stationary too. From (2.46), that would be satisfied when debt and primary deficits are cointegrated. Hence, the latter is Haug's (1991) sufficient condition for fiscal sustainability.

Haug tests for cointegration between US debt and primary surplus using quarterly data from the beginning of 1960 till the end of 1987. The null hypothesis of no cointegration is rejected and thus the IBC seems satisfied.

Another seminal statistical interpretation of fiscal sustainability is provided by Quintos (1995). She builds on earlier work, particularly Hakkio and Rush (1991a) to derive and also distinguish between 'weak' and 'strong' sustainability conditions. Using Hakkio and Rush's one-period budget constraint and defining similarly the total government expenditures, as well as those expenditures denoted by \( E_{i} \) in (2.42) above, she uses an intertemporal constraint of the following form\(^{18}\):

\[ (2.50) \]
\[ GG_{t} = T_{t} + \sum_{j=0}^{\infty} (1 + r)^{-j} (\Delta T_{t+j} - \Delta E_{t+j}) + \lim_{j \to \infty} (1 + r)^{-j} \Delta B_{t+j} \]

Quintos proceeds by reiterating Hakkio and Rush's strict sustainability requirement for the limit term in (2.50) to equal zero: total expenditures and revenues should be cointegrated with a vector \((1, -1)\). The remaining less strict requirement is that the estimate of \( b \) in (2.45) is positive but less than 1. Again, as evident from any standard one-period representation of the budget constraint, cointegration between total expenditures and revenue means stationarity of first-differenced debt.

\(^{18}\) Note that the difference operator in the limit value of debt differs from equation 6 in Hakkio and Rush (1991a, p. 432).
However, this time the argument goes that cointegration is only a sufficient condition for fiscal sustainability. Assuming a constant interest rate, Quintos (1995) proves that the expected value of the limit term in (2.50) reaches zero faster if $\Delta B_t$ is stationary than if $\Delta B_t$ is $I(1)$. In the latter case, as is true of any unit-root process, the convergence of the stochastic sequence to a zero-mean nonstochastic, i.e., zero-variance, sequence takes place at a rate of $\sqrt{T}$ only (Hamilton, 1994, p. 476).

Thus in the framework of Quintos (1995) stationarity of $\Delta B_t$, i.e., cointegration between total expenditures and revenue, is not a necessary condition for sustainability, as the ‘bubble term’ in (2.50) will still become zero if $\Delta B_t$ were $I(1)$, although more slowly. Quintos uses the same assumption as Hakkio and Rush (1991a) of first-difference stationarity of total expenditures and of revenue. However, contrary to Hakkio and Rush (1991a) Quintos demonstrates that cointegration between those two series is not a necessary but a sufficient condition for sustainability. The necessary and sufficient condition is that the regression coefficient from (2.45) above satisfies $0 < b \leq 1$.

Quintos (1995) generates the following fiscal sustainability criteria: ‘strong’, when the estimate of the coefficient on total expenditures in (2.45) equals 1 and total expenditures and revenues are cointegrated; ‘weak’, either when the estimate of the coefficient on total expenditures in (2.45) equals 1 and total expenditures and revenues are not cointegrated, or when the estimate of the coefficient on total expenditures in (2.45) is positive but less than 1 regardless of whether revenues and total expenditures are cointegrated. Quintos’s criteria therefore allow for a varied set of sustainability hypotheses to be tested. They have become popular in applied work and are also utilised in the empirical chapters of this thesis.

Based on US quarterly data over the full sample from the second quarter of 1947 until the third quarter of 1992, fiscal deficits are found to be sustainable, though only in the weak sense. When Quintos (1995) models the same data with breaks, sustainability is generally confirmed too.

The findings from the seminal papers discussed so far in the ‘statistical tests’ realm of fiscal sustainability analysis are summed up in Table 2.1.
Table 2.1. The statistical tests approach: summary of the founding theory

<table>
<thead>
<tr>
<th>Paper</th>
<th>Assumptions about real interest rate ((r))</th>
<th>Other assumptions</th>
<th>Sustainability condition(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hamilton and Flavin</td>
<td>Constant (calculated as average \textit{ex post} rate.)</td>
<td>(Discounted) Primary surplus (exclusive of interest payments) process is stationary. The limiting value of expected discounted debt (i.e. the violation of the borrowing constraint) is constant.</td>
<td>If debt process stationary too.</td>
</tr>
<tr>
<td>(1986)</td>
<td></td>
<td></td>
<td>Equivalent, any of the following:</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1) First difference of stock of debt is stationary.</td>
</tr>
<tr>
<td>Trehan and Walsh</td>
<td>Constant rate.</td>
<td>Expenditures (exclusive of interest payments), tax revenues and seignorage are nonstationary series but their first difference is stationary.</td>
<td>2) When deficit (inclusive of interest payments) is stationary.</td>
</tr>
<tr>
<td>(1988)</td>
<td></td>
<td></td>
<td>3) When stock of debt and deficit (exclusive of interest payments) are cointegrated with cointegrating vector ((r, 1)).</td>
</tr>
<tr>
<td>Trehan and Walsh</td>
<td>Constant expected rate.</td>
<td>Quasi-differencing the primary deficit ((D)) as ((I - L)D), where (0 \leq \lambda &lt; 1 + r), the process ((I - L)D) is zero-mean stationary.</td>
<td>If there exists a stationary linear combination of primary deficit and debt. When (\lambda = 0), Hamilton and Flavin’s (1986) case applies. Trehan and Walsh (1988) apply when (\lambda = 1).</td>
</tr>
<tr>
<td>(1991)</td>
<td></td>
<td></td>
<td>Equivalent, any of the following:</td>
</tr>
<tr>
<td>Wilcox (1989)</td>
<td>Stochastic (empirically calculated as the \textit{ex post} rate of return).</td>
<td>Surplus/Deficit (exclusive of interest payments) not necessarily stationary. The limiting value of expected discounted debt (i.e. the violation of the borrowing constraint) not necessarily constant.</td>
<td>If discounted debt process is stationary with an unconditional mean of zero.</td>
</tr>
<tr>
<td>Hakkio and Rush</td>
<td>Varying stationary rate.</td>
<td>Expenditures (including transfers and interest payments for the difference between current interest rate and its series mean value) and revenue are both non-stationary in levels, but first-difference stationary and follow random walks with a drift.</td>
<td>Both of the following: (1) Total expenditures (including transfers and interest payments) and revenues are cointegrated (2) The estimate of the coefficient on the total expenditures (when regressing revenue on expenditures) equals 1. (If that estimate is between 0 and 1, the IBC is still satisfied, but debt may grow infinitely in relation to GDP/GNP or population, which raises the incentive to default and makes marketing new debt harder.)</td>
</tr>
<tr>
<td>(1991a)</td>
<td></td>
<td></td>
<td>Coinintegration of surplus/deficit (exclusive of interest payments) and debt. (As a consequence, the error term in the one-period budget constraint equation is stationary.)</td>
</tr>
<tr>
<td>Haug (1991)</td>
<td>Constant (long-run equilibrium real rate; empirically calculated as actual average rate on certain bonds over the sample period).</td>
<td>Surplus/Deficit (exclusive of interest payments) and debt series are individually stationary in first differences. The error term in the one-period budget constraint equation is assumed zero-mean.</td>
<td></td>
</tr>
</tbody>
</table>
### Assumptions about real interest rate ($r$)

<table>
<thead>
<tr>
<th>Paper</th>
<th>Assumptions about real interest rate ($r$)</th>
<th>Other assumptions</th>
<th>Sustainability condition(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quintos (1995)</td>
<td>Constant rate.</td>
<td>Total expenditures (including debt interest payments) and revenues are both non-stationary in levels, but are first-difference stationary.</td>
<td>Cointegration between total expenditures (including debt interest payments) and revenues is sufficient but not necessary condition. The necessary and sufficient condition is that the estimate of the coefficient on total expenditures (when regressing revenues on expenditures) is positive but equal to or less than 1: 1) 'Strong' requirement for deficit sustainability: - when the estimate of the coefficient on total expenditures (when regressing revenues on expenditures) equals 1, and - when total expenditures and revenues are cointegrated. 2) 'Weak' requirement for deficit sustainability: - when the estimate of the coefficient on total expenditures (when regressing revenues on expenditures) equals 1 and total expenditures and revenues are not cointegrated, or - when the estimate of the coefficient on total expenditures (when regressing revenues on expenditures) is positive but less than 1, regardless of whether or not revenues and total expenditures are cointegrated.</td>
</tr>
</tbody>
</table>

Note: 'n/a' means either 'not applicable' or 'no implicit assumptions'.

**Bohn's critique 1: modelling sustainability under uncertainty**

In a series of papers since the early 1990s Bohn persistently argued that fiscal sustainability has not been correctly studied statistically in that the analyses are confined to a non-stochastic setting. As with all works pertaining to the 'statistical tests' approach presented here, the following discussion about the need to incorporate uncertainty is limited to a model which neither imposes additional constraints on fiscal variables nor advocates *ex ante* specific fiscal adjustments to restore an IBC. Instead, the perspective is one of a standard backward-looking IBC testing. The 'constrained sustainability' approach methodologically accommodates alternative models trying to account for fiscal volatilities when making forward projections (Mendoza and Oviedo, 2004, or various references from the IMF). That is, uncertainty is regarded in a narrower sense here: uncertainty following Bohn's model below and uncertainty as absent from the 'statistical tests' just reviewed.

Two lines of arguments justify Bohn's criticism. First and foremost, the uncertainty approach is more apt for the fact that 'we are living in an uncertain world', so it should be puzzling why 'much of the positive as well as normative theory of public finance has
been developed in the context of certainty models' (Bohn, 1991b, p. 580). A stochastic model would surely be 'more general than a deterministic model' (Bohn, 1995, p. 257).

Second, empirical evidence has suggested that for the United States interest rates have on average been below the economy's growth rates: '... historically, U.S. Treasury debt has paid a real return of less than 1 percent while the economy has grown at 3 percent annually' (Hamilton, 1991, p. 608). As discussed earlier, this means 'dynamic inefficiency' in the economy and a government being capable of running the 'rational' Ponzi game. The capacity to service debt would grow with the growth of the economy and, if expressed as a ratio to GDP, debt would never explode as seen from (2.9) and the IBC would not have to be satisfied. However, that would be valid for a deterministic economy only. The efficiency criterion differs in stochastic economies and Abel et al. (1989) provided 'strong evidence that the U.S. economy is in fact dynamically efficient' (Bohn, 1995, p. 258).

The assessment of fiscal sustainability under uncertainty requires an altogether different intertemporal setting as there are 'almost no restrictions' about the average primary balance needed to match outstanding debt: because 'the government can trade off primary deficits in some states of nature against surpluses in other states' (ibid., p. 259).

The generic problem of the statistical tests methods, relying on historical series to draw implications for future fiscal behaviour, is even more severe with uncertainty because the expectations across the states of nature are not verifiable empirically based on the single past realisations of the processes. Bohn's theoretic design takes that into account when constructing the no-Ponzi transversality condition. But the empirical application of his model remains an issue.

The states of nature at \( t \) are denoted \( \alpha_t \). The history of the economy up to time \( t \) is \( h_t \). The period \( t \) prices of securities that finance government spending at \( t+1 \) in a state \( \alpha_{t+1} \) is given by \( p(\alpha_{t+1} | h_t) \). Using the familiar remaining notation, Bohn's one-period budget equation is:

\[
B_t + G_t - T_t = \sum_{\alpha_{t+1}} p(\alpha_{t+1} | h_t)B(\alpha_{t+1} | h_t)
\]
Discrete-time probability distribution of the states of nature is assumed. In (2.51) the right-hand side describes the market value of all newly-issued state-contingent claims, ‘for convenience’ referred to as government debt (Bohn, 1991b, p. 584). In order to derive the intertemporal budget equation, Bohn argues that crucial for government’s ability to market new debt is its ability to find lenders. Thus the analysis needs to consider individuals’ consumption preferences. Denoting the probability of a history \( h \) by \( \pi(h) \), each individual \( i \)’s preference in terms of his utility function is:

\[
\sum_{i=0}^{N} E_0 \left[ \beta^t \cdot U_i(C_i(t)) \right] = \sum_{i=0}^{N} \sum_{h} \pi(h) \cdot \beta^t \cdot U_i(C_i(t))
\]

where \( C \) stands for private consumption and \( \beta \) is assumed positive. The willingness of individuals to buy government debt would depend on their preferences over consumption, i.e. their readiness to give up current in return for future consumption. That readiness is formalised via the marginal rates of utility substitution. Relating that to the pricing function in (2.51) leads to:

\[
p(\alpha_{it} | h_t) = \pi(\alpha_{it} | h_t) \cdot \beta \cdot \frac{U'_i(C_i(h_{it}))}{U'_i(C_i(h_t))}
\]

Generalising (2.53) for the period \( t + N \) is given by \( P(h_{i+N} | h_t) \), where:

\[
P(h_{i+N} | h_t) = \prod_{n=0}^{N} p(\alpha_{it+n} | h_{i+n})
\]

The specification in (2.54) shows that history \( h_{i+N} \) has been realised in effect, for all states of nature conditional on past histories. Bohn then assumes homogeneity among individuals in the economy, all having equilibrium consumption \( C_t = Y_t - G_t \). There \( Y_t \) denotes the total income constraining the individual budget and the government levies taxes \( T \) to pay for its expenditures \( G \). So (2.53) and (2.54) imply that the price of government debt in view of individual lenders’ preferences is:

\[
P(h_{i+N} | h_t) = \pi(h_{i+N} | h_t) \cdot \beta^N \cdot \frac{U'(Y_{i+N} - G_{i+N})}{U'(Y_t - G_t)}
\]

A non-discrete probability distribution would require the use of integrals instead of sums in the model (Bohn, 1995, p. 260, fn. 4).
As in (2.54) the expression is for the realised histories at $t + N$. The pricing in (2.55) is central in Bohn’s uncertainty model as it makes it possible to evaluate the government intertemporal constraint. The latter is given, based on (2.51), by the uncertainty IBC counterpart:

$$B_i = \sum_{n=0}^{\infty} \sum_{h_{r,N}} P(h_{r,N} \mid h_r) \cdot T(h_{r,N}) - \sum_{h_{r,N}} P(h_{r,N} \mid h_r) \cdot G(h_{r,N}) \left[\lim_{N \to \infty} \sum_{h_{r,N}} P(h_{r,N} \mid h_r) \cdot B(h_{r,N})\right]$$

The first term in the right-hand side of (2.56) comprises the probabilistic model of the future surpluses priced at $t$, for realised histories across all states of nature at $t + N$. The second right-hand side term is the limit value of debt, again for realised histories across all states of nature at $t + N$ priced at $t$. Ruling out perpetual debt financing would as usual necessitate that the limit term in (2.56) converge to zero.

If in (2.55) the conditional probability $\pi$ is replaced by expectations and if:

$$u_{i,N} = \beta^n \cdot \frac{U'(Y_{r,N} - G_{r,N})}{U'(Y_r - G_t)},$$

then (2.56) becomes:

$$B_i = \sum_{n=0}^{\infty} E_i \left[u_{i,N} \cdot (T(h_{r,N}) - G(h_{r,N}))\right] + \lim_{N \to \infty} E_i \left[u_{i,N} \cdot B(h_{r,N})\right]$$

Bohn (1995, pp. 263-264) underlines that the sustainability model under uncertainty in (2.58), while resembling the deterministic versions, does not involve discounted expected values. Instead, the fiscal variables are multiplied by an equilibrium marginal rate of utility substitution between period-$t$ and period-$(t+N)$ consumption. That is the key feature of the stochastic model with risk-averse individual lenders, which makes that model distinct from the deterministic world so far.

Regarding the empirical application of his model, however, Bohn asserts that equations (2.56) and (2.58) could hardly be transformed into observable counterparts because out of all the possible histories only one would have been realised and observed. Therefore, sustainability could be tested only under very strong assumptions about the distribution of government debt from a uniquely-observed time series. Recalling the invalidity of
deterministic sustainability models in an economy which is dynamically efficient only in a stochastic setting, the conclusion is that 'if one is not willing to accept such assumptions, one may even argue that sustainability is essentially untestable' (ibid., p. 269).

**Bohn’s critique 2: the (un)necessity of stationarity and cointegration restrictions**

Recently Bohn (2007) launched a further attack on the statistical tests for fiscal sustainability. His paper is likely to mark deeply the forthcoming empirical literature, as well as the related external sustainability methods. No responses to his propositions have yet been identified, so the following is a first attempt to justify the continued empirical application of unit root/stationarity and cointegration tests.

Bohn (2007) derives a formalisation analogous to (2.10)-(2.12) above. He challenges the seminal fiscal sustainability papers (Trehan and Walsh, 1988, Quintos, 1995, and Ahmed and Rogers, 1995, among others) about the necessity to have first-difference stationary debt or cointegration between expenditures and revenues. Bohn does allow the standard conditions to be regarded as sufficient if the integration of (first-difference) debt and/or the cointegration between the fiscal variables comprising the general deficit are not rejected. He proves though that even a rejection does not rule out the transversality no-Ponzi condition, hence the IBC. The reason is that any higher order of integration of the debt series would satisfy the IBC. Following that logic then, a non-rejection of unit roots at a lower order 'must be interpreted as inconclusive, not as evidence of non-sustainability' (ibid., p. 1846) if a sequential strategy of repeated differencing does not follow. But because any higher order of integration would do, such a sequential strategy may involve endless number of repetitions. Thus, the unit root and cointegration tests are of no use for fiscal sustainability assessment, Bohn (2007) claims.

To this end, he first proves that if debt is integrated of order $m$, i.e. is $I(m)$ for any finite $m \geq 0$, then the transversality condition of zero debt in the limit from (2.11) above is satisfied. In that framework, cointegration between revenues and total expenditures with

---

20 See Chapter Five.
a vector \((1, -1)\), if denoting as before debt \(B\), corresponds to \(\Delta B \sim I(0)\) or equivalently to \(B \sim I(1)\).

Regarding the cointegration condition, Bohn (2007) allows total expenditures and revenues to be integrated of any order, denoted \(m_x\) and \(m_r\), respectively. The two series may not be cointegrated and possibly may have different orders of integration, i.e. \(m_x \neq m_r\). Then debt turns out to be integrated of order \(m, B \sim I(m)\), such that \(m = \max(m_x, m_r) + 1\). In other words, the IBC will be satisfied in all cases, even without expenditure-revenue cointegration.

What therefore could justify the empirical application of the (co)integration tests? Some of the answers may be found in Bohn's (2007) paper itself. Above all, he points out that his focus is on the infinite-horizon IBC but it may be reasonable to impose 'more stringent bounds on the path of debt ... [that] ... are sometimes of economic interest' (ibid., p. 1841). The rationale behind fiscal constraints was discussed at length earlier in this chapter. The debt series may not require extra bounds only if stationary, i.e. if \(m = 0\). Although this route, strictly, is outside the 'statistical tests' strand it is intriguing that Bohn admits that testing for the null \(m = 0\) against the alternative \(m \geq 1\) still makes sense in terms of economics.

However the revenue-expenditure cointegration, which is commonly adopted in the fiscal sustainability literature and will also be adopted in the chapters to follow, implies that the null is \(m = 1\). That is, a linear trend in debt, or in the debt/GDP ratio if so specified, is allowed. Bohn's (2007) proposition to test for debt integration of any higher order is equivalent to allowing at least quadratic debt growth. Admittedly, the linear debt growth may be fiscally challenging for the economy: but is to be preferred to the at least quadratic growth allowed by Bohn. The latter will hardly be welcome by potential government-bond holders.

Bohn's (2007) condition that \(m\) may exceed 1 is therefore theoretically sound but is of no practical significance in the linear empirical world, to which also this thesis belongs. There is no need to sequentially test the debt series for orders of integration higher than 1 because fiscal policies resulting in such debt growth most certainly cannot be sustained. Furthermore, Bohn's arguments are less inhibiting because of the following.
He criticises Quintos (1995) for her assumptions that expenditures and revenues are $I(1)$ but in reality most macroeconomic series are integrated of at most that order. To preview the results from the empirical chapters at least, the series of interest in this thesis are found to be $I(1)$ if not even $I(0)$. And if such series are cointegrated and the cointegrating vector is $(1, -1)$, the first difference of debt is $I(0)$ and in Bohn’s terminology $m = 1$. If the series are not cointegrated, the first difference of debt is $I(1)$ and $m = 2$. The former case corresponds exactly to the ‘strong’ condition in Quintos (1995), whereas the latter equals her ‘weak’ sustainability condition when the regression coefficient estimate on the total expenditures lies between 0 and 1. But again, a rational creditor’s preference for a linear growth in his debtor’s debt will always dominate that for quadratic growth. From an economics perspective again, the cointegration with a vector $(1, -1)$ of the individually $I(1)$ series is more desirable. And the ‘absurdly weak’ condition, as Bohn (2007) himself terms his $m$-th order sustainability condition, must be the least desirable.

To recapitulate, although a stationary levels debt series may be the best option in the eyes of creditors, a linear growth in debt which is eliminated through first differencing is the second-best option. That is, cointegration between total expenditures and revenues with a vector $(1, -1)$ is justifiable as an optimal compromise between economic common sense and the otherwise infinite-horizon econometrics of the IBC. If tests confirm such cointegration, then fiscal sustainability is present, as even Bohn (2007) would agree. If they reject it, on the other hand, and the series are at most $I(1)$, then the IBC would be satisfied but with debt displaying quadratic growth. The fiscal authorities may find it problematic to service or market such debt and sustainability is potentially at risk.

So the only reason for the practising researcher to doubt the (un)sustainability conclusion, if she rejects the cointegration null, is the fear of a Type I error. Unfortunately, applied econometric analysis is not altogether safeguarded against such errors. Then the cointegration-related statistical tests are not only sufficient but remain, due to the broader economic considerations, necessary.

---

21 For Bohn this limitation on the coefficient is irrelevant.
Nonlinear fiscal adjustments

Even without Bohn's (2007) at least quadratic growth in the series of debt, or debt/GDP, the research into fiscal sustainability may incorporate nonlinearities in the fiscal policy, following a further strand of the literature. The policy reactions of the fiscal authorities may differ in direction and magnitude, depending on how large the deviations of the fiscal variables are from some normal/equilibrium level. Intuitively, a government may be expected to start to cut spending or increase taxes faster or only after exceeding a threshold level of debt or deficits. In other words, the restoration of the long-run fiscal sustainability may take place through a nonlinear fiscal adjustment.

Bertola and Drazen (1993) discuss that fiscal regime changes are infrequent, which 'may reflect political constraints blocking agreement on fiscal retrenchment', so that government expenditures may not be slowed or reversed until a 'significant upwards drift' (ibid., p. 16) is experienced. The reduction in spending is triggered only after the pre-stabilisation situation has deteriorated (Alesina and Drazen, 1991; Drazen and Grilli, 1993) and spending has reached levels that are regarded as critically high. Therefore a current increase in the government spending-to-output ratio 'has nonlinear effects on the expected present discounted value of the ratio of future government spending to output' (Bertola and Drazen, 1993, p. 19).

Besides the nonlinear mean-reverting stabilisation, in Bertola and Drazen's (1993) model the expectations about future fiscal policy imply another nonlinear relationship: between government spending and private consumption. A deficit reduction via spending cuts may raise private consumption, provided that it induces expectations for lower government spending and lower taxes in the future. But also an increased government spending may be expansionary if the private sector expects that 'high levels of spending are unsustainable and will soon be cut' (ibid., p. 12). The authors conclude that any time series analyses should reflect the presence of the nonlinearities suggested by economic considerations.

Giavazzi, Jappelli and Pagano (2000) continue the theme and, concentrating on national savings, provide extensive evidence of nonlinear effects of fiscal policy on the behaviour of the private sector. For the OECD countries, they find that only large and
persistent fiscal impulses trigger nonlinear responses by the private sector. The high or rapidly growing public debt does not turn out to predict the nonlinear national savings dynamics, unlike the evidence in Perotti (1999) where fiscal shocks have stronger effect on private consumption when public debt is high. Using a dataset of developing countries, Giavazzi et al. (2000) find that national savings respond nonlinearly more frequently, to both large fiscal expansions and large fiscal contractions, and that the impact of fiscal policy on national savings is smaller during periods of rapidly growing public debt.

Abstracting from the nonlinear effects of fiscal policy, the emerging literature on nonlinear fiscal adjustments has direct implications for fiscal sustainability in the sense of satisfying the intertemporal budget constraint. To that end, Bohn (1998) provides evidence that the US primary surplus is an increasing function of the debt/GDP ratio: the marginal impact of higher debt on the primary surplus is increasing across several estimated nonlinear regressions, despite the difficulty in identifying the exact form of nonlinearity (ibid., p. 959). The positive, and at least linear, response of primary surpluses to the debt-income ratio implies that the latter should be a stationary process and that the government fiscal policy ‘has been on a path consistent with the intertemporal budget constraint’ (ibid., p. 961). A decade later Greiner and Kauermann (2007) also analyse the response of the US primary surplus/GDP ratio to changes in the public debt/GDP ratio and find that it is a positive nonlinear function, thus confirming Bohn’s (1998) conjecture.

Cipollini (2001) applies a smooth transition error-correction model (STECM) to UK quarterly data. He models a regime shift in the adjustment towards a linear cointegrating relation between government spending and tax revenues, with the slope coefficient in the cointegrating regression equal to unity. The study finds that the government is likely to react only to large, in absolute values, public spending/GDP ratio changes in order to contain the deficit/surplus dynamic within a band of desired values. The politicians are therefore concerned either with a solvency constraint (cutting spending following a significant increase in expenditures and in deficits) or with an opportunistic popularity

---

22 Later Kamps (2006) challenged the findings of Giavazzi et al. (2000) that the effects of fiscal policy are nonlinear. He argues that their evidence is not robust because of the slope homogeneity assumption in their panel analysis, as well as because of the incorrectly identified too many episodes of large and persistent fiscal impulses.
constraint (boosting spending following a significant fall in expenditures and an increase in surpluses).

A more recent analysis of the UK's nonlinear fiscal adjustment is contained in Considine and Gallagher (2008). Their assessment of the sustainability of UK public finances applies an exponential smooth transition autoregression (ESTAR) representation. Based on a long span of annual twentieth century data, a nonlinear adjustment towards the long-run equilibrium is detected in the debt/GDP ratio.

Strong evidence of nonlinear mean reversion of the US debt/GDP ratio is provided in Sarno (2001). The debt ratio is modelled by a smooth transition autoregressive (STAR) model where the speed of adjustment varies depending on the deviation from equilibrium. The government turns out to have reacted more strongly to larger deviations from the equilibrium debt/GDP ratio. Furthermore, Sarno (2001) provides Monte Carlo simulation results demonstrating that standard univariate tests lack power to reject the false unit root null when the true model is nonlinearly mean-reverting.

Arestis, Cipollini and Fattouh (2004) also analyse the US case but they model the government real per capita deficit as a threshold autoregressive (TAR) process. The authorities would intervene by cutting deficits only after a certain threshold, i.e. nonlinearly. The empirical results suggest that this threshold is represented by a semi-annual increase in deficits by more than 0.313% between the previous quarter and the second quarter before. After such an increase in the deficit is observed, in a given quarter, the threshold is crossed and the regime changes so that 'politicians would become sensitive to budget deficits' (ibid., p. 220).

Recently Cipollini, Fattouh and Mouratidis (2009) have conducted another analysis of nonlinear fiscal adjustment in the US, this time shifting from a single-equation setting to a multivariate threshold vector error-correction regression model. This approach enables them to find both that the authorities intervene only after the deficit reaches a certain threshold, and that the adjustment occurs mainly through public expenditure cuts rather than through increases in tax revenue. The threshold, above which the fiscal adjustment in the real per capita budget deficit begins, is estimated at 8,859 US dollars.
Bajo-Rubio, Díaz-Roldán and Esteve (2004) assess the nonlinear fiscal adjustment towards sustainability in the dynamic behaviour of Spanish budget deficits. They conduct an analysis similar to Arestis et al. (2004) and detect mean-reversion of the deficits, once certain endogenously derived thresholds are reached, applying a TAR model. The authors find that significant fiscal consolidations would occur when the total deficit/GDP ratio in a certain year 'has shown an increase of more than 1.9% between the previous year and the 6th year before' (ibid., p. 241). The years when such an increase in the deficit/GDP ratio is observed are the 'trigger points', according to Bertola and Drazen's (1993) model.

Later Bajo-Rubio, Díaz-Roldán and Esteve (2006) take another sustainability condition within the 'statistical tests' strand of literature, the revenue-expenditure cointegration, and test it in a nonlinear analysis. Again using Spanish data, they seek for the possible presence of threshold cointegration between government revenues and expenditures. Bajo-Rubio et al. (2006) fit a vector error-correction model with one cointegrating vector and a threshold effect based on the value of the error-correction term: the model is split into two regimes depending on whether the error-correction term is below or above the threshold value. When using annual data, the error-correction terms are significant, hence there is cointegration and adjustment towards sustainability, only when the deficit/GDP ratio is above 5.30%. With quarterly data, Bajo-Rubio et al. (2006) find that the error-correction effects are significant only when the deficit/GDP ratio exceeds 7% in annual figures. Thus the successful fiscal consolidations in line with the intertemporal budget constraint occur in a nonlinear fashion, only when deficits become too high.

Argyrou and Luintel (2007) find that fiscal disequilibrium adjusts nonlinearly in four EMU member countries, however with different 'trigger points' and types of nonlinearity. They conduct several tests for nonlinear fiscal adjustment of the estimated fiscal disequilibrium term which accounts for structural breaks: the null of linear adjustment is generally tested against the alternative of nonlinear adjustment; the null of either linear or quadratic adjustment is tested against the alternative of nonlinear logistic adjustment; if rejecting the hypothesis of nonlinear logistic adjustment, the null of linear adjustment is tested against the alternative of nonlinear quadratic adjustment. Having rejected the linearity hypothesis for all four countries, Argyrou and Luintel (2007) find
evidence of quadratic-type nonlinearity for Greece and Italy and logistic-type nonlinearity for Ireland and the Netherlands. These nonlinearities are modelled by the quadratic logistic smooth threshold error-correction model (QL-STECM) and the logistic smooth threshold error-correction model (L-STECM), respectively. Both models involve two regimes but those regimes are separated by one threshold in the L-STECM and two threshold values in the QL-STECM. The QL-STECM threshold values define an ‘inner regime’ band within which the adjustment to equilibrium is different from the one outside the band. The estimates from the error-correction models suggest that the authorities in Greece and Italy ‘allow deficits to take substantial values before taking corrective action’ (ibid., p. 406), namely 16% and 14% of their total expenditures, respectively. For the other two countries, the single estimated regime threshold is below 10% in absolute value; and even though fiscal adjustment takes place both below and above this value, the deficits are corrected faster when they are higher.

Recently Chortareas, Kapetanios and Uctum (2008) analyse the sustainability of government debt in selected Latin American countries applying various new unit root tests with nonlinear alternatives. The results, when ‘compared to the gloomy picture of traditional unit root tests’ (ibid., p. 655) are more favourable to the hypothesis of fiscal sustainability. Depending on the debt measure and the model specification, the authors uncover stationarity in up to three of five countries where standard tests fail to support any stationarity. Chortareas et al. (2008) strongly advocate the use of an array of tests which allow for nonlinear mean reversion in order not to underestimate the assessment of fiscal sustainability.

2.4. Conclusion

In summary, there are two main approaches to fiscal sustainability analysis although all rely to different degrees on the IBC. This chapter presents an original taxonomy where the literature is subdivided into ‘constrained sustainability’ and ‘statistical tests’ groups.

The first strand is best exemplified through either additional rules/indicators ‘augmenting’ the basic IBC or the measurements of deviations from some longer-term IBC-compatible projections. In both cases, the focus is on the specific changes to fiscal
policy needed to restore or achieve sustainability: rather than merely counting on the posterior realisation of the IBC with debt converging to zero only in the limit.

Most fiscal rules and sustainability indicators are directly and explicitly derived from some representation of the IBC. Even if not expressly rooted in the IBC, the ‘constrained sustainability’ approach acknowledges that an IBC will always hold ex post, if required through adjustments to the ex ante discrepancies, be they planned or envisaged. As in the entire fiscal sustainability area, the distinction between fiscal solvency and fiscal sustainability is often obscured. The various constraints may be derived from formal tests and econometric modelling of past fiscal performance. But generally the advantage of the ‘constrained sustainability’ approach is that it is suitable for a more normative and forward-looking policy analysis.

The examples of fiscal constraints that are usually cited in the literature are not always intuitive and easy to interpret. Not all the rules and indicators proposed in practice are backed by sound economic theory. Furthermore, even if specific constraints are valid as theoretical constructions their practical implementation may be limited due to measurement errors arising from the uncertainty of long-term forward projections. Buiter’s ‘permanent’ rules provide an example of the difficulty of obtaining empirically observable variables. Still, some constraints are conveniently translated into practical policy indicators and perhaps that explains the continued drive to explore theoretically designed sustainability indicators and the practice of legislated fiscal rules.

The ‘statistical tests’ literature forms the second strand in the theory of fiscal sustainability. That approach is backward-looking and sets itself the limited task of assessing only a realised past performance. This sharply differentiates it from the more normative endeavours to study current and forthcoming sustainability recommending specific policy adjustments. But whereas the forward-looking exercises are typical of the ‘constrained sustainability’ perspective, they are burdened with uncertainty in the sense that they may need to rely on forecasts about the fiscal stance. Unless a researcher is willing to take on such assumptions behind the seemingly more ambitious ‘constrained sustainability’ approach, the ‘statistical tests’ may be regarded as robust enough for empirical purposes.
However, a far-sighted call for modelling uncertainty shadows the ‘statistical tests’. Bohn’s criticism of the deterministic tradition is well-founded theoretically and attempts to address it have been limited. It should be noted, however, that the models accounting for effects of uncertainty defined more generally, within both major strands of the literature, although gathering momentum in recent years have only partially resolved the issue. Ahmed and Rogers (1995) and more recently Leachman, Bester, Rosas and Lange (2005) study fiscal sustainability based on conditions under which cointegration tests remain valid even under uncertainty. Uctum and Wickens (2000) claim to have avoided the problem raised by Bohn (1995) by using discounted values for debt and deficits. If the environment were stochastic the rates of return (yields on government debt) would have to incorporate risk premia associated with uncertainty, as seen from the ‘discount’ factors in (2.58). Taking discounted debt and discounted deficits, on the other hand, has the advantage that ‘it avoids the need to take explicit account of the fact that ... [the rate of return] ... is stochastic’ (Uctum and Wickens, 2000, p. 202).

Bohn (1998) provides a conceptually different approach to account for uncertainty, arguing that traditional fiscal sustainability analyses based on the IBC and transversality conditions ‘depend sensitively on the choice of discount rates’ (ibid., p. 961). As demonstrated by Bohn’s (1991b, 1995) critique, the commonly-used empirical counterparts for those rates are inappropriate in a stochastic setting. That is why Bohn (1998) proposes his alternative model, where ‘a strictly positive and at least linear response of the primary surplus to changes in the debt-income ratio turns out to be sufficient for sustainability’ (ibid., pp. 960-961) for both ‘good’ and ‘bad’ states of nature.

Burnside (2004) argues that Bohn’s critique has only partially been overcome. Reviewing modern fiscal sustainability analyses, he states that ‘we should not expect major improvements in the accuracy of estimated debt ceilings, forecasting power, contingent liability valuation, or policy analysis’ (ibid., p. 2) because the old assumptions are relaxed at the cost of new problematic ones. Furthermore, Burnside contends that recent empirical studies tend to become quite specialised in terms of addressing varying aspects of sustainability. Thus on the horizon consensus is observed neither in modelling uncertainty nor in defining and testing fiscal sustainability.
As for the 'statistical tests' models, it may be concluded that even without explicitly addressing uncertainty they at least avoid any need for long-term projections into the future.

In short, no single approach could be regarded as superior. Neither are the methods, nor the two literature strands, necessarily complementary in drawing a subtler picture of fiscal sustainability. As discussed, the very fiscal sustainability notions are not unambiguous. The theories and the empirical approaches vary widely in assumptions and in focus. The fiscal sustainability literature is so diverse that this chapter attempts to bring together the loose strands into some unifying classification rather than to put forward an exhaustive framework for studying sustainability.

Then which among the multitude of approaches would best fit a study of fiscal sustainability in Europe? Is compliance with the fiscal rules under the Maastricht Treaty and the SGP synonymous with sustainability, or a more sophisticated statistical analysis of historical data would be required? The answer really depends on the research focus.

The 'constrained sustainability' approach yields indicators to augment the IBC or to eliminate _ex ante_ the gap between the forecast fiscal paths and what would be needed to comply with an IBC in the future. That approach corresponds exactly to the Maastricht/SGP fiscal criteria, the association of which to the IBC was discussed above. So a fulfilment of the fiscal rules is enough if just a snapshot of _some_ notion of fiscal sustainability is aimed.

The 'statistical tests' approach is justified if the researcher is interested in the past fiscal performance of the European economies. The implicit assumption behind the statistical tests is that policies will not change so that the data series are representative for the 'long run'. The advantage of that approach is the direct targeting of the IBC condition, whereas the durability of the various 'constrained sustainability' fiscal rules is more debatable.

The statistical analysis can deliver relevant policy conclusions, to the extent to which the public is interested in long-run solutions. But it has important theoretical underpinnings too about the power of the European fiscal framework to induce
sustainability in line with the IBC. The latter is a central concern of this thesis, as it aims to analyse whether the European economies made a progress towards long-run fiscal sustainability and what, if any, were the effects of the Maastricht Treaty and the SGP in that respect. Providing the tools to assess the past fiscal performance therefore, the ‘statistical tests’ serve well the purposes of the research agenda of this thesis.

Still, even if confined to the ‘statistical tests’ literature strand, the assessment of fiscal sustainability in Europe should choose among various approaches. There is no unique or universally accepted econometric method, and the path-breaking studies surveyed above have established a multitude of statistically testable conditions for fiscal sustainability.

Stationarity of a fiscal data generating process may be sufficient to have sustainability. Or, cointegration between debt and primary deficit, or between total revenues and total expenditures, along with a unitary cointegrating parameter on the latter, may suffice (Table 2.1). Revenue-expenditure cointegration is the sufficient condition following certain seminal papers on fiscal sustainability (e.g. Hakkio and Rush, 1991a, and the ‘strong’ sustainability condition defined by Quintos, 1995) as well as many empirical applications thereafter. Quintos (1995) has left the fiscal sustainability literature with an option to permit a more relaxed definition: the revenues and expenditures need not be cointegrated as long as the independent variable’s parameter estimate in the bivariate regression lies between 0 and 1. Her ‘weak’ sustainability condition however may potentially put a strain on an economy with a rising debt; therefore it will be safer if the data support the ‘stronger’ sustainability case. The above requirements also nest a special case when the transversality condition in (2.11), hence sustainability, is satisfied: if the expenditures and revenues series are individually I(0). Otherwise, the cointegration with a vector (1, -1) is needed.

Clearly therefore, a range of possible methods can be applied to establish fiscal sustainability. In the subsequent empirical chapters, the range of preferred methods is narrowed down to that of revenue-expenditure cointegration. The cointegration approach is employed here for the following reasons.

23 Recalling at this point the limitations, from an economics point of view as discussed, of Bohn (2007) who allows for higher orders of integration of the fiscal series.
First, this chapter has put forward a straightforward argument for resorting to cointegration analysis rather than single-series stationarity. As Ahmed and Rogers (1995) show, under some very general conditions cointegration between total revenue and total expenditures is necessary and sufficient for sustainability even in a stochastic environment. Thus a major theoretical concern may be overcome.

Second, the analysis of the cointegrating relationship between revenues and expenditures below takes advantage of Quintos' (1995) sustainability conditions. Thus the assessment of fiscal sustainability may distinguish between the 'weak' vs. the 'strong' sustainability hypotheses, to bring forward evidence of varied degrees of compliance with the IBC.

Third, the cointegration approach accommodates the convergence modelling in Chapter Three. The recursive estimation of the slope parameter in the cointegrating regression provides the means to identify any gradual adjustments towards, or deviations from, long-run fiscal sustainability, as well as any effect from the Maastricht Treaty. Thus a verifiable merit of the cointegration technique is that it addresses prime research questions of the thesis.

Certainly one may argue that recursive techniques in a univariate time series analysis can also expose hypothetical fiscal adjustments in Europe in the 1990s and beyond. For example, unit root tests on the series of debt or deficit may be performed recursively, plotting the relevant test statistics appropriately scaled. However, the cointegration approach is preferable because it may also be extended to study increasing fiscal sustainability convergence in a case with an increasing number of cointegrating vectors. This will become possible if data are available for three fiscal series: public revenues, non-interest expenditures and interest payments. This is a likely future extension to the current work: so a fourth reason to use the cointegration framework is making the provision for continuity and potential comparisons with future empirical results.

Fifth, the revenue-expenditure cointegration is chosen as the favoured sustainability measure because, as Chapter Five will demonstrate, the econometric methods, including those dealing with gradual fiscal adjustments, may also be utilised for the open economy. That enables a comprehensive empirical analysis of fiscal sustainability in
Europe as the running theme of this thesis: across both 'old' and accession Europe, closed and open economies, and highlighting the reactions of both the government and the private sector.

The first appendix to this chapter lists empirical literature on Europe in accordance with the econometric approaches to fiscal sustainability. The chapters to follow then aim to contribute in several dimensions to the evidence about the enlarged European Union, using various statistical tests related to the revenue-expenditure sustainability condition.
APPENDIX 2.A
EUROPEAN FISCAL SUSTAINABILITY STUDIES

The table here documents the emerging European fiscal sustainability literature. Whereas Chapter Two is focused exclusively on theory and thus provides the analytical background, the studies identified below summarise the empirical literature context.

Table 2.A.1 contains empirical works within the ‘statistical tests’ strand of literature. Research into fiscal sustainability in Europe began only after the North American studies and gained momentum since the 1990s. The existing findings are based on diverse research strategies and are often contradictory across papers and samples.

As long as this thesis aims to expand the eclectic empirical evidence for Europe, the selection follows the geographical criterion. As such, Table 2.A.1 intends to represent the most comprehensive European fiscal sustainability catalogue so far, enriching similar attempts in Vieira (1999) and Afonso (2005b).
Table 2.A.1. Some existing empirical evidence about fiscal sustainability in Europe

<table>
<thead>
<tr>
<th>Paper</th>
<th>Country (period)</th>
<th>Data frequency</th>
<th>Tests$^{(1)}$</th>
<th>Panel analysis</th>
<th>Sustainability$^{(2)}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Afonso (2005b)</td>
<td>EU15 (1970-2003)</td>
<td>Annual</td>
<td>Unit root tests for first difference of debt, unit roots with breaks for debt, cointegration for revenues and expenditures (including structural shift tests)</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Afonso and Rault (2007a)</td>
<td>EU15 (1970-2006)</td>
<td>Annual</td>
<td>Cointegration for revenues and expenditures (with and without breaks)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Afonso and Rault (2007b)</td>
<td>EU15 (1970-2006)</td>
<td>Annual</td>
<td>Cointegration for revenues and expenditures, unit root tests for first difference of debt (with and without breaks)</td>
<td>Yes$^{(3)}$</td>
<td>Yes: for the panel No: for some tests for the individual countries</td>
</tr>
<tr>
<td>Artis and Marcellino (1998)</td>
<td>EU15 without Greece and Luxembourg (period varies across countries between 1963 and 1994)</td>
<td>Annual</td>
<td>Unit root tests for (un)discounted debt (gross/net)</td>
<td>No</td>
<td>Yes: for discounted debt in Belgium, Spain and Italy (net) and in Austria, Belgium, Netherlands and UK (gross) No: all other countries/debt definitions</td>
</tr>
<tr>
<td>Caporale (1995)</td>
<td>10 EU countries (period varies across countries between 1960 and 1991)</td>
<td>Annual and semi-annual (for the different countries)</td>
<td>Unit root tests for debt</td>
<td>No</td>
<td>No: Denmark, Germany, Greece and Italy Yes: the rest</td>
</tr>
<tr>
<td>Cipollini (2001)</td>
<td>UK (1963:1-1997:3)</td>
<td>Quarterly</td>
<td>Unit root tests for overall balance, cointegration for revenues and expenditures (and a regime switch to adjust towards linear cointegrating relationship)</td>
<td>No</td>
<td>No (unless regime shift in the face of large imbalances)</td>
</tr>
<tr>
<td>Clineys (2007)</td>
<td>EU15 without Luxembourg (1970-2001)</td>
<td>Annual</td>
<td>Unit root tests for debt, unit root tests for overall balance, cointegration for revenues, expenditures and interest payments</td>
<td>Yes$^{(4)}$</td>
<td>Yes: for the panel No: for some tests for the individual countries</td>
</tr>
</tbody>
</table>

81
<table>
<thead>
<tr>
<th>Paper</th>
<th>Country (period)</th>
<th>Data frequency</th>
<th>Tests&lt;sup&gt;(1)&lt;/sup&gt;</th>
<th>Panel analysis</th>
<th>Sustainability&lt;sup&gt;(2)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Considine and Gallagher (2008)</td>
<td>UK (1919-2001)</td>
<td>Annual</td>
<td>Exponential smooth transition autoregressive model of the debt/GDP ratio</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Corsetti and Roubini (1991)</td>
<td>18 OECD countries (1960-1989)</td>
<td>Annual</td>
<td>Unit root tests for discounted debt, unit root tests for uncounted debt, unit root tests for overall balance</td>
<td>No</td>
<td>No: Belgium, Greece, Ireland, Italy and Netherlands Yes: the rest</td>
</tr>
<tr>
<td>Feve and Henin (2000)</td>
<td>G7 (various, unspecified)</td>
<td>Semi-annual</td>
<td>Unit root tests for debt</td>
<td>No</td>
<td>Yes: UK No: the rest</td>
</tr>
<tr>
<td>Greiner and Semmler (1999)</td>
<td>Germany (1955-1994)</td>
<td>Annual</td>
<td>Unit root tests for discounted debt, unit root tests for discounted primary and overall deficit</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Hatemi-J (2002a)</td>
<td>Sweden (1963:1-2000:1)</td>
<td>Quarterly</td>
<td>Cointegration for revenues, expenditures, debt and private consumption</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Hatemi-J (2002b)</td>
<td>Sweden (1963:1-2000:1)</td>
<td>Quarterly</td>
<td>Cointegration for taxes and expenditures including interest payments (time varying coefficient model)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Kalyoncu (2005)</td>
<td>Turkey (1970-2001), Mexico, South Africa, South Korea and the Philippines (period varies across countries between 1970 and 2003)</td>
<td>Annual (Turkey) and quarterly (the rest)</td>
<td>Cointegration for revenues and expenditures</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>Kirchgässner and Prohl (2006)</td>
<td>Switzerland (1900-2002)</td>
<td>Annual</td>
<td>Unit root tests for debt and deficit (with and without a break), cointegration for revenues and expenditures</td>
<td>No</td>
<td>Yes: over entire period No: before 1940 and after 1945</td>
</tr>
<tr>
<td>Leachman, Bester, Rosas and Langs (2005)</td>
<td>15 industrialised countries (1960-1998)</td>
<td>Annual</td>
<td>Cointegration (and multicointegration) for revenues and expenditures</td>
<td>No</td>
<td>Yes: from multicointegration tests, Norway and UK No: all other countries/tests</td>
</tr>
<tr>
<td>Llorca and Redzepagic (2008)</td>
<td>8 EU accession countries (1999:1-2006:1)</td>
<td>Quarterly</td>
<td>Unit root tests for debt, unit root tests for overall balance, unit root tests for revenues and expenditures, Cointegration for revenues and expenditures</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Paper</td>
<td>Country (period)</td>
<td>Data frequency</td>
<td>Tests(1)</td>
<td>Panel analysis</td>
<td>Sustainability(2a)</td>
</tr>
<tr>
<td>-------</td>
<td>-----------------</td>
<td>----------------</td>
<td>----------</td>
<td>----------------</td>
<td>-------------------</td>
</tr>
<tr>
<td>MacDonald and Speight (1990)</td>
<td>UK (1961-1986)</td>
<td>Annual</td>
<td>Cointegration for debt and primary deficit</td>
<td>No</td>
<td>Inconclusive</td>
</tr>
<tr>
<td>Papadopoulos and Sidiropoulos (1999)</td>
<td>Belgium, Greece, Italy, Portugal and Spain (period varies across countries between 1961 and 1995)</td>
<td>Annual</td>
<td>Unit root tests for deficit (with and without breaks), cointegration for revenues and expenditures</td>
<td>No</td>
<td>Yes: Greece, Portugal and Spain No: Belgium and Italy</td>
</tr>
<tr>
<td>Payne (1997)</td>
<td>G7 countries (period varies across countries between 1949 and 1994)</td>
<td>Annual</td>
<td>Cointegration for revenues and expenditures</td>
<td>No</td>
<td>Yes: Germany No or inconclusive: the rest</td>
</tr>
<tr>
<td>Uctum, Thurston and Uctum (2006)</td>
<td>G7 and selected Latin America and Asia countries (1970-2002)</td>
<td>Annual</td>
<td>Unit root tests for discounted debt (with and without a break)</td>
<td>No</td>
<td>Yes: with a break, France, Italy, Turkey and UK No: all other European countries with or without testing for unit roots with a break</td>
</tr>
<tr>
<td>Uctum and Wickens (2000)</td>
<td>11 EU countries and US (period varies across countries between 1965 and 1994)</td>
<td>Annual</td>
<td>Unit root tests for (discounted) debt</td>
<td>No</td>
<td>Yes: Denmark, France, Ireland and Netherlands No: the rest</td>
</tr>
<tr>
<td>Vanhorebeek and Van Rompuy (1995)</td>
<td>8 EU countries (1970-1994), and Belgium separately (1870-1993)</td>
<td>Annual</td>
<td>Unit root tests for debt, unit root tests for overall deficit</td>
<td>No</td>
<td>No or inconclusive: the rest</td>
</tr>
<tr>
<td>Vieira (1999)</td>
<td>Belgium, Germany, France, Italy, Netherlands and UK (period varies across countries between 1950 and 1996)</td>
<td>Annual and quarterly</td>
<td>Unit root tests for deficit (with and without breaks), cointegration for revenues and expenditures</td>
<td>Yes(3)</td>
<td>Yes: Germany No: the rest</td>
</tr>
<tr>
<td>Westerlund and Prohl (2008)</td>
<td>8 OECD countries</td>
<td>Quarterly</td>
<td>Cointegration for revenues and expenditures (with breaks)</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Notes: (1) Further tests depending on the paper’s research questions may have been performed.
(2) The conclusion regarding only European sustainability if the sample also comprises non-Europe countries. Where tested for, weak-form sustainability following Quintos (1995) is here documented as a lack of sustainability.
(3) Both panel and single time series tests.
APPENDIX 2.B
THE 'PERMANENT BALANCE' RULE

This appendix details the derivation of the 'permanent' version of the intertemporal budget constraint (equation 2.20 above) and the 'permanent balance' rule for the non-primary government deficit (equation 2.21 above), as per Buiter and Grafe (2004). The notation, modified from the original to keep consistency with the corresponding discussion in Chapter Two, is summarised in the following list:

\[
\begin{align*}
    \text{\textit{b}} & \quad \text{government debt, share of GDP} \\
    \text{\textit{d}} & \quad \text{primary government deficit, share of GDP} \\
    \text{\textit{d}'} & \quad \text{non-primary government deficit, share of GDP} \\
    \text{\textit{g}} & \equiv \text{\textit{g}'} + \text{\textit{g}c} + \text{\textit{g}T} \quad \text{government expenditures, share of GDP} \\
    \text{\textit{g}T} & \quad \text{government transfers and subsidies, share of GDP} \\
    \text{\textit{g}c} & \quad \text{government consumption, share of GDP} \\
    \text{\textit{g}T} & \quad \text{government capital formation, share of GDP} \\
    \text{\textit{i}} & \quad \text{nominal interest rate on government debt} \\
    \pi & \quad \text{rate of inflation} \\
    r & \equiv i - \pi \quad \text{real interest rate} \\
    r' & \quad \text{short-term real interest rate} \\
    s & \equiv r - g \quad \text{primary surplus, share of GDP} \\
    \tau & \equiv \tau_0 + \psi k \quad \text{total government taxes and other current government revenues, share of GDP} \\
    \tau_0 & \quad \text{government tax revenues, share of GDP} \\
    \psi & \quad \text{gross financial rate of return on the government capital stock} \\
    k & \quad \text{government capital stock, share of GDP} \\
    \theta & \quad \text{real GDP growth rate} \\
    \theta' & \quad \text{short-term real GDP growth rate}
\end{align*}
\]

Furthermore, a 'dot' over a variable denotes 'its instantaneous rate of change' (ibid., p. 70) and a 'p' superscript denotes the 'permanent' nature of a variable.
Buiter and Grafe (2004) specify their no-Ponzi solvency constraint in a non-discrete form:

\[
(2.B.1) \quad b(t) \leq \int_{t}^{\infty} e^{-(r(u)-\theta(u))du} [r(u) - g(u)]du
\]

In other words, debt should not exceed the present value of all future primary surpluses. Decomposing the total government taxes and other current government revenues, as well as the government expenditures, as shown in the list of notation, (2.B.1) can be rewritten as:

\[
(2.B.2) \quad b(t) \leq \int_{t}^{\infty} e^{-(r(u)-\theta(u))du} s(u)du
\]

\[
= \int_{t}^{\infty} e^{-(r(u)-\theta(u))du} [r(u) + \psi(u)k(u) - g_{T}(u) - g_{C}(u) - g_{I}(u)]du
\]

Then a 'permanent' primary surplus/GDP ratio is defined as 'that constant primary surplus-GDP ratio whose present discounted value is the same as the present discounted value of the actual (or anticipated) future sequence of primary surplus-GDP ratios' (ibid., p. 73). In the infinite time horizon, this means:

\[
(2.B.3) \quad s^p = \left( \int_{t}^{\infty} e^{-(r(u)-\theta(u))du} s(u)du \right)^{-1} \int_{t}^{\infty} e^{-(r(u)-\theta(u))du} s(u)du
\]

'Permanent' counterparts to all other government revenue and expenditure flows are defined analogously. The term:

\[
= \int_{t}^{\infty} e^{-(r(u)-\theta(u))du} du
\]
is interpreted as 'the value of a real (that is, index-linked) perpetuity whose (real) coupon grows at a proportional rate ... from an initial value of one unit of output' (ibid., p. 74). Then the 'permanent' real interest rate minus the 'permanent' real growth rate is defined as 'that constant value of the excess of the real interest rate over the real growth rate that generates the same value for this real perpetuity as is generated using the actual (or anticipated) future values' (ibid., p. 74) of $r - \Theta$:

\[
(r^p - \Theta^p) = \left( \frac{1}{e^{\int_0^\infty (r(u) - \Theta(u))du}} \right)^{1/t}
\]

Therefore (2.B.2), using (2.B.3) and (2.B.4), produces the 'permanent' version of the intertemporal budget constraint:

\[
b \leq \frac{g^p}{r^p - \Theta^p} = \frac{\pi^p - g^p}{r^p - \Theta^p} = \frac{\pi^p + k^p - g^p - q^p - r^p - \theta^p}{r^p - \Theta^p},
\]

that is equation (2.20) in Chapter Two.

As for the 'permanent balance' rule for the non-primary budget deficit, again as a share of GDP, Buiter and Grafe (2004) first define that deficit as:

\[
d^p \equiv g - \pi + i\bar{b}
\]

Also the instantaneous rate of change of government debt, as a share of GDP, is defined as the sum of the primary deficit plus the short real interest on existing debt adjusted for the short real growth in GDP:

\[
\dot{b} \equiv g - \pi + (r^s - \theta^s)b
\]

Because $r \equiv i - \pi$, and using the expression for the non-primary deficit in (2.B.6), (2.B.7) results in:
The next step involves the ‘permanent’ intertemporal constraint from \((2.B.5)\). Buiter and Grafe (2004, p. 76) define a ‘prudent government borrowing rule’ as keeping the government tax revenue as a share of GDP \((\tau_o)\) at a constant value (denoted \(\tau_o^p\)) which should at least equal the sum of permanent government spending flows, as shares of GDP, plus the growth-adjusted interest cost of government debt, as a share of GDP, minus the ‘permanent’ income from the government capital stock, again as a share of GDP. That ‘prudent borrowing rule’ is actually a tax smoothing rule and it comes directly from \((2.B.5)\), i.e.:

\[
\tau_o = \tau_o^p \leq g_T^p + g_c^p + g_i^p + b(r^p - \theta^p) - \psi^p k^p
\]

The behaviour of the government debt/GDP ratio in \((2.B.7)\), after decomposing the total expenditures and revenues into their flows as defined in the list of notation above, and using the tax smoothing rule of \((2.B.9)\), can be manipulated as:

\[
b = g_T + g_c + g_i - (\tau_o + \psi k) + (r^p - \theta^p) b
\]

\[
\leq g_T + g_c + g_i - g_T^p - g_c^p - g_i^p - b(r^p - \theta^p) + \psi^p k^p - \psi k + (r^p - \theta^p) b
\]

\[
= \psi^p k^p - \psi k + g_T - g_T^p + g_c - g_c^p + g_i - g_i^p + [(r^p - r^p) - (\theta^p - \theta^p)] b
\]

Finally, from \((2.B.8)\) and \((2.B.10)\) it follows that:

\[
d^t \leq (\theta^p + \pi)b + \psi^p k^p - \psi k + g_T - g_T^p + g_c - g_c^p + g_i - g_i^p + [(r^p - r^p) - (\theta^p - \theta^p)] b
\]

which is exactly equation (2.21) in Chapter Two, i.e. the ‘permanent balance’ rule for the general (non-primary) government deficit.
CHAPTER THREE
FISCAL SUSTAINABILITY CONVERGENCE
IN ‘OLD’ EUROPE

Progress has not followed a straight ascending line, but a spiral with rhythms of progress and retrogression, of evolution and dissolution.

- Johann Wolfgang von Goethe (1749 - 1832)

The empirical studies summarised in Appendix 2.A disagree in their findings regarding the long-run fiscal sustainability in Europe. Neither does consensus exist on the power of E(M)U’s fiscal rules in particular to bring such sustainability. There is more than the differing datasets or research techniques to explain the latter: the achievements of Maastricht and the SGP remain obscure because limited ways have so far been proposed to display the evolution in sustainability. This chapter proposes a way to assess fiscal sustainability convergence over time, in addition to the hypothetical Maastricht regime change. A comprehensive application on ‘old’ Europe’s data illustrates the approach.

At first sight the analysis of historical data should reveal whether or not EU members are in fact compliant with the IBC: and then Maastricht/SGP might automatically be (dis)credited for the results. This seems to have been the research route followed so far in the European fiscal sustainability literature. Using this approach however, it could be argued that the exact contribution of the E(M)U to fiscal sustainability may never be extracted unless the stages in any convergence towards sustainability are identified.

The rules of the E(M)U seek to impose fiscal discipline on the road to and then within the monetary union and, as the next section shows, the 1990s do point to significant fiscal adjustments in some countries. Whereas the ‘backward-looking’ statistical analysis is not directly compatible with those rules, it can nonetheless test the hypothesis if fiscal sustainability has been achieved; hence whether the Maastricht Treaty and SGP definitions correspond to the notion of long-run fiscal sustainability. Moreover, the statistical tests can reveal when historical sustainability of fiscal policies has been attained.
How sustainability is achieved or changes over time, are issues almost never discussed in the empirical literature. Some studies note that more complex dynamics with particular instances of structural breaks exist (Tanner and Liu, 1994, Liu and Tanner, 1995, Quintos, 1995, Arghyrou and Luintel, 2007, or for all the EU15 countries Afonso, 2005b). De Bandt and Mongelli (2000) use ‘convergence’ in a different context to measure the correlation between key fiscal variables and also the existing pairwise cointegration among country and group (European) averages. Blot and Serranito (2006) analyse convergence in certain EMU fiscal policy indicators but not in sustainability of fiscal policy in the IBC sense.

A notable recent contribution is Prazmowski’s (2005) study of the Dominican Republic based on recursive cointegration but his approach differs in that it uses the Kalman filter and also does not validate the method and its results across more (or European) countries. Before that Hatemi-J (2002b) also applies the Kalman filter on Swedish quarterly data from 1963 till 2000 to estimate a time varying coefficient model. While my research agenda also involves the recursive estimation of a slope parameter, I draw on a simple and transparent dynamic OLS cointegration analysis and a dataset covering almost the entire ‘old’ Europe. That is complemented by an explicit treatment of the Maastricht shift, further highlighting the performance in the 1990s and beyond.

In summary, this chapter addresses the two sequential research questions: have the EU15 countries achieved long-run fiscal sustainability over the period in question, and if so have they become more sustainable due to Maastricht and the SGP? The empirical applications examine the hypothetical gradual convergence towards or away from fiscal sustainability, as well as the particular effect from the Maastricht Treaty. The narrative of the chapter goes as follows. The next section reviews the fiscal experience of Western Europe, based on the two Maastricht fiscal rules, in the run-up to the EMU and in the first years of its existence. The research methods and strategy are outlined then, followed by the section describing the data and presenting the empirical findings. The chapter concludes with a brief summary of results and policy implications.
3.1. Fiscal policy before and after the Euro

This section presents the main fiscal aggregates from 1970 until 2006, the same time span as in the empirical tests below. The descriptive statistics here provide an intuitive view of the hypothesis for convergence towards sustainability since the Maastricht Treaty was signed in 1992. They give a background for the more formal analysis later.

General government fiscal balances

Article 104 of the Maastricht Treaty declares that EU member states should avoid excessive deficits. Article 1 of the Protocol on the excessive deficit procedure (EDP) to the Treaty stipulates that the reference value is 3 percent for the ratio of planned or actual government deficit to GDP at market prices. The SGP in 1997 re-stated that limit, emphasising that within it 'dealing with normal cyclical fluctuations', hence also the operation of automatic fiscal stabilisers, is still possible. The enforcement mechanism is stronger for EMU members than for non-Euro member countries. When the latter have excessive deficits, recommendations are made by the Council. These recommendations according to Article 104(7) are not made public unless no effective measures are taken by the member country. However, the notices under Article 104(9) and the sanctions under Article 104(11) are not applied to non-Euro members (EC, 2006a, p. 40, Box I.1).

Figures 3.1 to 3.4 illustrate the dynamics of non-primary general government fiscal balances in the pre-2004-enlargement EU, as percent of GDP. Figure 3.1 shows the non-Euro countries, Figure 3.2 shows the five biggest and Figure 3.3 the six smallest Euro area economies (before the Eastern enlargements including Slovenia, Malta, Cyprus and Slovakia, but excluding Luxembourg24).

Figure 3.4 plots three unweighted EU14 averages over the same period: for the whole EU minus Luxembourg, abstracting from the 2004 and 2007 enlargements, for the pre-2007-enlargement Euro area, again without Luxembourg, and for the same Euro area but without Greece which adopted the Euro one year after the first eleven countries.

---

24 Historical data on Luxembourg is very scarce so this country is not included. This would hardly alter the overall conclusions about fiscal sustainability in Europe, as in 2006 the country's GDP was only 0.4 percent of the Euro area total (source: Eurostat).
Figure 3.1. General government fiscal balance: EU15 non-Euro countries (percent of GDP)*

* Data unavailable for Denmark for 1970.
Source: Own calculations based on OECD and Eurostat data as described in the data subsection below.

Figure 3.2. General government fiscal balance: five biggest Euro area countries (percent of GDP)

Source: Own calculations based on OECD and Eurostat data as described in the data subsection below.
The four figures above reveal the fiscal turbulences in those countries over the last three and a half decades. Individual country experiences differ substantially yet two common patterns are evident. First, a deterioration is observed in the overall budget stance since the mid-1970s, arguably due to the oil shocks in that decade (see Fatás and Mihov, 2003, p. 116). Second, since the early 1990s fiscal adjustments have taken place with the best fiscal positions achieved around the turn of the century in nearly all countries.
over the whole period. Yet the only year since the early 1970s when the EU on average was in a fiscal surplus is 2000.

It is also evident that the three non-EMU members performed rather similarly to the rest. One suggestion would be that all countries have been well integrated through common trade, cross-border investments and perhaps synchronisation of the business cycles. Hence national budgets have reflected that. Such a surmise deserves a separate study and may not be equally valid for each country, but the experiences of Denmark, Sweden and Great Britain indirectly challenge any straightforward explanation that it was just the signing of the Maastricht Treaty that set off the improvement in fiscal sustainability throughout the nineties.

Yet the Maastricht convergence criteria must have mattered for countries eager to adopt the single currency. Indirect evidence for that is the widespread deterioration in fiscal balances after introducing the Euro in 1999. It may intuitively be implied that, having joined the EMU, countries found the SGP fiscal burdens less binding. For some such as Germany the time had come for deep structural reforms while for others such as Portugal the Euro exposed the lack of competitiveness of the economy. In many cases the result was higher deficits or at least looser fiscal policies.

The analysis of the institutional quality of European public finances (see Afonso, Ebert, Schuknecht and Thöne, 2005) lies beyond the scope of the current analysis. Likewise the decomposition of expenditures and revenues is not needed to test for fiscal sustainability. Fatas and Mihov (2003, p. 121) assert that the deficit reductions after 1992 were due first to tax increases and subsequently to later reductions in government spending. Finally, the coordination of fiscal policy in a monetary union and particularly in the EMU is a broad topic of its own. Such coordination especially against the background of the poor performance of some EMU countries has spurred a huge policy and academic discussion about reforming the SGP. A recent survey by Fischer, Jonung and Larch (2006) identifies and analyses 101 such reform proposals. The assessment of the Pact is at best a side effect of the current study: only inasmuch as it affects long-term fiscal sustainability as earlier defined.
General government debt

The second fiscal provision stemming from Maastricht is that the gross general government consolidated debt at nominal value should not exceed 60 percent of GDP at market prices. That criterion is taken into account when reviewing the performance of candidates for full-EMU membership. In their 'convergence programmes' debt data and projected debt paths are reported, whereas the current EMU members report those in their 'stability programmes' (Council Regulation 1466/97). Thus compliance is monitored for all EU members under the surveillance based on the EDP, however in practice no binding disciplinary action can be taken if the debt limits are breached by existing EMU members or by the two EU members with the 'opt-out' clause.

Even in the run-up to the third stage of the EMU, the Maastricht debt criterion was viewed more flexibly and considered with greater scope for discretion. Against the very high debt/GDP ratios for some European countries, the Treaty allowed for exceeding the reference value in cases when 'the ratio is sufficiently diminishing and approaching the reference value at a satisfactory pace' (Article 104).

It should therefore not necessarily be expected for the debt/GDP ratios to have declined before 1999 or afterwards, although convergence towards the 60 percent value is likely. And that is indeed the overall message of Figures 3.5 to 3.8 which show debt defined according to the Maastricht definition for the 'old' pre-2004-enlargement EU (data unavailable before 1990).

Figure 3.5 illustrates the evolution of the Maastricht debt/GDP ratio of the three non-Euro countries. Figures 3.6 and 3.7 respectively present the five biggest and the six smallest Euro area countries (before the EMU enlargement to include Slovenia in 2007 and Malta and Cyprus in 2008; based on GDP at market prices). Although available since 1990, the Luxembourg data are not shown in Figure 3.7, like in Figure 3.3 previously.

The debt/GDP time path differs substantially from the rest of the EU15: Luxembourg's debt is only 5.4 percent of GDP in 1990 and 6.8 percent of GDP in 2006, according to Eurostat.
Figure 3.5. Maastricht debt: EU15 non-Euro countries (percent of GDP)*

Source: Eurostat.

Figure 3.6. Maastricht debt: five biggest Euro area countries (percent of GDP)*

* Data unavailable for Germany for 1990.
Source: Eurostat.
Finally, Figure 3.8 demonstrates the unweighted average Maastricht debt/GDP ratios for ‘old’ Europe in several dimensions: for the whole EU15, for EU14 (that is EU15 without Luxembourg), for the whole Euro area before 2007, and for the same Euro area without Luxembourg or without Greece.

It can be seen that indeed the years just before the Euro witnessed an overall decline in the general government/GDP ratio, although the Euro area was formed in 1999 with an
unweighted average still above the 60 percent reference value. In the EU12, debt/GDP remained higher than the EU15’s. Certainly individual countries differ: Luxembourg as mentioned has very low indebtedness while some Euro area countries (notably Italy, Belgium and Greece) exhibit very high debt/GDP ratios. Ireland managed to reduce its debt from 94.2 percent of GDP in 1990 to 53.8 percent of GDP in 1998; after joining the EMU, debt reduction continued to reach as low as 24.9 percent of GDP in 2006.

Debt reduction in the late 1990s generally reflects the improvement in budget balances. That may be implied for most individual countries, though with exceptions such as Greece, with a continually high debt, and Austria, where budget deficits shrank while debt as a share of GDP did not change significantly in the years just before the Euro. Germany and France similarly did not succeed in reducing debt despite some budget consolidation right in the run-up to the single currency. Although high, the debt/GDP ratio of Belgium shows a declining trend.

3.2. Between Maastricht and the long-run fiscal sustainability

The overall budget balances and general government debt data so far present varied degrees of compliance with the fiscal criteria from Maastricht and the SGP, both before and after the countries adopted the Euro. A tentative suggestion is therefore that despite efforts by Brussels and individual countries to ensure the sustainable public finances required (in a Ricardian sense) in a monetary union, evidence has been mixed.

Yet even for countries with seemingly successful short-term adjustments an open question remains: have fiscal outcomes, even within the Maastricht bounds, contributed to long-run fiscal sustainability? In other words, have fiscal policies in the 1990s and beyond been such that, looking back at the historical data, the IBC is already satisfied without a need for future changes in policy?

From that perspective, the analysis of fiscal sustainability in ‘old’ Europe should resort to the more formal econometric methods discussed in the previous chapter. This chapter will demonstrate that the longer annual fiscal series now available from the EU14 countries equip an econometric study of not merely the convergence of the fiscal variables, e.g. on some reference deficit and debt values, but of the fiscal sustainability
convergence per se along the road to the Euro. As the empirical methods below rely on the time series properties of past fiscal series, some basic econometrics background is presented first.

Econometrics background

Chapter Two concluded in favour of the cointegration between total revenues and total expenditures as the testable condition for fiscal sustainability in this thesis. Cointegration refers to a stationary linear combination of individually integrated variables. The orders of integration of the variables matter and should first be established. This thesis does not consider the bounds testing approach to the analysis of level relationships by Pesaran, Shin and Smith (2001) where the order of integration of regressors is not preconditioned and it is not known with certainty if they are purely \( I(0) \), purely \( I(1) \) or mutually cointegrated. The two major procedures for cointegration analysis are the two-step method following Engle and Granger (1987) and the system-based one of Johansen (1988, 1991 and 1995). The standard specifications of these tests exploit the relationship between individually \( I(1) \) variables. It is possible to adapt these and test for either 'multicointegration' (i.e. a stationary linear combination of variables with different orders of integration; Granger and Lee, 1990) or 'polynomial cointegration' (i.e. cointegration between the levels and the first differences in variables which are \( I(2) \); Engsted and Haldrup, 1999, p. 237, fn. 1). However this is not needed if the fiscal series are found to be \( I(1) \).

The tests for the order of integration, which must precede and justify the subsequent cointegration analysis, might conclude that the expenditures and revenues are in fact both stationary. This would mean that the overall deficit/surplus is also necessarily stationary, as it is a linear combination of the expenditures and revenues, and so a sustainable fiscal policy will be signalled (Trehan and Walsh, 1988, 1991). It follows that if the series are convincingly found to be \( I(0) \) in the levels, cointegration tests may not be needed.

The first unit root test to be applied below is the generalised least squares version of the augmented Dickey-Fuller (ADF) test. The ADF is a standard tool in the analysis of
single time series and, in its complete form with a constant and a linear trend, is based on the following regression:

\[ \Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha \sum_{i=1}^{\infty} \Delta Y_{t-i} + \varepsilon_t \]

where \( \beta_1 \) is the constant, \( \beta_2 \) is the coefficient on the trend term \( t \), and from the estimation of \( \delta \) the 'tau' statistic is obtained and compared to relevant critical values. The null hypothesis is that \( \delta \) is zero, i.e. there is a unit root. There are several methods for choosing the number of lags of the dependent variable on the right-hand side of (3.1), and more than one of them are applied in the empirical tests below for robustness. It is the added lags of \( \Delta Y \), that 'augment' the first test proposed by Dickey (1976) and Dickey and Fuller (1979).

The Dickey-Fuller generalised least squares test (DFGLS) suggested by Elliott, Rothenberg and Stock (1996) performs a modified Dickey-Fuller type test. The null hypothesis is that the series is \( I(1) \) while the alternative is that it is stationary around a linear time trend or stationary without such trend. In the first case, the intercept and the trend in the original series are estimated by GLS, before transforming and detrending the series and performing an ADF test on it. In the second case, only the intercept in the original series is estimated by GLS before transforming the series and performing an ADF test on it. It has been shown that the power of the DFGLS is higher than of the former Dickey-Fuller tests, so it is nowadays preferred as a 'second-generation' unit root test (Baum, 2001, p. 9).

The assumption for the validity of the non-augmented Dickey-Fuller test is that the residuals in the regression are not serially correlated. If they are, the aim of the ADF is to add the lagged terms as in (3.1) until the serial correlation is overcome. Another way to address a possible serial correlation in the residuals is contained in the test designed by Phillips and Perron (1988), hereafter PPERRON. They use the Newey-West (1987) heteroskedasticity and autocorrelation consistent covariance matrix estimator for that purpose. The asymptotic distribution and the critical values for the PPERRON test statistic are the same as in the ADF test. The PPERRON test has a null hypothesis that the series is \( I(1) \) and is performed below in order to complement the results from the DFGLS test.
A third test, the one by Kwiatkowski, Phillips, Schmidt and Shin (1992, hereafter KPSS) is also applied to the fiscal series in order to achieve yet further robustness. Unlike the previous two tests, this test is based on the null that the series to be tested is \( I(0) \) and not \( I(1) \). Doing DFGLS, PPERRON and KPSS tests guarantees robustness if the findings are not contradictory at a given level of significance. This approach to testing for unit roots/stationarity in the total revenue and total expenditures series is pursued below.

These tests are fairly standard in applied research today but their sometimes low power and size properties are also admitted. The literature in that respect is vast. Haldrup and Jansson (2005) review some criticisms of unit root tests and the theoretical advances in increasing their power and size. More recently, Jönsson (2006) and Carrion-i-Silvestre and Sansó (2006) have discussed the size and power properties of the KPSS stationarity test. Unit root tests with a null of nonstationarity may lack the power to reject a wrong null when the root of the time series is 'close to' but less than unity. In addition, misspecification regarding a trend or the numbers of lags may distort the size of the test, in which case a true null may be rejected. This is a reason why various specifications and tests are compared below.

The revenue-expenditure fiscal sustainability condition may be explored via a number of cointegration methods, once the individual series are found to be \( I(1) \)\(^{26} \). The analysis of long-run relationships in accordance with the IBC requires an estimation of the cointegrating vector. Johansen (1988, 1991 and 1995) and Ahn and Reinsel (1990) have considered efficient estimation based on cointegrated systems fitted in vector error-correction models (VECM). An alternative model for cointegrated systems, the ‘triangular’ representation, yields other efficient estimators such as in Saikkonen (1991) and Stock and Watson (1993). The empirical analysis below employs the dynamic OLS (DOLS) and the dynamic GLS (DGLS) estimators as proposed by Stock and Watson (1993)\(^{27} \). These estimators are simple to compute and, in the case when the individual

\(^{26}\) Previewing the empirical results below, the prevailing evidence from 'old' Europe supports such an order of integration.

\(^{27}\) Saikkonen’s (1991) estimator for cointegrated \( I(1) \) variables is generalised in Stock and Watson (1993) for cointegrating regressions among \( I(d) \) variables.
series are I(1) and there is a single cointegrating vector, they are asymptotically equivalent to the Johansen/Ahn-Reinsel estimator (ibid., p. 784).

The preliminary triangular representation for a bivariate system (as in the current empirical setting) with I(1) variables is:

\( Y_t = \alpha + \beta X_t + \varepsilon_t \)
\( \Delta Y_t = u_t \)

where \( \varepsilon_t \) and \( u_t \) are stationary processes\(^{28}\). In order to control for any correlation between \( \varepsilon_t \) and \( u_t \), Saikkonen (1991) and Stock and Watson (1993) suggest augmenting (3.2) with differenced leads and lags of the regressor, i.e. the following DOLS regression is estimated:

\( Y_t = \alpha + \beta X_t + \sum_{k=-K}^{K} \gamma_k \Delta X_{t-k} + \varepsilon_t \)

where \( k \) is the lead/lag order. \( K \) should be such that the correlation between \( \varepsilon_t \) and \( u_t \) disappears for \( |k| > K \). There is no unique method for determining the lead/lag order (Argyrou and Luinntel, 2007, p. 393) but the least-squares estimation of (3.3) is 'not feasible if \( K \) is too large compared with the sample size' (Saikkonen, 1991, p. 13). Stock and Watson (1993) choose \( K = 2 \) or \( K = 3 \) for their Monte Carlo samples with 100 or 300 observations, respectively (ibid., p. 797), and both \( K = 2 \) and \( K = 3 \) for their empirical data with over 80 years of annual observations (ibid., p. 802). In view of the shorter series of annual data from the EU14, below the lead/lag order is set to 1.

If the residuals in (3.3) are autocorrelated, then the DGLS is the correct cointegrating regression estimator. The construction of the GLS estimator assumes that \( \varepsilon_t \) follows an AR(\( p \)) process. Stock and Watson (1993, p. 797 and p. 802) set \( p = K \) and that is also the general approach in the application here, i.e. \( p = 1 \). In few cases where the first-order autoregressive correction is not sufficient to capture the autocorrelation in the errors, the latter are modelled as an AR(2) for the GLS transformation. The estimation of the autocorrelation structure thus follows Campbell and Perron (1991, p. 51).

\(^{28}\) This follows equations (2.1a) and (2.1b) in Stock and Watson (1993, p. 785); an analogous but more general system nesting (3.2) is presented in Saikkonen (1991, p. 3).
In (3.3), $\alpha$ and $\beta$ are the cointegrating parameters; hence the estimated cointegrating vector, $\hat{\nu}$, is given by $\hat{\nu} = Y, -\hat{\alpha} - \hat{\beta}X$, and ‘its stationarity can be checked through any standard unit root test’ (Arghyrou and Luintel, 2007, p. 393).

The research strategy

Using the econometric techniques just described, the assessment of fiscal sustainability in Europe involves the following stages. First, the orders of integration of the series of total revenues and total expenditures are examined. In the cointegrating equation then the total revenues are regressed on the total expenditures, applying either the DOLS or, if the residuals are serially correlated, the DGLS estimators. The null hypothesis of a unit root in the cointegrating equation is tested, and a number of diagnostic tests are also performed to check the model specification.

Fiscal sustainability strictly requires a cointegrating vector of $(1, -1)$, following Quintos (1995), so the convergence in fiscal sustainability over time can be inferred from the recursive estimation of the cointegrating (slope) parameter. That is why the recursive estimates of the coefficient of total expenditures along with the 95% confidence band are reported, treating 1985 as the start date for the recursion. If there were any Maastricht/SGP effects or other structural breaks in the cointegrating relationship, they should be visually detected. The recursive estimation of the cointegrating (slope) parameter delineates the current study from previous fiscal sustainability literature and forms an essential part of the research strategy$^{29}$.

Finally, the Maastricht effect can be tested by estimating the total multiplier of Maastricht effect through an overall slope dummy for the whole period following the treaty$^{30}$. The analytical framework at this stage mirrors Arghyrou and Luintel (2007). Other things being equal, a positive coefficient of the slope dummy ‘implies a move towards ... strong-form sustainability because the bubble term converges faster to zero

---

$^{29}$ Hatemi-J (2002b) takes a related yet distinctly different step: he provides time varying estimates of the slope coefficient but in a state-space model and where expenditures are regressed on revenues; his empirical analysis covers only one European economy.

$^{30}$ Thus the break date is exogenously selected.
when $\beta \equiv 1$ rather than when $\beta < 1$ (ibid., p. 400); the converse interpretation applies when the same coefficient is estimated negative.

The strategy for research into the (convergence in) fiscal sustainability in ‘old’ Europe is summarised diagrammatically in Figure 3.9.

Figure 3.9. The research strategy

3.3. Data and empirical results

This section demonstrates the empirical analysis of fiscal sustainability in the EU14, the hypothesized convergence in sustainability over time and the Maastricht effect. The relevant fiscal data are discussed first.

Data

A key consideration about the data concerns the level of government. The fiscal sustainability theory reviewed in Chapter Two preferred the general government as the most comprehensive level of government, best revealing the fiscal stance of a country. The Maastricht and SGP deficit and debt criteria, which are a natural context for ‘old’
Europe's fiscal sustainability assessment in a historical perspective, not coincidentally are also set in terms of general government data.

Another consideration regards the frequency of the fiscal series. Alternative data sources were thoroughly reviewed, such as the quarterly version of the International Financial Statistics of the IMF, Eurostat's Quarterly Non-financial Accounts of the General Government, and the databases of the Economist Intelligence Unit. The choice of annual data was preferred and the key argument for that is an econometric one. Unit root/stationarity and cointegration tests are of little value if the series are too short to allow for the reversion to a mean or trend equilibrium. The small-sample bias in traditional time series econometrics is well-documented but simulation studies (Hakkio and Rush, 1991b, and Otero and Smith, 2000) have shown that increasing the frequency of the sample does not significantly raise the test power and a false null hypothesis is still easily accepted. Neither are the size distortions of the tests alleviated by increasing the frequency while staying at a relatively short time span: a true null hypothesis is still easily rejected. With those limitations in mind, annual general government fiscal data are used here.

Furthermore, working with a very large group of countries like those belonging to 'old' Europe requires special attention regarding consistency across the sample. In that respect, additional alternative annual general government finance data sources were reviewed: again the International Financial Statistics but also the Government Finance Statistics of the IMF, World Economic Outlook of the IMF, and the annual versions of databases of the Economist Intelligence Unit. None of those provided consistent and long enough fiscal data series at the EU15 general government level. It must also be emphasised that platforms such as Datastream or ESDS International only give access to data collected and arranged by other organisations such as the previously listed.

It was finally Eurostat and the database of the OECD (accessed through SourceOECD) which provided the longest and the most consistent, hence best comparable across countries and over time, series for the empirical analysis. Wherever available, primarily Eurostat data are used. Arguably this dataset is the most methodologically reliable for intra-European research and closest to the decision-making processes in Brussels and

---

31 Even without Luxembourg where as discussed data are scarce.
Frankfurt. Eurostat data are mirrored in the AMECO macroeconomic database of the European Commission. As it also largely coincides with the more user-friendly (and in many cases longer) Economic Outlook database from the OECD however, technically the latter features as the most commonly used source in Table 3.1 below.

Table 3.1 presents the series of general government total expenditures and total revenues. The choice of these two series corresponds to revenue-expenditure cointegration being the preferred empirically testable condition.

<table>
<thead>
<tr>
<th>NO.</th>
<th>COUNTRY</th>
<th>DATA SPAN</th>
<th>SOURCES AND ADJUSTMENTS</th>
</tr>
</thead>
</table>

Note: Annual general government total revenues and total expenditures, as ratios to GDP. The original series are at current prices, in millions of national currency, not seasonally adjusted. Pre-1999 data for the Euro area countries are fixed to the Euro at the country’s irrevocable Euro conversion rate.

Initially, the opportunity to model increasing fiscal sustainability convergence through a rising number of cointegrating vectors in a Johansen framework was also explored. The latter requires separate interest payments data but such series are inconsistently available across the sample of all EU15 countries over the 37-year time span. An alternative could have been to construct interest payments series synthetically by multiplying stocks of debt with some interest rate. That poses further empirical difficulties. First, the choice of the interest rate is itself limited by data availability and is also contingent upon the theoretical assumptions for constant or varying rate. Wilcox (1989) circumvents those assumptions by empirically calculating ex post the rates of
return to see if discounted debt was stationary but data for this purpose are limited and the ‘correct’ rate may not be obtained. Second, the debt series wherever available are usually given in terms of debt outstanding, whereas the market value of the debt might better reflect the true fiscal burden.

Before proceeding to the empirical tests, two remaining points about the data and the empirical counterparts to the theoretical models for fiscal sustainability convergence should be noted. As reviewed in Chapter Two, nominal rather than real values of the fiscal variables are preferable for three reasons. First, real values are not directly observed or observable, neither empirically or as policy targets. Second, any attempt to convert nominal values into real means more ‘pre-test intervention’ and hence a way of distorting the raw data. Third, the need to use some deflator would further blur the comparability between countries. Even if the European Harmonised Index of Consumer Prices (HICP) is used, it has limitations and also some countries still do not report it.

Another preference also justified previously is the practice of taking the nominal values as ratios to nominal GDP. That reflects the implicit limitation on the government’s potential to meet its fiscal obligations. The context of economic growth in a country is central when assessing its fiscal and overall sustainability.

In summary, it is general government, annual and nominal total expenditures and total revenues that are presented in Table 3.1, all expressed as ratios to GDP at market prices.

Unit root/stationarity results

The first results from the unit root and stationarity tests are presented in Table 3.2. A battery of specifications and tests were applied in order to achieve robustness. At the conventional confidence intervals the evidence suggests overwhelmingly that the series of total expenditures and total revenues in the levels are not stationary for the fourteen countries in this sample. Table 3.3 displays the evidence from the same tests but this time performed on the first-differenced series. The results suggest that the differenced series are $I(0)$ rather than $I(1)$.

---

32 See Chapter Two.
Table 3.2. Unit root/stationarity tests: total expenditures and total revenues (levels)

<table>
<thead>
<tr>
<th>Country</th>
<th>Series</th>
<th>Tests with trend(^{(1)})</th>
<th>Tests without trend(^{(1)})</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DFGLS (^{(0,6)})</td>
<td>KPSS (^{(9)})</td>
</tr>
<tr>
<td>Austria</td>
<td>(te)</td>
<td>-0.495 (1)</td>
<td>0.424*</td>
</tr>
<tr>
<td></td>
<td>(tr)</td>
<td>-0.426 (1)</td>
<td>0.421*</td>
</tr>
<tr>
<td>Belgium</td>
<td>(te)</td>
<td>-1.580 (2)</td>
<td>0.254*</td>
</tr>
<tr>
<td></td>
<td>(tr)</td>
<td>-1.410 (1)</td>
<td>0.248*</td>
</tr>
<tr>
<td>Denmark</td>
<td>(te)</td>
<td>-1.474 (1)</td>
<td>0.347*</td>
</tr>
<tr>
<td></td>
<td>(tr)</td>
<td>-1.447 (1)</td>
<td>0.249*</td>
</tr>
<tr>
<td>Finland</td>
<td>(te)</td>
<td>-2.119 (1)</td>
<td>0.204**</td>
</tr>
<tr>
<td></td>
<td>(tr)</td>
<td>-0.272 (1)</td>
<td>0.345*</td>
</tr>
<tr>
<td>France</td>
<td>(te)</td>
<td>-1.574 (1)</td>
<td>0.345*</td>
</tr>
<tr>
<td></td>
<td>(tr)</td>
<td>-1.266 (1)</td>
<td>0.333*</td>
</tr>
<tr>
<td>Germany</td>
<td>(te)</td>
<td>-1.777 (1)</td>
<td>0.125**</td>
</tr>
<tr>
<td></td>
<td>(tr)</td>
<td>-1.621 (1)</td>
<td>0.123**</td>
</tr>
<tr>
<td>Greece</td>
<td>(te)</td>
<td>-0.611 (1)</td>
<td>0.41*</td>
</tr>
<tr>
<td></td>
<td>(tr)</td>
<td>-2.284 (1)</td>
<td>0.118</td>
</tr>
<tr>
<td>Ireland</td>
<td>(te)</td>
<td>-1.462 (1)</td>
<td>0.364*</td>
</tr>
<tr>
<td></td>
<td>(tr)</td>
<td>-1.536 (1)</td>
<td>0.366*</td>
</tr>
<tr>
<td>Italy</td>
<td>(te)</td>
<td>-0.999 (1)</td>
<td>0.444*</td>
</tr>
<tr>
<td></td>
<td>(tr)</td>
<td>-1.330 (1)</td>
<td>0.31*</td>
</tr>
<tr>
<td>Netherlands</td>
<td>(te)</td>
<td>-0.867 (1)</td>
<td>0.429*</td>
</tr>
<tr>
<td></td>
<td>(tr)</td>
<td>-1.258 (1)</td>
<td>0.411*</td>
</tr>
<tr>
<td>Portugal</td>
<td>(te)</td>
<td>-1.072 (1)</td>
<td>0.365*</td>
</tr>
<tr>
<td></td>
<td>(tr)</td>
<td>-3.087***</td>
<td>-1.997 (2)</td>
</tr>
<tr>
<td>Spain</td>
<td>(te)</td>
<td>-0.847 (1)</td>
<td>0.448*</td>
</tr>
<tr>
<td></td>
<td>(tr)</td>
<td>-0.938 (1)</td>
<td>0.439*</td>
</tr>
<tr>
<td>Sweden</td>
<td>(te)</td>
<td>-0.806 (1)</td>
<td>0.376*</td>
</tr>
<tr>
<td></td>
<td>(tr)</td>
<td>-0.403 (1)</td>
<td>0.424*</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>(te)</td>
<td>-2.349 (1)</td>
<td>0.128***</td>
</tr>
<tr>
<td></td>
<td>(tr)</td>
<td>-3.021 (1)</td>
<td>0.9987</td>
</tr>
</tbody>
</table>

Notes: \(te\) and \(tr\) stand for total expenditures and total revenues, respectively, as shares of GDP.

\(^{(1)}\) Both tests with and without a trend include a constant term.

\(^{(2)}\) Lag order selected according to the minimum Schwarz Information criterion.

\(^{(3)}\) Lag order selected according to the minimum Ng-Perron (2001) modified Akaike information criterion.

\(^{(4)}\) Same lag order used as determined by either the modified Akaike information criterion if lag at most 3 there, or if otherwise: by the minimum Schwarz Information criterion from the DFGLS test. In PPERRON, that is set to correspond to Newey-West truncation lags window used in calculating the standard error (i.e. correction for serial correlation of up to that lag order).

\(^{(5)}\) The rho statistic in the PPERRON test, \(H_0: \rho = 1\).

\(^{(6)}\) The brackets report the number of lags selected for each test statistic.
Table 3.3. Unit root/stationarity tests: total expenditures and total revenues (first differences)

<table>
<thead>
<tr>
<th>Country</th>
<th>Series</th>
<th>Tests with trend(4)</th>
<th>Tests without trend(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DFGLS (1,6)</td>
<td>DFGLS (3,6)</td>
</tr>
<tr>
<td>Austria</td>
<td>$\Delta e$</td>
<td>-5.740** (1)</td>
<td>-3.740** (1)</td>
</tr>
<tr>
<td></td>
<td>$\Delta r$</td>
<td>-5.840 (1)</td>
<td>-5.840 (1)</td>
</tr>
<tr>
<td>Belgium</td>
<td>$\Delta e$</td>
<td>-2.347 (1)</td>
<td>-2.347 (1)</td>
</tr>
<tr>
<td></td>
<td>$\Delta r$</td>
<td>-3.201*** (1)</td>
<td>-2.079 (2)</td>
</tr>
<tr>
<td>Denmark</td>
<td>$\Delta e$</td>
<td>-3.895* (1)</td>
<td>-3.895* (1)</td>
</tr>
<tr>
<td></td>
<td>$\Delta r$</td>
<td>-4.093* (1)</td>
<td>-0.963 (8)</td>
</tr>
<tr>
<td>Finland</td>
<td>$\Delta e$</td>
<td>-3.391** (1)</td>
<td>-3.391** (1)</td>
</tr>
<tr>
<td></td>
<td>$\Delta r$</td>
<td>-4.397* (1)</td>
<td>-4.397* (1)</td>
</tr>
<tr>
<td>Greece</td>
<td>$\Delta e$</td>
<td>-3.657*** (3)</td>
<td>-2.731 (1)</td>
</tr>
<tr>
<td></td>
<td>$\Delta r$</td>
<td>-3.608* (1)</td>
<td>-2.544 (2)</td>
</tr>
<tr>
<td>Germany</td>
<td>$\Delta e$</td>
<td>-3.259*** (1)</td>
<td>-1.462 (5)</td>
</tr>
<tr>
<td></td>
<td>$\Delta r$</td>
<td>-3.330*** (1)</td>
<td>-1.445 (6)</td>
</tr>
<tr>
<td>Ireland</td>
<td>$\Delta e$</td>
<td>-4.069* (1)</td>
<td>-0.890 (8)</td>
</tr>
<tr>
<td></td>
<td>$\Delta r$</td>
<td>-2.270*** (1)</td>
<td>-2.343 (2)</td>
</tr>
<tr>
<td>Italy</td>
<td>$\Delta e$</td>
<td>-3.346*** (1)</td>
<td>-3.346*** (1)</td>
</tr>
<tr>
<td></td>
<td>$\Delta r$</td>
<td>-3.598* (1)</td>
<td>-2.683 (2)</td>
</tr>
<tr>
<td>Netherlands</td>
<td>$\Delta e$</td>
<td>-3.407*** (1)</td>
<td>-1.626 (5)</td>
</tr>
<tr>
<td></td>
<td>$\Delta r$</td>
<td>-3.026 (1)</td>
<td>-2.371 (2)</td>
</tr>
<tr>
<td>Portugal</td>
<td>$\Delta e$</td>
<td>-4.168* (1)</td>
<td>-4.168* (1)</td>
</tr>
<tr>
<td></td>
<td>$\Delta r$</td>
<td>-5.376* (1)</td>
<td>-1.037 (8)</td>
</tr>
<tr>
<td>Spain</td>
<td>$\Delta e$</td>
<td>-2.958 (1)</td>
<td>-2.958 (1)</td>
</tr>
<tr>
<td></td>
<td>$\Delta r$</td>
<td>-2.925 (1)</td>
<td>-1.944 (3)</td>
</tr>
<tr>
<td>Sweden</td>
<td>$\Delta e$</td>
<td>-3.246*** (1)</td>
<td>-3.246*** (1)</td>
</tr>
<tr>
<td></td>
<td>$\Delta r$</td>
<td>-3.651*** (1)</td>
<td>-3.651*** (1)</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>$\Delta e$</td>
<td>-2.871 (1)</td>
<td>-2.871 (1)</td>
</tr>
<tr>
<td></td>
<td>$\Delta r$</td>
<td>-3.932* (1)</td>
<td>-3.927 (1)</td>
</tr>
</tbody>
</table>

Notes: $\Delta e$ and $\Delta r$ stand for the first differences of total expenditures and total revenues, respectively, as shares of GDP.

* ** and *** denote rejection of the null at 1%, 5% and 10%. In DFGLS, the 5% and 10% critical values are from Cheung and Lai (1995), while the 1% critical values are interpolated from the ones presented by Elliott, Rothenberg and Stock (1996). In KPSS, the critical values are taken from Kwiatkowski et al. (1992). In PFEKRON, the critical values are linearly interpolated from the ones in Fuller (1976).

(1) Both tests with and without a trend include a constant term.

(2) Lag order selected according to the minimum Schwarz information criterion.

(3) Lag order selected according to the minimum Ng-Perron (2001) modified Akaike information criterion.

(4) Same lag order used as determined by either the modified Akaike information criterion if lag at most 3 there, or if otherwise: by the minimum Schwarz information criterion from the DFGLS test. In PPFEKRON, that is set to correspond to Newey-West truncation lags window used in calculating the standard error (i.e. correction for serial correlation of up to that lag order).

The $rho$ statistic in the PPFEKRON test, $H_0: rho = 1$.

(5) The brackets report the number of lags selected for each test statistic.
Cointegration results

The cointegration analysis is to provide the main evidence for or against fiscal sustainability. Having established that the fiscal series are $\mathcal{A}(1)$, the regression specification from (3.3) is applied to the EU14 data, with total revenue the dependent variable and total expenditures the regressor. The results from the DOLS (DGLS) regression, the unit-root tests for the estimated cointegrating vector and the set of diagnostics are presented in Table 3.4, following the research strategy outlined in the previous section.

In Austria, Belgium, Denmark, Finland, France, Greece, Ireland, Italy, and Spain the cointegrating coefficient on the expenditures ($\beta$) is statistically significant but the unity null is strongly rejected. The slope parameter is estimated positive and less than 1, and the unit root in the cointegrating vector is not rejected: hence, weak-form sustainability is confirmed for these countries.

Non-stationarity of the cointegrating vector is rejected, at various significance levels, in Germany, the Netherlands, Sweden and the United Kingdom but the cointegrating coefficients are statistically different from unity, positive and less than 1. Thus, again evidence for only weak-form sustainability is provided there.

For Portugal, even though the unity null of the slope coefficient cannot be rejected at the 5% level and its actual estimate is close to 1, the cointegrating vector is not stationary. Portugal therefore satisfies another weak-form sustainability definition as per Quintos (1995).

The DGLS transformations employ up to second-order autocorrelation corrections. The diagnostic tests rarely indicate specification problems at the conventional significance levels: the residuals are normal, serially uncorrelated, homoskedastic and without ARCH effects.
Table 3.4. Cointegration analysis without breaks

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>AT</th>
<th>BE</th>
<th>DK</th>
<th>FI</th>
<th>FR</th>
<th>DE</th>
<th>GR</th>
<th>IE</th>
<th>IT</th>
<th>NL</th>
<th>PT</th>
<th>ES</th>
<th>SE</th>
<th>GB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DGLS (1)</td>
<td>DGLS (2)</td>
<td>DGLS (1)</td>
<td>DGLS (1)</td>
<td>DGLS (1)</td>
<td>DGLS (1)</td>
<td>DGLS (1)</td>
<td>DGLS (1)</td>
<td>DGLS (1)</td>
<td>DGLS (1)</td>
<td>DGLS (1)</td>
<td>DGLS (1)</td>
<td>DGLS (2)</td>
<td>DGLS (2)</td>
</tr>
<tr>
<td>alpha</td>
<td>0.160*</td>
<td>0.401*</td>
<td>0.186*</td>
<td>0.215*</td>
<td>0.135*</td>
<td>0.217*</td>
<td>0.084*</td>
<td>0.219*</td>
<td>0.015*</td>
<td>0.156*</td>
<td>-0.021</td>
<td>0.075</td>
<td>0.274*</td>
<td>0.200</td>
</tr>
<tr>
<td>TE</td>
<td>0.640*</td>
<td>0.140*</td>
<td>0.647*</td>
<td>0.601*</td>
<td>0.685*</td>
<td>0.483*</td>
<td>0.660*</td>
<td>0.400*</td>
<td>0.822*</td>
<td>0.646*</td>
<td>0.929</td>
<td>0.738</td>
<td>0.376</td>
<td>0.486</td>
</tr>
<tr>
<td>F-Wald test, H0: β = 0</td>
<td>163.93</td>
<td>12.71</td>
<td>57.41</td>
<td>211.74</td>
<td>410.91</td>
<td>28.36</td>
<td>321.37</td>
<td>245.92</td>
<td>237.87</td>
<td>267.54</td>
<td>529.61</td>
<td>486.52</td>
<td>55.30</td>
<td>35.84</td>
</tr>
<tr>
<td>[p-value]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td></td>
</tr>
<tr>
<td>F-Wald test, H0: β = 1</td>
<td>51.54</td>
<td>477.45</td>
<td>17.13</td>
<td>93.06</td>
<td>87.07</td>
<td>32.44</td>
<td>85.61</td>
<td>555.00</td>
<td>11.11</td>
<td>80.51</td>
<td>3.06</td>
<td>61.29</td>
<td>152.76</td>
<td>40.01</td>
</tr>
<tr>
<td>[p-value]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td>[0.009]</td>
<td></td>
</tr>
<tr>
<td>Misspecification tests</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(p-values)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Breusch-Godfrey LM P-test for 1st order autocorrelation</td>
<td>0.94</td>
<td>0.25</td>
<td>0.62</td>
<td>0.67</td>
<td>0.85</td>
<td>0.76</td>
<td>0.39</td>
<td>0.92</td>
<td>0.26</td>
<td>0.07</td>
<td>0.68</td>
<td>0.69</td>
<td>0.25</td>
<td>0.22</td>
</tr>
<tr>
<td>Jarque-Bera Chi² test for normality</td>
<td>0.61</td>
<td>0.13</td>
<td>0.21</td>
<td>0.45</td>
<td>0.58</td>
<td>0.83</td>
<td>0.95</td>
<td>0.89</td>
<td>0.90</td>
<td>0.49</td>
<td>0.00</td>
<td>0.77</td>
<td>0.81</td>
<td></td>
</tr>
<tr>
<td>Engle's LM Chi² test for ARCH</td>
<td>0.09</td>
<td>0.94</td>
<td>0.36</td>
<td>0.69</td>
<td>0.08</td>
<td>0.42</td>
<td>0.51</td>
<td>0.52</td>
<td>0.75</td>
<td>0.03</td>
<td>0.52</td>
<td>0.87</td>
<td>0.46</td>
<td>0.85</td>
</tr>
<tr>
<td>White's Chi² test for heteroskedasticity</td>
<td>0.58</td>
<td>0.30</td>
<td>0.93</td>
<td>0.38</td>
<td>0.60</td>
<td>0.32</td>
<td>0.16</td>
<td>0.23</td>
<td>0.28</td>
<td>0.23</td>
<td>0.31</td>
<td>0.12</td>
<td>0.33</td>
<td>0.31</td>
</tr>
</tbody>
</table>

Sustainability inference [Weak-form] [Weak-form] [Weak-form] [Weak-form] [Weak-form] [Weak-form] [Weak-form] [Weak-form] [Weak-form] [Weak-form] [Weak-form] [Weak-form] [Weak-form] [Weak-form] [Weak-form]


1 DGLS order of the autocorrelation correlation.

* ** and *** denote significance at the 1%, 5% and 10% level, respectively.

TR and TE stand for total revenue and total expenditures, respectively, as shares of GDP.

ADF is the Augmented Dickey-Fuller test (lag order selected using the minimum Schwarz information criterion; cointegration test critical values from MacKinnon, 1991, Table I).
In summary, 'old' Europe appears to be no more than weak-form fiscally sustainable. This evidence broadly confirms Arghyrou and Luintel's (2007) results from a previous European study exploring Quintos's (1995) fiscal sustainability conditions. In view of such results, however, it is important to remember that 'weak' fiscal sustainability may in practice place an undue fiscal burden on the public finances of a country and lead to fiscal unsustainability eventually. All in all therefore, the full samples from the last four decades from 'old' Europe hardly offer any evidence in favour of the hypothesis that fiscal sustainability, in a historical perspective, has been achieved as of today.

The recursive estimation of the cointegrating (slope) coefficient ($\beta$) in the DOLS (DGLS) regression of total revenue on total expenditures can uncover evidence for fiscal pressures and adjustment towards sustainability. In this way, the cointegration analysis incorporates an assessment of possible gradual convergence in fiscal sustainability in Western Europe. Figures 3.10 - 3.23 display the recursive estimation of the slope coefficients, including the 95% confidence bands. The recursions start from 1985, so as to disentangle any positive influence of Maastricht/SGP on fiscal sustainability: if sustainability has emerged only after 1992, then such effects can plausibly be confirmed.

The recursive cointegration evidence indicates weak-form sustainability across most of the countries, with the estimated 95% confidence bands for the coefficients varying between 0 and 1. As long as the upper end of the confidence range for the cointegrating parameter suffices for such a conclusion, the results suggest possible strong-form sustainability in Finland in the mid-1980s (Figure 3.13), France shortly after the start of the recursions (Figure 3.14), and Portugal after 1994 (Figure 3.20). If minding that the 95% confidence band partly lies outside the (0, 1) interval, however, the charts imply absence of fiscal sustainability in Portugal during the first half of the recursive period and in the United Kingdom (Figure 3.23) before 1991.

The estimates of the slope coefficient show that the fiscal stance in Germany generally improved, despite a slight deterioration after the launch of the Euro (Figure 3.15). Greece likewise displays steady improvement throughout the 1990s (Figure 3.16). Again just within Quintos's (1995) weak-form definition, there is a marked

---

33 The weak-form results in the empirical papers in Table 2.A.1 are documented as a lack of sustainability.
improvement in fiscal sustainability in Spain after the country joined the EU in 1986 (Figure 3.21). For the rest of 'old' Europe, the results demonstrate little or no signs of convergence in fiscal sustainability since 1985.

As for a particular 1992 regime change, only Austria (Figure 3.10), Germany, Greece and Portugal display any more visible jumps in the estimated coefficient of the expenditures, suggesting that Maastricht at least initially spurred a convergence in fiscal sustainability. No clear positive effect can be seen in Denmark (Figure 3.12), Ireland (although Figure 3.17 hints that the Maastricht Treaty may have stopped the deviation from fiscal sustainability), Italy (Figure 3.18), the Netherlands (Figure 3.19), Spain, Sweden (Figure 3.22), and the United Kingdom. Conversely, a negative Maastricht effect is rather observed in the cases of Belgium (Figure 3.11), Finland and France.

Figure 3.10. Austria: convergence in fiscal sustainability

Figure 3.11. Belgium: convergence in fiscal sustainability
Figure 3.12. Denmark: convergence in fiscal sustainability

Figure 3.13. Finland: convergence in fiscal sustainability

Figure 3.14. France: convergence in fiscal sustainability
Figure 3.15. Germany: convergence in fiscal sustainability

Figure 3.16. Greece: convergence in fiscal sustainability

Figure 3.17. Ireland: convergence in fiscal sustainability
To sum up, no country belonging to ‘old’ Europe satisfies the IBC in the ‘strong’ sense defined by Quintos (1995) because either the revenue and expenditures are not cointegrated, or the estimated cointegrating vector is not (1, -1), or both. Such is the
evidence from the cointegration analysis over the full sample periods; the recursive estimation of the coefficient on the expenditures signifies no convergence in sustainability either.

The recursions also showed little empirical support for a Maastricht Treaty effect. The hypothesis of a regime change can be addressed explicitly with the estimation of the total multiplier of Maastricht effect through an overall slope dummy for the whole period after the (exogenously selected) break in 1992. As in Arghyrou and Luintel (2007), a significantly positive slope coefficient will then suggest that Maastricht has induced fiscal adjustment towards the strong-form sustainability. This further view on the EU14 is illustrated by the empirical results in Table 3.5, where the specification from (3.3) is augmented by the structural shift dummies.

The total multiplier associated with Maastricht turns out to be significantly positive, but its estimated value suggests only a modest regime change to improve the fiscal outlook after 1992, in Austria, Belgium, Denmark, Germany, Ireland, Portugal, and Spain. The same Maastricht effect seems only slightly stronger in the cases of Greece and Italy. Finland, France, the Netherlands and Sweden (a non-EMU country) show a statistically insignificant total multiplier, thus indicating no fiscal sustainability effect from the Maastricht Treaty. The estimated Maastricht slope dummy appears significantly negative in the United Kingdom, confirming the move away from strong-form sustainability after 1992. The UK did not have to conform to the European convergence criteria in order to adopt the Euro; hence the Maastricht Treaty may have not been the cause for the negative post-1992 effect on the country’s government finances.

In all countries except the UK, the overall slope \((\beta + \phi)\) is statistically different from zero and positive but less than 1, thus implying weak-form fiscal sustainability regardless of whether the cointegrating vector residuals appear stationary (Austria, Germany, the Netherlands) or not.

The UK evidence stands out with an estimated coefficient of the overall slope which is statistically insignificant. Hence, despite rejecting the unit root null in the residuals from the cointegrating vector, the evidence from this country poses a challenge even to the weak-form fiscal sustainability definition of Quintos (1995).
### Table 3.5. Cointegration analysis with a break

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>AT</th>
<th>BE</th>
<th>DK</th>
<th>FI</th>
<th>FR</th>
<th>DE</th>
<th>GR</th>
<th>IE</th>
<th>IT</th>
<th>NL</th>
<th>PT</th>
<th>ES</th>
<th>SE</th>
<th>GB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DGLS (1)</td>
<td>DGLS (1)</td>
<td>DGLS (1)</td>
<td>DGLS (1)</td>
<td>DGLS (1)</td>
<td>DGLS (1)</td>
<td>DGLS (1)</td>
<td>DGLS (1)</td>
<td>DGLS (1)</td>
<td>DGLS (2)</td>
<td>DGLS (2)</td>
<td>DGLS (1)</td>
<td>DGLS (1)</td>
<td></td>
</tr>
<tr>
<td>Estimated equation: $TR = \alpha + \beta T + \varphi (D, TE) + \varepsilon$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\alpha$</td>
<td>0.183</td>
<td>0.226</td>
<td>0.251</td>
<td>0.123</td>
<td>0.277</td>
<td>0.172</td>
<td>0.188</td>
<td>0.079</td>
<td>0.189</td>
<td>0.033</td>
<td>0.097</td>
<td>0.368</td>
<td>0.322</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.024)*</td>
<td>(0.029)*</td>
<td>(0.045)*</td>
<td>(0.029)*</td>
<td>(0.024)*</td>
<td>(0.051)*</td>
<td>(0.022)*</td>
<td>(0.023)*</td>
<td>(0.028)*</td>
<td>(0.024)</td>
<td>(0.012)*</td>
<td>(0.032)*</td>
<td>(0.055)*</td>
<td></td>
</tr>
<tr>
<td>$T$</td>
<td>0.586</td>
<td>0.326</td>
<td>0.504</td>
<td>0.619</td>
<td>0.711</td>
<td>0.347</td>
<td>0.376</td>
<td>0.457</td>
<td>0.628</td>
<td>0.590</td>
<td>0.740</td>
<td>0.656</td>
<td>0.391</td>
<td>0.229</td>
</tr>
<tr>
<td></td>
<td>(0.047)*</td>
<td>(0.052)*</td>
<td>(0.085)*</td>
<td>(0.067)*</td>
<td>(0.049)*</td>
<td>(0.110)*</td>
<td>(0.052)*</td>
<td>(0.043)*</td>
<td>(0.050)*</td>
<td>(0.050)*</td>
<td>(0.063)*</td>
<td>(0.032)*</td>
<td>(0.052)*</td>
<td>(0.118)*</td>
</tr>
<tr>
<td>$D^*TE(D = 1$ in 1992-2006, 0 otherwise)</td>
<td>0.020</td>
<td>0.069</td>
<td>0.049</td>
<td>-0.007</td>
<td>-0.005</td>
<td>0.016</td>
<td>0.132</td>
<td>0.031</td>
<td>0.105</td>
<td>-0.018</td>
<td>0.087</td>
<td>0.044</td>
<td>-0.014</td>
<td>-0.045</td>
</tr>
<tr>
<td>$F$-Wald test, $H_0: \beta + \varphi = 0$</td>
<td>179.64</td>
<td>47.98</td>
<td>47.19</td>
<td>135.00</td>
<td>252.37</td>
<td>11.69</td>
<td>144.07</td>
<td>69.75</td>
<td>257.95</td>
<td>97.63</td>
<td>239.55</td>
<td>548.66</td>
<td>52.01</td>
<td>2.07</td>
</tr>
<tr>
<td>(p-value)</td>
<td>(0.00)*</td>
<td>(0.09)*</td>
<td>(0.01)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.16)</td>
</tr>
<tr>
<td>$F$-Wald test, $H_0: \beta + \varphi = 1$</td>
<td>76.00</td>
<td>113.34</td>
<td>30.82</td>
<td>53.99</td>
<td>43.94</td>
<td>35.79</td>
<td>159.44</td>
<td>76.44</td>
<td>34.19</td>
<td>54.77</td>
<td>101.41</td>
<td>141.48</td>
<td>40.63</td>
<td></td>
</tr>
<tr>
<td>(p-value)</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td>(0.00)*</td>
<td></td>
</tr>
</tbody>
</table>

#### Misspecification tests

<table>
<thead>
<tr>
<th>Breusch-Godfrey LM F-test for 1st order autocorrelation</th>
<th>0.83</th>
<th>0.34</th>
<th>0.48</th>
<th>0.67</th>
<th>0.88</th>
<th>0.63</th>
<th>0.68</th>
<th>0.95</th>
<th>0.69</th>
<th>0.07</th>
<th>0.78</th>
<th>0.57</th>
<th>0.19</th>
<th>0.46</th>
</tr>
</thead>
<tbody>
<tr>
<td>(p-values)</td>
<td>0.06</td>
<td>0.00</td>
<td>0.00</td>
<td>0.48</td>
<td>0.55</td>
<td>0.84</td>
<td>0.40</td>
<td>0.72</td>
<td>0.03</td>
<td>0.14</td>
<td>0.53</td>
<td>0.06</td>
<td>0.80</td>
<td>0.98</td>
</tr>
<tr>
<td>Jarque-Bera Chi² test for normality</td>
<td>0.26</td>
<td>0.64</td>
<td>0.45</td>
<td>0.66</td>
<td>0.08</td>
<td>0.70</td>
<td>0.79</td>
<td>0.88</td>
<td>0.36</td>
<td>0.76</td>
<td>0.23</td>
<td>0.97</td>
<td>0.32</td>
<td>0.34</td>
</tr>
<tr>
<td>Engle's LM Chi² test for ARCH</td>
<td>0.38</td>
<td>0.20</td>
<td>0.27</td>
<td>0.23</td>
<td>0.39</td>
<td>0.27</td>
<td>0.27</td>
<td>0.20</td>
<td>0.21</td>
<td>0.42</td>
<td>0.42</td>
<td>0.25</td>
<td>0.42</td>
<td>0.45</td>
</tr>
<tr>
<td>White's Chi² test for heteroskedasticity</td>
<td>0.38</td>
<td>0.20</td>
<td>0.27</td>
<td>0.23</td>
<td>0.39</td>
<td>0.27</td>
<td>0.27</td>
<td>0.20</td>
<td>0.21</td>
<td>0.42</td>
<td>0.42</td>
<td>0.25</td>
<td>0.42</td>
<td>0.45</td>
</tr>
</tbody>
</table>

#### Sustainability inference

| Weak-form | Weak-form | Weak-form | Weak-form | Weak-form | Weak-form | Weak-form | Weak-form | Weak-form | Weak-form | Weak-form | Weak-form | Weak-form | No Sustainability |
|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-------------------|

**Notes:** Standard errors in parentheses. Annual data from 1970 (1971 in Denmark) to 2006.

1. DGLS order of the autocorrelation correction.

* * * and *** denote significance at the 1%, 5% and 10% level, respectively.

TR and TE stand for total revenue and total expenditures, respectively, as shares of GDP.

ADF is the Augmented Dickey-Fuller test (lag order selected using the minimum Schwarz information criterion; cointegration test critical values from MacKinnon, 1991, Table 1).

118
All in all, the combined results from Table 3.4 and Table 3.5 provide evidence against fiscal sustainability which is fairly uniform across the fourteen countries and robust in terms of whether the Maastricht effect is explicitly considered or not. In most cases in 'old' Europe, the Treaty of 1992 has encouraged only negligible adjustments to satisfy the strong-form definition of long-run fiscal sustainability; sometimes the Maastricht effect is absent or even significantly negative.

3.4. Conclusion

A comprehensive statistical assessment of the fiscal performance of 'old' Europe during the last almost four decades hardly offers any evidence in favour of the hypothesis that fiscal sustainability, in a historical perspective, has been achieved. This verdict conforms to the majority of previous European-based studies documented in Appendix 2.A. However, the recursive cointegration methodology in this chapter makes it possible to examine if there was any convergence in fiscal sustainability over time. It may now be acknowledged that the fiscal rules imposed to ensure the successful launching and functioning of the monetary union have not in fact induced national policies compliant with the IBC. This conclusion is all the more robust since the analysis here is one of the first really pan-European fiscal sustainability studies.

There has always been keen academic interest in the fiscal side of the EMU, the literature both spurring and shadowing the policies in the run-up to the Euro in the 1990s and the SGP reform debate in the current decade. As the E(M)U enlarges further and new economies experience some old compliance challenges, public finances in Europe will remain an area where theory and policy intersect. What are the policy implications then, if neither Maastricht, nor the Pact, nor the actual advent of the Euro seem to have mattered in streamlining any efforts to run public finances in keeping with the intertemporal constraint?

The first implication to note is that since the countries over most of the period reviewed have failed the IBC condition, policy changes are to be expected if authorities are keen to restore long-run sustainability. Unfortunately this suggestion may be alerting but is not straightforwardly translatable into concrete budgetary policies. Policymakers may intuitively expect that reducing the government debt is required, implying an increase in

119
revenue or cut in expenditures. But hardly anything is clear about the size and sign of adjustments needed to achieve a stationary linear combination between revenues and total expenditures.

Whereas the evidence here may be judged more narrowly as just an empirical application of the proposed sustainability convergence model, it nonetheless sheds new light on the rationale behind the European fiscal rules. Opponents of the current fiscal regime in Europe might be tempted to arm themselves with the findings from this chapter. A possible neutral argument, however, could be that the results above do not immediately relate to the efficacy of the fiscal rules: but rather bear on a claim that the Maastricht and SGP fiscal arrangements differ from some definitions of long-run sustainability.
CHAPTER FOUR
FISCAL SUSTAINABILITY IN EU ACCESSION COUNTRIES: A PANEL (CO)INTEGRATION PERSPECTIVE

But the only way of discovering the limits of the possible is to venture a little way past them into the impossible.
- Arthur C. Clarke, 'Profiles of the Future' (1962)

During the period from 2004 to 2007 the European Union enlarged further to include a total of twenty-seven members. The accession of the new members from Central and Eastern Europe marked an end to the transition process that followed their political transformation and the start of economic reforms after 1989. In most cases the transition began with severe recessions and then deep structural reforms followed, which necessarily meant a complete makeover of the fiscal environment in an economic, legislative and policymaking horizon. The accession countries have also undergone remarkable fiscal adjustments with debt and deficits often below those in the 'old' European Union (the EU15). Following EU accession, all new members must comply with the fiscal requirements of the Stability and Growth Pact. Many of them already joined the ERM 2 and made efforts to adopt the single currency rapidly. Slovenia in 2007 became the thirteenth member of the currency union; Cyprus and Malta followed suit in 2008; Slovakia joined the Euro area in 2009. Despite the apparent overall progress in fiscal consolidation, the whole evidence points to both fiscal slippages and successes in the past, as well as ongoing pressures to abide by prudent fiscal policies.

Now that the accession countries all joined the EU and the SGP should be guiding their policies, delving into their fiscal performance so far could be revealing. An imminent research question is whether, based on their historical record, fiscal policies in the region as a whole can be categorised as 'sustainable'.

Having stated that, relatively little work has been done to study fiscal sustainability in the accession countries using the formal methods of fiscal sustainability assessment, discussed in the previous two chapters. Therefore this chapter aims to fill a gap in the
empirical literature and extend the fiscal sustainability analysis to the twelve EU accession countries.

Undoubtedly an obstacle to the analysis of Central and Eastern Europe is the very short time series of available data. Thus for purely econometric reasons it has until recently been argued that studying long-run sustainability there will remain impossible for years to come. Appendix 2.A confirms that the region has received minimal research attention so far in this particular literature strand.


Instead, accession countries’ fiscal sustainability has been addressed as a broader concept and/or analysis has focused on concrete aspects of fiscal policy. Thus recent research includes Coricelli (2004) and Schwartz, Corbacho, Cui, Ganelli and Manasse (2007) who dealt with the public investments side of fiscal policies aimed at catching-up with the more advanced European economies; Afonso, Nickel and Rother (2006) highlighted the fiscal consolidation experience; Wagner (2006) surveyed the fiscal challenges related to EU accession; Lewis (2007) analysed country-specific fiscal dynamics in the run-up to the EU; and Staehr (2008) studied the cyclicity of fiscal policies.

Green, Holmes and Kowalski (2001) are a notable exception in that they empirically prove an IBC-rooted fiscal sustainability for one accession country, Poland. Their analysis is based on high-frequency (monthly) data from January 1991 through March 1998, i.e. long before the EU entry. Recently Llorca and Redzepagic (2008) assessed fiscal sustainability in a panel of eight accession countries, using quarterly data from 1999 until the first quarter of 2006, in accordance with the revenue-expenditure cointegration criterion. Their statistical methods are akin to the ones utilised in this thesis and represent a major extension of the empirical fiscal sustainability literature to the region of Central and Eastern Europe. This chapter, however, tackles some of the
issues overlooked in Llorca and Redzepagic (2008) and offers important advances along the following lines.

The analysis here will cover for the first time all the twelve EU accession countries and the fiscal time series from them are longer. As Chapter Three discusses, the cointegration study of macroeconomic data requires long data spans and increasing the frequency in order to provide more observations does not alleviate the power and size distortions with series of relatively short length.

Furthermore, this chapter is based on an original dataset constructed for the purposes of the empirical agenda. To study the hypothesized fiscal adjustment 'puzzle' for the region, I propose adopting some novel applications from panel econometrics. The variety of panel time series methods applied below exceeds any of the panel sustainability studies so far documented in Table 2.A.1 and certainly Llorca and Redzepagic (2008).

Not least, this chapter relaxes the strong assumption of cross-sectional independence in the panel data. This assumption has been a limitation of the tests which have so far dominated the panel cointegration literature. The analysis below follows some very recent theoretical breakthroughs and is the first to assess the historical fiscal sustainability of accession Europe, in keeping with the IBC, without confining the data to a cross-sectional independence assumption.

In summary, from a theoretical perspective the chapter is among the first contributions in a recent literature importing the advances in the econometrics of unit roots and cointegration in panels into the domain of fiscal sustainability. Taking advantage of a new dataset covering more countries with longer time series of relevant fiscal data than ever before, this chapter conducts the most comprehensive so far fiscal sustainability analysis for accession Europe. Furthermore, the variety of econometric methods and specifications aim for maximal robustness of the empirical results, hence - plausibility of the policy implications.

Applying the tools of fiscal sustainability analysis in the IBC sense to accession Europe provides continuity and a common framework for comparing the results from other
chapters and discussing cross-country and cross-region evidence. However, the data limitations are necessarily reflected in the scope of the research now. Macroeconomic series from Central and Eastern Europe before the start of transition are, if available at all, incompatible with what those countries began to report in the 1990s. The complete makeover of institutions, legislation and accounting conventions means that annual series substantially longer than a decade are not feasible. What is more, some of the countries in the sample did not emerge as independent political entities until the early 1990s. That precludes an analysis of the evolution over time (or essentially, convergence) in fiscal sustainability in the spirit of Chapter Three.

In view of the above, before studying how the accession countries held up to the IBC, it is worth noting the major dissimilarities between them and 'old' Europe. Briefly presenting their distinct fiscal background in the next section will highlight the research focus, justify the choice of empirical strategy and ease the interpretation of results. After that the chapter proceeds with motivating the panel fiscal sustainability analysis and a background for the panel time series techniques. The data and the empirical results come next, before the final section which briefly concludes.

4.1. The fiscal experience of accession countries

The section below presents some background descriptive statistics and a summary of key developments that affected the fiscal stance of the twelve countries which have joined the EU since 2004.

The transition and EU accession context

The fiscal paths of CEE countries since the early 1990s were marked by periods of imbalances and volatility, as illustrated by Table 4.1 and Table 4.2. The fiscal turbulence reflected the dual pressure of transition reforms and progress towards EU accession. It may be argued that whereas some countries were delaying politically unpopular structural reforms, that seems to have resulted in slower growth (Table 4.3) rather than in a distinct pattern of the aggregate fiscal indicators.

34 The narrative here and in Chapter Five also relates to Malta and Cyprus, the two nominally non-transition countries which acceded to the EU in May 2004.
### Table 4.1. General government fiscal balance, percent of GDP

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>1.7</td>
<td>-0.4</td>
<td>0.5</td>
<td>1.9</td>
<td>0.1</td>
<td>-0.9</td>
<td>2.2</td>
<td>1.9</td>
<td>3.3</td>
</tr>
<tr>
<td>Cyprus</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>-4.2</td>
<td>-4.4</td>
<td>-2.4</td>
<td>-2.3</td>
<td>-4.4</td>
<td>-6.3</td>
<td>-4.1</td>
<td>-2.3</td>
<td>-1.5</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>-13.4</td>
<td>-3.3</td>
<td>-3.8</td>
<td>-5.0</td>
<td>-3.7</td>
<td>-5.7</td>
<td>-6.8</td>
<td>-6.6</td>
<td>-2.9</td>
<td>-3.5</td>
<td>-2.9</td>
<td></td>
</tr>
<tr>
<td>Estonia</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>-0.2</td>
<td>-0.3</td>
<td>0.4</td>
<td>2.0</td>
<td>2.3</td>
<td>2.3</td>
<td>3.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>-2.9</td>
<td>-3.4</td>
<td>-8.2</td>
<td>-7.2</td>
<td>-6.5</td>
<td>-7.8</td>
<td>-9.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latvia</td>
<td>-2</td>
<td>1.5</td>
<td>0.6</td>
<td>-5.3</td>
<td>-2.8</td>
<td>0.1</td>
<td>-0.9</td>
<td>-0.9</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lithuania</td>
<td>-1.6</td>
<td>-1.1</td>
<td>-1.9</td>
<td>-3.1</td>
<td>-2.8</td>
<td>-3.2</td>
<td>-2.1</td>
<td>-1.5</td>
<td>-1.3</td>
<td>-1.5</td>
<td>-0.5</td>
<td>-0.3</td>
</tr>
<tr>
<td>Malta</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>0.7</td>
<td>-7.6</td>
<td>-6.1</td>
<td>-6.4</td>
<td>-5.5</td>
<td>-10</td>
<td>-5</td>
<td>-3.1</td>
<td>-2.6</td>
</tr>
<tr>
<td>Poland</td>
<td>-4.4</td>
<td>-4.9</td>
<td>-4.6</td>
<td>-4.3</td>
<td>-1.8</td>
<td>-1.5</td>
<td>-3.7</td>
<td>-3.2</td>
<td>-6.3</td>
<td>-5.7</td>
<td>-4.3</td>
<td>-3.9</td>
</tr>
<tr>
<td>Romania</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>-3.2</td>
<td>-4.5</td>
<td>-4.6</td>
<td>-3.3</td>
<td>-2</td>
<td>-1.5</td>
<td>-1.5</td>
<td>-1.4</td>
<td>-1.9</td>
</tr>
<tr>
<td>Slovakia</td>
<td>-1.8</td>
<td>-6.7</td>
<td>-4.8</td>
<td>-6.4</td>
<td>-11.8</td>
<td>-6.5</td>
<td>-7.7</td>
<td>-2.7</td>
<td>-2.4</td>
<td>-2.8</td>
<td>-3.4</td>
<td></td>
</tr>
<tr>
<td>Slovenia</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>4.4</td>
<td>1.1</td>
<td>2.5</td>
<td>0.7</td>
<td>1.3</td>
<td>1.5</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EU15</td>
<td>-53</td>
<td>-41</td>
<td>-2.5</td>
<td>-1.7</td>
<td>-0.8</td>
<td>0.5</td>
<td>-1.1</td>
<td>-2.2</td>
<td>-2.9</td>
<td>-2.7</td>
<td>-2.3</td>
<td>-1.6</td>
</tr>
</tbody>
</table>

Source: Eurostat  
Note: 'n/a' means data unavailable

### Table 4.2. General government consolidated gross debt, percent of GDP

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria</td>
<td>105.1</td>
<td>79.6</td>
<td>79.3</td>
<td>73.6</td>
<td>66.2</td>
<td>54</td>
<td>45.9</td>
<td>37.9</td>
<td>29.2</td>
<td>22.8</td>
<td></td>
</tr>
<tr>
<td>Cyprus</td>
<td>n/a</td>
<td>61.6</td>
<td>62</td>
<td>61.6</td>
<td>61.9</td>
<td>64.7</td>
<td>69.1</td>
<td>70.3</td>
<td>69.2</td>
<td>65.3</td>
<td></td>
</tr>
<tr>
<td>Czech Republic</td>
<td>12.2</td>
<td>12.9</td>
<td>13.4</td>
<td>18.2</td>
<td>26.3</td>
<td>28.5</td>
<td>30.1</td>
<td>30.7</td>
<td>30.4</td>
<td>30.4</td>
<td></td>
</tr>
<tr>
<td>Estonia</td>
<td>6.4</td>
<td>5.6</td>
<td>6</td>
<td>4.7</td>
<td>4.7</td>
<td>5.6</td>
<td>5.7</td>
<td>5.2</td>
<td>4.4</td>
<td>4.1</td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td>64.2</td>
<td>61.9</td>
<td>61.2</td>
<td>55.4</td>
<td>52.2</td>
<td>54</td>
<td>58</td>
<td>59.4</td>
<td>61.7</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>Latvia</td>
<td>152</td>
<td>16.5</td>
<td>23</td>
<td>23.8</td>
<td>22.9</td>
<td>22.2</td>
<td>21.2</td>
<td>19.4</td>
<td>18.6</td>
<td>18.2</td>
<td></td>
</tr>
<tr>
<td>Lithuania</td>
<td>51.5</td>
<td>64.9</td>
<td>56.8</td>
<td>56.4</td>
<td>63.5</td>
<td>60.1</td>
<td>70.4</td>
<td>73.9</td>
<td>72.4</td>
<td>66.5</td>
<td></td>
</tr>
<tr>
<td>Malta</td>
<td>44</td>
<td>39.1</td>
<td>40.3</td>
<td>36.8</td>
<td>39.8</td>
<td>39.1</td>
<td>37.7</td>
<td>45.7</td>
<td>47.1</td>
<td>47.8</td>
<td></td>
</tr>
<tr>
<td>Poland</td>
<td>16.5</td>
<td>17.8</td>
<td>24.2</td>
<td>22.7</td>
<td>n/a</td>
<td>23.8</td>
<td>21.5</td>
<td>18.8</td>
<td>15.8</td>
<td>12.4</td>
<td></td>
</tr>
<tr>
<td>Romania</td>
<td>30.6</td>
<td>33.1</td>
<td>34</td>
<td>47.2</td>
<td>49.9</td>
<td>49.2</td>
<td>43.3</td>
<td>42.4</td>
<td>41.5</td>
<td>34.5</td>
<td>30.7</td>
</tr>
<tr>
<td>Slovakia</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>23.6</td>
<td>24.9</td>
<td>27.4</td>
<td>28.4</td>
<td>29.1</td>
<td>28.6</td>
<td>28.9</td>
<td>27.8</td>
</tr>
<tr>
<td>Slovenia</td>
<td>72.6</td>
<td>71</td>
<td>68.9</td>
<td>67.9</td>
<td>64.1</td>
<td>63.1</td>
<td>61.5</td>
<td>63.1</td>
<td>63.3</td>
<td>64.4</td>
<td>63.3</td>
</tr>
</tbody>
</table>

Source: Eurostat  
Note: 'n/a' means data unavailable

### Table 4.3. Gross domestic product, constant prices, annual percent change

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria</td>
<td>-9.1</td>
<td>-10.8</td>
<td>-8.4</td>
<td>-11.6</td>
<td>-3.7</td>
<td>-1.6</td>
<td>-8</td>
<td>-3.6</td>
<td>4</td>
<td>2.3</td>
<td>5.2</td>
</tr>
<tr>
<td>Cyprus</td>
<td>7.3</td>
<td>0.3</td>
<td>8.4</td>
<td>1.5</td>
<td>4.8</td>
<td>8.2</td>
<td>1.8</td>
<td>2.3</td>
<td>5</td>
<td>4.8</td>
<td>3.5</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>-1.2</td>
<td>-11.5</td>
<td>-3.3</td>
<td>0.6</td>
<td>3.2</td>
<td>6.4</td>
<td>4.2</td>
<td>-0.7</td>
<td>-0.8</td>
<td>1.3</td>
<td>4</td>
</tr>
<tr>
<td>Estonia</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>-1.6</td>
<td>4.5</td>
<td>4.4</td>
<td>11.1</td>
<td>4.4</td>
<td>0.3</td>
<td>9.1</td>
</tr>
<tr>
<td>Hungary</td>
<td>-3.5</td>
<td>-11.9</td>
<td>-3.1</td>
<td>-0.6</td>
<td>2.9</td>
<td>3.5</td>
<td>1.3</td>
<td>4.6</td>
<td>4.9</td>
<td>4.2</td>
<td>4.4</td>
</tr>
<tr>
<td>Latvia</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>-11.4</td>
<td>2.2</td>
<td>0.9</td>
<td>3.8</td>
<td>8.3</td>
<td>4.7</td>
<td>8.5</td>
</tr>
<tr>
<td>Lithuania</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>-16.2</td>
<td>-9.8</td>
<td>1.2</td>
<td>5.1</td>
<td>8.5</td>
<td>7.5</td>
<td>-1.5</td>
<td>7.2</td>
</tr>
<tr>
<td>Malta</td>
<td>4.7</td>
<td>5.9</td>
<td>8.1</td>
<td>3.9</td>
<td>4.6</td>
<td>6.9</td>
<td>4.8</td>
<td>3.4</td>
<td>3.8</td>
<td>0.4</td>
<td></td>
</tr>
<tr>
<td>Poland</td>
<td>7.2</td>
<td>-7</td>
<td>2</td>
<td>4.3</td>
<td>5.2</td>
<td>6.8</td>
<td>6.2</td>
<td>7.1</td>
<td>5</td>
<td>4.5</td>
<td>3.6</td>
</tr>
<tr>
<td>Romania</td>
<td>-5.6</td>
<td>-12.9</td>
<td>-8.8</td>
<td>1.5</td>
<td>3.9</td>
<td>7.1</td>
<td>3.9</td>
<td>-6.1</td>
<td>-4.8</td>
<td>-12</td>
<td>5.5</td>
</tr>
<tr>
<td>Slovakia</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>6.3</td>
<td>5.8</td>
<td>8</td>
<td>5.7</td>
<td>3.7</td>
<td>0.3</td>
<td>4.5</td>
</tr>
<tr>
<td>Slovenia</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>2.8</td>
<td>5.3</td>
<td>4.1</td>
<td>3.7</td>
<td>4.8</td>
<td>3.9</td>
<td>5.4</td>
<td>3.8</td>
</tr>
</tbody>
</table>

Source: International Monetary Fund, World Economic Outlook Database, April 2007, and own calculations.  
Note: 'n/a' means data unavailable
The initial instances of GDP decline, hence shrinking of the tax base, exacerbated the fiscal burden and were considered an important cause for the large primary deficits (Budina and van Wijnbergen, 1997). That is a first feature of the transition experience which differentiates those countries from the EU15 group. Unemployment then rose sharply, further aggravated by large-scale privatisation and pro-market structural reforms, and the social security systems were strained.

The collapse of the centrally planned economies revealed a heritage of outdated and malfunctioning infrastructures (EBRD, 2004). Schwartz et al. (2007) state that roads had been lacking investment and maintenance as the use of private cars had been limited compared to Western standards. The railways were mostly suited for the transport of industrial production. Telecommunication technology was not up to date and not widely accessible. Water supply was often insufficient and water waste disposal not environmentally friendly.

That necessitated significant public sector outlays, even after newly-emerged private sector institutions allowed for public-private investment partnerships and after access to the EU pre-accession funds was opened up. In order to pursue international competitiveness and attract much needed foreign investors, the accession countries also embarked on more radical tax reforms. Nowadays they exhibit lower corporate and income tax rates than EU15. Most countries in the region gradually adopted flat-tax regimes. Whereas in the medium term that strategy indeed spurred growth and led to increase of tax revenues, initially the fiscal consolidation may have been jeopardised.

The budgetary process has been adversely affected by a greater share of the shadow economy and hence tax evasion. Schneider and Klinglmair (2004) estimate that the average size of the shadow economy by the end of the last century was 38 percent of official GDP in the transition countries, compared to only 17 percent in the OECD.

Not surprisingly then, most countries in the 1990s experienced budget deficits higher than the EU15 average. On the other hand however, their fiscal adjustment paths benefited from the generally lower (except for Bulgaria) initial government debt ratios.
In addition to their transition specifics, those countries also differ from the EU15 group in the fiscal challenges related to EU accession advancement taking place simultaneously. Wagner (2006) presents a comprehensive survey of fiscal costs and benefits resulting from EU membership, on both the expenditures and revenues side. Thus compliance with EU regulations required more public expenditures. According to Kopits and Székely (2004) the reform of public administration alone could cost up to 1.5 percent of GDP. Following accession, the new members also had to contribute to the EU budget. Although the accession treaties initially provided for some temporary compensation against the possibility that the new members incurred negative budget balances against the EU, the 2004 enlargement group are no longer eligible for those. In the financial programming period for 2007-2013 only the two most recent entrants, Bulgaria and Romania, were entitled to such compensations (fixed at EUR 0.4 billion). Moreover, the co-financing required for taking advantage of EU funds may have a negative impact on the accession countries’ budgets: although private sources might also be drawn on for such projects. The European Commission estimated that in 2004, the first even if incomplete year of membership, co-financing amounted to about 0.3 percent of GDP on average for the new EU members (Schwartz et al., 2007).

Fiscal gains would be expected too. State subsidies should gradually be eliminated, taking off some pressure on the budgets. Reduced interest risk premia following EU accession should also benefit some countries, although as illustrated in Table 4.2 the debt and hence debt-service burden have generally declined or at least stayed low.

Government revenues might be affected in both directions, again in the shorter or longer term. The new members benefit from transfers from the EU budget. The ten 2004 EU entrants were allocated expenditures of EUR 9.1 billion in 2005 (9.5 percent of the EU total). Poland then became the 8th largest recipient of all European expenditure. But the emphasis was increasingly being put on the absorption capacity: in 2007 for the first time, funds committed but not spent by the accession countries were to be cancelled under the ‘n+2 rule’, i.e. after two years if still unspent (EC, 2006b).

EU membership also further stimulates investment and economic growth in the new members, and thus contributes to higher tax proceeds. Conversely, exposure to competitive pressures from the common market may deteriorate the financial positions
of domestic companies and spur intra- or cross-border mobility of production factors including labour: hence, undermine tax sources.

All in all, the net fiscal impact of EU accession is hard to assess, even though all new members are net receivers of EU transfers. First post-accession estimates based on actual data indicated that EU-related transfers may have led to a fiscal drag of 0.5 to 1 percent of GDP and an additional aggregate demand stimulus of up to 1 percent of GDP (Rosenberg and Sierhej, 2007).

Neither is the precise factor of EU accession easy to assess when looking at the aggregate numbers in Table 4.1 and Table 4.2. Compared to the EU15, whereas in some cases significant fiscal adjustments took place throughout the 1990s via reduction of gross debt/GDP ratios, about the turn of the century the accession countries fared worse in their fiscal balances (Buiter and Grafe, 2004). Some countries improved on their balances subsequently but causal links to EU accession are ambiguous: it is worth reminding that in the run-up to accession no macroeconomic criteria were conditioned.

Still, after joining the EU the new members became automatically subject to the Stability and Growth Pact. Although before entering the ERM 2 and before full membership of the EMU the non-Euro countries may not, technically, be sanctioned against for violating the fiscal criteria of the Pact, their performance is subject to close scrutiny as discussed in section 3.1 above. Therefore it could be surmised that overall the drive for EU accession and then the obligations arising from it may partly explain the more recent fiscal consolidations in most accession countries. Schwartz et al. (2007, p. 7) have identified 38 episodes of fiscal consolidations, defined as annual positive changes in the overall budget balance, between 1999 and 2005.

While the role of EU accession for the fiscal adjustments in CEE so far may be debatable, a separate strand of literature dwells on the ongoing policy discussions about reforms of the SGP. The Pact has attracted criticism concerning its relevance to the accession economies. Convergence and catch-up growth there are often argued to require high public investment outlays that may break the budget deficit limits (Coricelli, 2004).
In essence, despite controversies and limited research into the fiscal background for the road towards EU membership, it is the specifics stemming from the transition and EU accession experiences which justify an analysis of the CEE countries as a group of their own. Their historical fiscal sustainability should be analysed separately, notwithstanding the fact that there are also many factors affecting the fiscal stance shared by any European country. Thus liberalisation of markets, globalisation and international competition are common challenges with oftentimes direct fiscal implications at national levels. Ageing populations, pension and public sector reforms may likewise provoke fiscal costs across otherwise varying countries. Although not subject to the disciplinary measures envisaged for existing EMU members, accession into the EU already requires some compliance with the Stability and Growth Pact for all. As the accession countries are not allowed the ‘opt-out’ clause, they would eventually have to adopt the Euro and must thus gradually bring their public finances under the Maastricht debt and deficit criteria.

**The long-run fiscal sustainability criterion revisited**

The issue about whether fiscal policies of the accession countries have been sustainable, as defined under the ‘backward-looking’ statistical tests approach adopted empirically in this thesis, requires tools and data beyond the intuitive discussion and descriptive statistics. Observed high debt and deficit levels alone may not contradict the notion of sustainability if growing at rates lower than economic growth rates. Or the government may run fiscal surpluses in the future to compensate for accumulated debt, again requiring a statistical analysis beyond the mere debt/GDP ratios.

Chapter Two discussed the rationale behind the ‘statistical tests’ approach to fiscal sustainability: assessment is done under the assumption that past policies are kept unchanged and the fiscal sequences are continued into the future. Considering the short data series typical of accession countries, that assumption seems necessary in the empirical work here.

The pioneering contribution of Hamilton and Flavin (1986) reflects that interpretation of ‘testing’ the IBC, although for them a violation of the IBC in historical data would just mean that the government has chosen the alternative fiscal path requiring perpetual debt
financing. Hamilton and Flavin's (1986) stationarity conditions for the presence of fiscal sustainability were in subsequent literature complemented by econometrically testable cointegration conditions, as emphasized in the previous chapters. Today it is standard research practice to assess historical fiscal sustainability by testing for cointegration between revenues and total expenditures and estimating the parameters in the cointegrating vector.

This chapter extends the European fiscal sustainability literature to cover all EU accession countries. The same revenue-expenditure cointegration conditions as in Chapter Three are tested in order to keep the research methodology uniform across Europe and ease the comparison of evidence and the interpretation of policy implications. Historical fiscal sustainability will be confirmed provided that the series of total revenues and total expenditures are either both stationary in their levels, or are integrated of order 1 and cointegrated with a vector \((1, -1)\).

The assessment of fiscal sustainability is thwarted by the short series of accession countries' data. Long-run macroeconomic relationships cannot easily be tested since the structural transition from centrally-planned to market economy makes any fiscal data before the mid-1990s either impossible to obtain or irrelevant. It is not surprising that this area is less often studied for less developed countries as a whole. Green et al. (2001) and Llorca and Redzepagic (2008) represent the first attempts until now, to the best of my knowledge, to apply to some accession countries the methods of fiscal sustainability assessment of past data in the IBC sense.

As long as data permit, such type of long-run sustainability analysis has been confined to other EU countries. Afonso (2005b) finds little evidence in favour of sustainability for the majority of EU15 countries between 1970 and 2003, similarly to Bravo and Silvestre (2002) before that. Some of the countries assessed by Papadopoulos and Sidiropoulos (1999) turn out to be fiscally sustainable, as are the countries from the study by Arghyrou and Luintel (2007).

Prohl and Schneider (2006) applied panel cointegration techniques to render the opposite evidence that the EU15 countries are fiscally sustainable: but only in the

35 Certainly, data availability or adaptations of the seminal methods have permitted research such as Ghatek and Sánchez-Fung (2006).
weaker form following Quintos's (1995) definition. Claeys (2007) in another recent attempt to import panel methods concluded that the EU15's fiscal policy has been sustainable overall. At least at a panel level, the positive conclusion is not reversed if allowing for breaks and using a slightly longer dataset (Afonso and Rault, 2007a and 2007b).

The panel approach can also provide the means to study consistency with the IBC of the fiscal policies of accession countries. It is the limited existence of formal fiscal sustainability assessment of these countries that inspired the search for new methods in the sections to follow.

4.2. A panel fiscal sustainability analysis

The revenue-expenditure cointegration framework for the analysis of fiscal sustainability, this time adapted in a panel setting, is motivated next. This section also contains a background for the relevant panel time series techniques.

*The implications of panel tests on the issue of sustainability*

The panel perspective is an appealing alternative because of the low power and hence low value of unit root and cointegration tests if the individual time series are too short. According to Hakkio and Rush (1991b) and Otero and Smith (2000), it is not worthwhile to increase the frequency of the sample in otherwise short time spans. The new advances in panel econometrics, however, make it possible now to seek the application of traditional fiscal sustainability assessment methods for the countries that recently joined the EU.

In the context of the fiscal sustainability literature, the panel cointegration framework essentially involves a pooling of the data from individual countries in order to test for sustainability. Traditionally, fiscal sustainability is usually assessed on a country by country basis; what then is the economic rationale for applying the panel cointegration framework to the EU accession countries as a whole? The following reasons have justified this approach. First, the countries in the region have much in common to allow for a group-wise analysis. They have shared the common goal of acceding to the EU.
and, as noted above, their policies have been conducted within the related fiscal context of both EU enlargement and transition to a market economy. Thus the panel approach is a reasonable first step in approximating the evidence for or against fiscal sustainability based on accession countries’ data available at present.

Second, as Afonso and Rault (2007b, p. 8) assert, 'even if there is no single fiscal policy in the EU, a panel sustainability analysis of public finances has to be seen as relevant in a context of EU countries seeking to pursue common and sound fiscal policy behaviour within the SGP framework'. This argument is not less applicable to the recent accession countries.

Not least, as the results in Giuliodori and Beetsma (2008) suggest, there is interdependence between the planned fiscal stances of the EU members. Potential reasons for the relationship between national fiscal policies in the EU are the common interest rates in the integrated capital market, yardstick and tax competition between the countries, their contesting to attract foreign investment through domestic infrastructure enhancements, and the peer pressure exerted by ‘fiscally virtuous’ countries (ibid., p. 222). These reasons may be expected to imply co-dependent fiscal policies in the accession countries as well.

Furthermore, from an econometric point of view Prohl and Schneider (2006) emphasise the higher power of the panel approach, in comparison with the shorter individual series, to examine the sustainability hypothesis. Panel data models provide more observations and hence more degrees of freedom while deriving the appropriate panel test statistics. Recently Westerlund and Prohl (2008) study a panel of the rich OECD countries and also put forward the argument for the higher power of panel cointegration tests permitting better the analysis of breaks, the latter always being costly in terms of power loss.

In other areas, the rising interest in panel (co)integration has also primarily been motivated by a desire to gain more statistical power over the single time series counterparts. Because the short time series are typical of transition and less developed economies, the panel versions of unit root and cointegration tests are increasingly attractive for cross-country research. Numerous applications are found in areas like the
purchasing power parity, equilibrium exchange rates and exchange rate pass-throughs, among others (Osbat, 2004).

The revenue-expenditures cointegration condition in a panel setting might prove difficult to interpret because panel cointegration may hold for the whole of the panel but not for some individual members. While this argument applies to all panel cointegration studies, to mitigate it the first extension in the cointegration analysis below involves country sub-samples, thus extracting the maximal individual country inference possible using short series that preclude any univariate analysis. Such strategy further delineates this study from the existing ground-breaking panel sustainability literature.

*The panel unit root and stationarity tests*

The panel unit root tests performed in the next section follow Breitung (2000). The choice is motivated by the documented superior small-sample behaviour of this test. With the early panel unit root tests ‘it is hard to detect nonstationarity in short time series’, as Hlouskova and Wagner (2006, p. 25) put it; but their large-scale simulation study shows that Breitung’s (2000) test is among the best performing. Hadri’s (2000) test is then also applied for robustness as it has the alternative null of panel stationarity.

Both tests belong to the class of ‘first generation’ panel tests in that they assume cross-sectional independence. This ‘simplifies the derivation of the asymptotic distributions of panel unit root and stationarity tests considerably’ (Hlouskova and Wagner, 2006, p. 86) but is an arguably strong assumption, often violated in practice. Cross-sectional dependence in the errors is due to ‘omitted observed common factors, spatial spill over effects, unobserved common factors, or general residual interdependence’ (Breitung and Pesaran, 2005, p. 18). A country’s macroeconomic performance may be affected by policies and outcomes in trade partners or related foreign economies. Another complication is the possible cross-section cointegration (Banerjee, Marcellino and Osbat, 2004). Breitung and Pesaran (2005) point out that cross-cointegration should be

---

37 Initially the panel unit root tests developed by Maddala and Wu (1999), Levin, Lin and Chu (2002), and Im, Pesaran and Shin (2003) were also applied here. Indeed, their empirical results were inconsistent and contradictory. These results are available upon request.
distinguished from the case when the errors are cross-correlated without any
cointegration of the units.

In recent times a variety of 'second generation' panel unit root tests have been proposed
to deal with different forms of cross-section dependence. Those include the
contributions by Chang (2002), Choi (2002), Phillips and Sul (2003), Bai and Ng
(2004), Moon and Perron (2004) and Pesaran (2007). Those tests, however, are not
widely implemented yet, and to-date their finite-sample properties have not been
examined as fully as those of the former panel unit root tests (Hlouskova and Wagner,
2006). That is why the empirical approach below parallels the panel time series
literature in other areas using the now standard 'first generation' tests.

A further reason to keep the cross-sectional independence assumption and carry it
forward to the subsequent panel cointegration analysis is the research strategy. The
fiscal sustainability analysis of accession Europe aims to provide continuity with
Chapter Three in favouring the revenue-expenditure cointegration condition. It is in the
panel cointegration stage below that the assumption of cross-sectional independence is
relaxed eventually. Thus the thesis becomes the first analysis of long-run fiscal
sustainability in Central and Eastern Europe where the time series are not restricted to
be independent across the countries in the panel\(^38\).

\textit{Panel cointegration tests}

Panel cointegration is in its infancy compared to the upsurge in the panel unit roots
literature. Yet a multitude of tests have recently been proposed to deal with issues
beyond the traditional univariate time series models: heterogeneity of the cointegrating
parameters and of the trends and intercepts across units, cross-section dependence and
cointegration between variables from different units. As in the single time series
dimension, panel cointegration techniques belong to two classes: residual based and
system based. The popular tests of Kao (1999) and Pedroni (1999, 2004) belong to the
first class. The tests proposed by Larsson, Lyhagen and Löthgren (2001) and Breitung
(2005) exemplify the latter and represent panel extensions of the Johansen (1995)

\(^{38}\) The issue of whether the empirical country series are cross-sectionally independent is discussed again
in the data section.
procedure to identify multiple cointegrating vectors. A ‘hybrid’ alternative is the meta-analytic derivation of test statistics from individual series tests’ $p$ values.

Banerjee et al. (2004) conduct Monte Carlo experiments for the size and power of some panel cointegration tests and find that the short series necessitate a particularly cautious application of panel cointegration methods. Similar warnings come from the large scale simulation study carried out by Hlouskova and Wagner (2007) who investigate the properties of panel cointegration tests as well as estimators. So although the panel perspective may be the only feasible way to conduct a wide-ranging analysis of fiscal sustainability in Central and Eastern Europe, the empirical results here should be interpreted against the small-sample robustness of the different tests.

Again in view of facilitating comparisons with well-established other applications of panel cointegration, and so to have a simple first-step extension of traditional fiscal sustainability analysis into the panel dimension, the popular panel cointegration tests by Kao (1999) and Pedroni (1999, 2004) are applied first below.

The short time dimension of the panel dataset from the accession countries precludes attempting to also address possible structural breaks in the panel following a separate growing strand of the panel cointegration literature (Carrion-i-Silvestre, Lluís and Sansó, 2006; Westerlund, 2006a and 2006b). The policy assumption to justify a lesser need to model breaks in the current sample is that in most CEE countries the deep structural reforms were already implemented, or at least started, before 1995.

Panel cointegration estimation

Estimation of the cointegrating vector(s) is required finally in order to test the hypothesis of ‘strong’ vs. ‘weak’ fiscal sustainability following Quintos (1995). If both cointegration and unit cointegrating parameters were found, the data sample will give unambiguous evidence in favour of sustainability. The evidence will be less vigorous if panel cointegration estimators cannot confirm the null hypothesis of unitary coefficient(s) on the right-hand side variable in the cointegration regression.
Recently growing literature has emerged to propose various methods of estimating the panel cointegrating relationship. Maeso-Fernandez, Osbat and Schnatz (2006) and Hlouskova and Wagner (2007) review some of them. Among others, such estimators comprise the fully-modified OLS (FMOLS) by Pedroni (2000) and Phillips and Hansen (1999), the dynamic OLS (DOLS) following Saikkonen (1991) and Mark and Sul (2003), the mean-group and pooled mean-group estimators proposed by Pesaran, Shin and Smith (1999) or more recent system estimators such as Binder, Hsiao and Pesaran (2005) or Breitung (2005).

The FMOLS and DOLS estimators are recommended in the univariate time series cases for handling non-exogeneity of the regressors and serial correlation of the errors (Osbat, 2004). The same considerations should be addressed in panel data too. That is why, after the panel cointegration tests, the panel cointegration estimators proposed by Pedroni (2000, 2001) are applied here. The following reasons have broadly justified that choice.

First, the group-mean panel FMOLS estimator ‘allows for a more flexible alternative hypothesis’ (Pedroni, 2000, p. 96) in that the estimated coefficient(s) need not be identical across units. In group-mean estimators data are pooled along the ‘between’ dimension of the panel so that the null hypothesis of a common value of the cointegrating parameter across all units is tested against the alternative that the parameter has a value different from the null and is not required to be identical in all units. Conversely, pooled estimators are based on pooling the data along the ‘within’ dimension of the panel so that the null hypothesis of a common value of the cointegrating parameter across all units is tested against the alternative that the parameter has a value different from the null but is still identical in all units. Second, comparing the asymptotic properties of the pooled (along the ‘within’ dimension) ‘adjusted’ FMOLS and ‘residual’ FMOLS, and the group-mean (along the ‘between’ dimension) FMOLS, Pedroni shows that the latter exhibits least small-sample distortions. Third, because Pedroni’s result is based on T being larger than N, but that is not always so in the sample below, DOLS estimation is also applied to ensure robustness of the empirical findings. Pedroni (2001) claims that the between-dimension group-mean panel DOLS reveals less size distortions compared to the within-dimension panel DOLS estimators and it is the group-mean estimator proposed by him (ibid.)
which is adopted here. Like the group-mean FMOLS estimator, the group-mean panel DOLS estimator has the further advantage to allow for a heterogeneous alternative hypothesis: the cointegrating vectors may differ across units.

Finally, the recommended estimators although fairly recent today enjoy popularity among practitioners. Therefore applying them here for a first time in the fiscal sustainability context could again, much like with the tests, ease comparisons and bridge with existing panel analyses elsewhere.

Further details about the panel cointegration methods are given in the following section.

4.3. Data, methods and empirical results

The empirical analysis of panel fiscal sustainability in the EU accession countries is performed on an original set of data, presented next.

**Data**

The data series are compiled from mainly Eurostat sources. The tests for unit roots and cointegration as well as the estimations use data from Central and Eastern Europe between 1995 and 2006. To stay in line with the fiscal sustainability theory and the approach in Chapter Three, all fiscal variables are general government level unless otherwise noted, annual, nominal and expressed as ratios to GDP. Data sources and adjustments are described in detail in Table 4.4.

The countries’ total current expenditures and revenues are calculated from the AMECO data, except for some countries/years as explained in the table below. AMECO is the annual macro-economic database of the European Commission’s Directorate General for Economic and Financial Affairs (DG ECFIN). The database used was updated as of 21 May 2007 (7 May 2007 for the GDP data). The relevant series and AMECO codes are:

- Total expenditure at current prices, mrd. Code UUTG, ESA 1995 convention. Including one-off proceeds (treated as negative expenditure) related to the allocation of mobile phone licences (UMTS).
- GDP at current market prices, mrd. Code UVGDH. The EDP reference level.

Table 4.4. Country fiscal data overview (accession countries)

<table>
<thead>
<tr>
<th>NO.</th>
<th>COUNTRY</th>
<th>DATA SPAN</th>
<th>SOURCES AND ADJUSTMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bulgaria</td>
<td>1995-2006</td>
<td>Annual fiscal data from Eurostat (through the AMECO database as described above), except for 1995-2001 (taken from the Economist Intelligence Unit database: the 'budget expenditure' and 'budget revenue' lines there).</td>
</tr>
<tr>
<td>2</td>
<td>Cyprus</td>
<td>1995-2006</td>
<td>Annual fiscal data from Eurostat (through the AMECO database as described above), except for 1995-1997 (taken from the Economist Intelligence Unit database: the 'budget expenditure' and 'budget revenue' lines there).</td>
</tr>
<tr>
<td>3</td>
<td>Czech Republic</td>
<td>1995-2006</td>
<td>Annual fiscal data from Eurostat (through the AMECO database as described above).</td>
</tr>
<tr>
<td>4</td>
<td>Estonia</td>
<td>1995-2006</td>
<td>Annual fiscal data from Eurostat (through the AMECO database as described above).</td>
</tr>
<tr>
<td>5</td>
<td>Hungary</td>
<td>1995-2006</td>
<td>Annual fiscal data from Eurostat (through the AMECO database as described above), except for 1995 (taken from the Economist Intelligence Unit database: the 'budget expenditure' and 'budget revenue' lines there).</td>
</tr>
<tr>
<td>6</td>
<td>Latvia</td>
<td>1995-2006</td>
<td>Annual fiscal data from Eurostat (through the AMECO database as described above).</td>
</tr>
<tr>
<td>7</td>
<td>Lithuania</td>
<td>1995-2006</td>
<td>Annual fiscal data from Eurostat (through the AMECO database as described above).</td>
</tr>
<tr>
<td>8</td>
<td>Malta</td>
<td>1995-2006</td>
<td>Annual fiscal data from Eurostat (through the AMECO database as described above) from 1998 onwards. Before that, the ratios are calculated on the basis of GDP data from Eurostat and fiscal data from the National Statistics Office of Malta (the &quot;government consolidated fund&quot; annual figures; total revenues are adjusted from the &quot;total recurrent revenue&quot; item minus the revenue from public corporations and from the central bank of Malta).</td>
</tr>
<tr>
<td>9</td>
<td>Poland</td>
<td>1995-2006</td>
<td>Annual fiscal data from Eurostat (through the AMECO database as described above).</td>
</tr>
<tr>
<td>10</td>
<td>Romania</td>
<td>1995-2006</td>
<td>Government expenditures and revenue as ratios to GDP are directly from the Economist Intelligence Unit (forecast for 2006). The same data (until 2004) are available from IMF's Romania: Selected Issues and Statistical Appendix, 9 May 2006, Table 16. The general government data is consolidated and in that the Romanian data differ from other countries. The compromise was needed in order to get consistent data series (the otherwise standard general government data from Eurostat and the European Commission are available from 1998 only). As both series are given on a consolidated basis, any cointegrating relationship among them should stay (although possibly the cointegrating process is affected by the consolidation).</td>
</tr>
<tr>
<td>11</td>
<td>Slovakia</td>
<td>1995-2006</td>
<td>Annual fiscal data from Eurostat (through the AMECO database as described above).</td>
</tr>
<tr>
<td>12</td>
<td>Slovenia</td>
<td>1995-2006</td>
<td>Annual fiscal data from Eurostat (through the AMECO database as described above) from 2000 onwards. Before that, the ratios are directly from Eurostat's website.</td>
</tr>
</tbody>
</table>

Note: The nominal revenue and expenditure series are divided by GDP at market prices. Not seasonally adjusted. Slovenian data are fixed to the Euro at the country's irrevocable rate for the 2007 Euro conversion.

The previous section underlined that the panel unit root and stationarity tests applied in this thesis are 'first generation' tests, i.e. they assume cross-sectional independence. The same assumption is behind the popular panel cointegration tests of Kao (1999) and
Pedroni (1999, 2004) which are also applied here. The empirical evidence therefore is contingent upon the validity of this assumption: but is it supported by the data from accession Europe?

A rationale to keep the assumption of cross-section independence for now can be the expectation that government expenditures are more a function of national political and economic priorities and little correlated to total outlays abroad. The latter reasoning may be arguably less legitimate for government revenues, if they are viewed as more directly reflecting the business cycle, itself possibly linked to foreign developments. As the independence assumption is key and macroeconomic series are often correlated across countries, simple descriptive statistics from my data sample are provided in Tables 4.5a and 4.5b to check the extent of co-movement among national fiscal policies.

Table 4.5a. Are country fiscal policies mutually independent? Correlation coefficients (total expenditures as % of GDP)

<table>
<thead>
<tr>
<th></th>
<th>Bulgaria</th>
<th>Cyprus</th>
<th>Czech rep.</th>
<th>Estonia</th>
<th>Hungary</th>
<th>Latvia</th>
<th>Lithuania</th>
<th>Malta</th>
<th>Poland</th>
<th>Romania</th>
<th>Slovakia</th>
<th>Slovenia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyprus</td>
<td>-0.25</td>
<td>-</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Czech rep.</td>
<td>0.36</td>
<td>-0.24</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estonia</td>
<td>0.47</td>
<td>-0.87</td>
<td>0.29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td>-0.55</td>
<td>0.16</td>
<td>-0.15</td>
<td>-0.09</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latvia</td>
<td>0.20</td>
<td>-0.50</td>
<td>-0.06</td>
<td>0.69</td>
<td>0.05</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lithuania</td>
<td>-0.39</td>
<td>-0.55</td>
<td>-0.29</td>
<td>0.44</td>
<td>0.07</td>
<td>0.33</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malta</td>
<td>-0.45</td>
<td>0.86</td>
<td>-0.17</td>
<td>-0.67</td>
<td>0.24</td>
<td>-0.55</td>
<td>-0.29</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poland</td>
<td>0.22</td>
<td>-0.56</td>
<td>0.33</td>
<td>0.58</td>
<td>0.37</td>
<td>-0.01</td>
<td>0.19</td>
<td>-0.22</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Romania</td>
<td>0.37</td>
<td>-0.80</td>
<td>-0.04</td>
<td>0.78</td>
<td>-0.35</td>
<td>0.77</td>
<td>0.57</td>
<td>-0.80</td>
<td>0.08</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slovakia</td>
<td>0.39</td>
<td>-0.85</td>
<td>-0.09</td>
<td>0.75</td>
<td>-0.24</td>
<td>0.40</td>
<td>0.63</td>
<td>-0.74</td>
<td>0.42</td>
<td>0.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slovenia</td>
<td>0.47</td>
<td>-0.37</td>
<td>0.88</td>
<td>0.96</td>
<td>-0.48</td>
<td>0.14</td>
<td>-0.24</td>
<td>-0.45</td>
<td>0.06</td>
<td>0.27</td>
<td>0.07</td>
<td></td>
</tr>
</tbody>
</table>

Table 4.5b. Are country fiscal policies mutually independent? Correlation coefficients (total revenues as % of GDP)

<table>
<thead>
<tr>
<th></th>
<th>Bulgaria</th>
<th>Cyprus</th>
<th>Czech rep.</th>
<th>Estonia</th>
<th>Hungary</th>
<th>Latvia</th>
<th>Lithuania</th>
<th>Malta</th>
<th>Poland</th>
<th>Romania</th>
<th>Slovakia</th>
<th>Slovenia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cyprus</td>
<td></td>
<td>0.67</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Czech rep.</td>
<td></td>
<td>0.65</td>
<td>0.34</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Estonia</td>
<td></td>
<td>-0.61</td>
<td>-0.68</td>
<td>0.22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hungary</td>
<td>-0.57</td>
<td>-0.65</td>
<td>0.12</td>
<td>0.87</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Latvia</td>
<td>-0.34</td>
<td>-0.59</td>
<td>-0.25</td>
<td>0.57</td>
<td>0.40</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lithuania</td>
<td>-0.38</td>
<td>-0.66</td>
<td>-0.66</td>
<td>0.33</td>
<td>0.21</td>
<td>0.70</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Malta</td>
<td>0.55</td>
<td>0.94</td>
<td>0.53</td>
<td>-0.56</td>
<td>-0.56</td>
<td>-0.37</td>
<td>-0.67</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Poland</td>
<td>-0.80</td>
<td>-0.70</td>
<td>-0.08</td>
<td>0.73</td>
<td>0.79</td>
<td>0.45</td>
<td>0.31</td>
<td>-0.63</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Romania</td>
<td>0.71</td>
<td>0.39</td>
<td>0.13</td>
<td>-0.10</td>
<td>-0.01</td>
<td>-0.04</td>
<td>-0.16</td>
<td>0.40</td>
<td>0.36</td>
<td>-</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slovakia</td>
<td>-0.63</td>
<td>-0.92</td>
<td>-0.19</td>
<td>0.83</td>
<td>0.80</td>
<td>0.46</td>
<td>0.59</td>
<td>-0.88</td>
<td>0.78</td>
<td>-0.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Slovenia</td>
<td>0.53</td>
<td>0.54</td>
<td>0.63</td>
<td>-0.19</td>
<td>-0.12</td>
<td>-0.46</td>
<td>-0.80</td>
<td>0.57</td>
<td>-0.27</td>
<td>0.38</td>
<td>-0.44</td>
<td></td>
</tr>
</tbody>
</table>

The correlation coefficients from the tables hardly point to any cross-country dependence in the fiscal processes: not even between countries which are usually

---

39 Claeys (2007) supports his assumption of cross-sectional independence by conducting cointegration analysis on pairs of countries. The series of the accession countries however are too short to engage in such bilateral country cointegration assessment.
grouped together and assumed to share most in terms of transition background, common economic policies or even geography. Whereas the above provides some justification for the cross-section independence assumption to be carried forward, remaining correlation in the errors, both within country observations and between countries, is of course still possible. Hence, the assumption of cross-section independence is relaxed below in the final panel cointegration test: the new sieve bootstrap test suggested by Westerlund and Edgerton (2007).

**Panel unit root/stationarity results**

The tests by Breitung (2000) and Hadri (2000) were computed. The first test has the hypothesis for the presence of unit root as the null, whereas the second one is a panel stationarity test. The tests assume a common autoregressive structure across the panel units.

The nature of the unit root process can be illustrated through the following general first-order autoregressive panel setting:

\[(4.1)\quad y_{it} = \rho_i y_{it-1} + X_{it} \delta_i + \epsilon_{it}\]

where \(i\) and \(t\) denote the cross-section and time dimensions of the panel, respectively, \(X_{it}\) are the exogenous variables including any fixed effects or individual trends, \(\rho_i\) are the autoregressive coefficients and the errors \(\epsilon_{it}\) are by assumption mutually independent idiosyncratic disturbances. Stationarity requires \(|\rho_i| < 1\), whereas if \(|\rho_i| = 1\) then \(y_{it}\) contains a unit root. In the Breitung (B) and Hadri (H) tests, \(\rho_i = \rho\) for all \(i\) (i.e. there is a common unit root process).

The B test considers the following ADF variant of (4.1):

\[(4.2)\quad \Delta y_{it} = \alpha y_{it-1} + \sum_{j=1}^{p_t} \beta_j \Delta y_{it-j} + X_{it} \delta_i + \epsilon_{it}\]

where the unit root is common across the series, i.e. \(\alpha = \rho - 1\), but the lag orders \(p_t\) for the differenced regressors may be unit-specific. The null hypothesis is that \(\alpha\) equals zero whereas the alternative hypothesis is that \(\alpha\) is less than zero.
In order to estimate $\alpha$, Breitung (2000) runs two auxiliary regressions, for a given set of lag orders. He regresses both $\Delta y_t$ and $y_{t-1}$ on $\Delta y_{t-1}$ (ibid., p. 170). Denoting the respective estimated coefficients from these two regressions $\hat{\beta}$ and $\hat{\phi}$, the following proxies for $\Delta y_t$ and $y_{t-1}$ are derived:

\[
\Delta \tilde{y}_t = (\Delta y_t - \sum_{j=1}^p \hat{\beta}_j \Delta y_{t-j}) / s_t
\]

\[
\tilde{y}_{t-1} = (y_{t-1} - \sum_{j=1}^p \hat{\phi}_j \Delta y_{t-j}) / s_t
\]

where $s_t$ are the estimated standard errors from each regression in (4.2). Then Breitung (ibid., p. 171) transforms and detrends the proxies in (4.3) as follows:

\[
\Delta y_{t}^* = \frac{(T-t)}{(T-t+1)} \left( \Delta \tilde{y}_{y} - \frac{\Delta \tilde{y}_{y+1} + \ldots + \Delta \tilde{y}_{y_T}}{T-t} \right)
\]

\[
y_{t}^* = \tilde{y}_t - \tilde{y}_n - \frac{t-1}{T-1} (\tilde{y}_T - \tilde{y}_n)
\]

Finally, $\alpha$ is estimated from the pooled regression:

\[
\Delta y_{t}^* = \alpha y_{t-1}^* + \nu_0
\]

Breitung (2000) shows that the estimator for $\alpha$ is asymptotically normally distributed.

The test of Hadri (2000) also assumes a common unit root process but has a null hypothesis of no unit root in any of the series. Initially, the residuals are obtained from the individual OLS regressions of $y_t$ on an intercept or on an intercept and a time trend; i.e. in the latter case the residuals are obtained from\textsuperscript{40}:

\[
y_{t} = \delta_i + \eta_i t + \varepsilon_{it}
\]

\textsuperscript{40} Equation (4.6) corresponds to Hadri's (2000, p. 150) equation 3.
Let $\hat{\varepsilon}_i$ be the estimated residuals in (4.6). Hadri (2000, p. 151) then constructs the following LM statistic:

$$LM = \frac{1}{N} \sum_{i=1}^{N} \frac{1}{T^2} \sum_{t=1}^{T} S_{ht}^2$$

(4.7)

where $S_{ht}$ is the partial sum of the residuals, $S_{ht} = \sum_{j=h}^{T} \hat{\varepsilon}_j$, and $\hat{\sigma}_e^2$ is the consistent estimator of $\sigma_e^2$ under the null hypothesis. The expression in (4.7) may also allow heteroskedasticity in $\hat{\varepsilon}_i$ across the units, i.e. in this case (4.7) takes the form:

$$LM = \frac{1}{N} \sum_{i=1}^{N} \left( \frac{1}{T^2} \sum_{t=1}^{T} S_{ht}^2 \right)$$

(4.8)

Hadri then constructs the following test statistics which is asymptotically normally distributed:

$$Z = \frac{\sqrt{N}(LM - \xi)}{\zeta}$$

(4.9)

where $\xi = 1/6$ and $\zeta = 1/45$ if the model contains an intercept only, i.e. $\eta_i$ in (4.6) equals zero for all $i$, and $\xi = 1/15$ and $\zeta = 11/6300$ if the model contains an intercept and a trend. The heteroskedastic consistent statistic in (4.9) is reported throughout this thesis wherever the Hadri tests are performed.

The results from the application of the B and H tests here are given in Table 4.6 through to Table 4.9. Exploiting the second right-hand side term in (4.1), the test specifications allow for heterogeneity across the countries as well as the possibility of a linear trend in the series. Two versions of each test are performed to check the robustness: having as exogenous variables either individual intercepts (fixed effects) or both individual intercepts and individual trends.
The evidence from the levels data suggests that the series are not I(0), both with and without a linear trend.

Table 4.6. Panel unit root/stationarity results: total expenditures (levels)

<table>
<thead>
<tr>
<th>Test</th>
<th>Exogenous variables</th>
<th>Test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breitung (B)</td>
<td>individual intercepts</td>
<td>-1.134</td>
</tr>
<tr>
<td>H0: Unit root (common unit root process)</td>
<td>individual trend &amp; intercept</td>
<td>0.022</td>
</tr>
<tr>
<td>Hadri (H)</td>
<td>individual intercepts</td>
<td>5.534*</td>
</tr>
<tr>
<td>H0: Stationarity (common unit root process)</td>
<td>individual trend &amp; intercept</td>
<td>5.448*</td>
</tr>
</tbody>
</table>

Notes: * denotes rejection of the null at 1%. The modified Akaike information criterion is used for automatically selecting the lag numbers in the B tests (preset from 0 to 1, in view of the short sample). The tests assume asymptotic normality. In the H test, the heteroskedastic consistent Z-statistic is used.

Table 4.7. Panel unit root/stationarity results: total revenues (levels)

<table>
<thead>
<tr>
<th>Test</th>
<th>Exogenous variables</th>
<th>Test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breitung (B)</td>
<td>individual intercepts</td>
<td>0.512</td>
</tr>
<tr>
<td>H0: Unit root (common unit root process)</td>
<td>individual trend &amp; intercept</td>
<td>1.100</td>
</tr>
<tr>
<td>Hadri (H)</td>
<td>individual intercepts</td>
<td>6.264*</td>
</tr>
<tr>
<td>H0: Stationarity (common unit root process)</td>
<td>individual trend &amp; intercept</td>
<td>5.928*</td>
</tr>
</tbody>
</table>

Notes: * denotes rejection of the null at 1%. The modified Akaike information criterion is used for automatically selecting the lag numbers in the B tests (preset from 0 to 1, in view of the short sample). The tests assume asymptotic normality. In the H test, the heteroskedastic consistent Z-statistic is used.

Before proceeding to the cointegration analysis about whether the accession countries have been fiscally sustainable or not, the same panel tests are applied to the first-differenced data.

Table 4.8. Panel unit root/stationarity results: total expenditures (first differences)

<table>
<thead>
<tr>
<th>Test</th>
<th>Exogenous variables</th>
<th>Test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breitung (B)</td>
<td>individual intercepts</td>
<td>-2.551*</td>
</tr>
<tr>
<td>H0: Unit root (common unit root process)</td>
<td>individual trend &amp; intercept</td>
<td>-2.729*</td>
</tr>
<tr>
<td>Hadri (H)</td>
<td>individual intercepts</td>
<td>1.770**</td>
</tr>
<tr>
<td>H0: Stationarity (common unit root process)</td>
<td>individual trend &amp; intercept</td>
<td>9.547*</td>
</tr>
</tbody>
</table>

Notes: * and ** denote rejection of the null at 1% and 5%. The modified Akaike information criterion is used for automatically selecting the lag numbers in the B tests (preset from 0 to 1, in view of the short sample). The tests assume asymptotic normality. In the H test, the heteroskedastic consistent Z-statistic is used.

Table 4.9. Panel unit root/stationarity results: total revenues (first differences)

<table>
<thead>
<tr>
<th>Test</th>
<th>Exogenous variables</th>
<th>Test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breitung (B)</td>
<td>individual intercepts</td>
<td>-2.109**</td>
</tr>
<tr>
<td>H0: Unit root (common unit root process)</td>
<td>individual trend &amp; intercept</td>
<td>-1.658**</td>
</tr>
<tr>
<td>Hadri (H)</td>
<td>individual intercepts</td>
<td>2.993*</td>
</tr>
<tr>
<td>H0: Stationarity (common unit root process)</td>
<td>individual trend &amp; intercept</td>
<td>11.895*</td>
</tr>
</tbody>
</table>

Notes: * and ** denote rejection of the null at 1% and 5%. The modified Akaike information criterion is used for automatically selecting the lag numbers in the B tests (preset from 0 to 1, in view of the short sample). The tests assume asymptotic normality. In the H test, the heteroskedastic consistent Z-statistic is used.
Tables 4.8 and 4.9 show that in their first differences total expenditures and revenues as a ratio to GDP are stationary for the panel of the twelve accession countries, except for the H test. However, Hlouskova and Wagner (2006) have detected the high tendency of the Hadri (2000) test to commit Type I errors. As noted above, the interpretation of the results should take into account the performance of the tests in short samples: and the cited extensive simulation study shows that Breitung’s (2000) test exhibits superior power and size behaviour.

**Panel cointegration tests results**

The conclusion is that total expenditures and revenues are not stationary in their levels (which would have implied fiscal sustainability) but are rather $I(1)$ instead, so I proceed to the panel cointegration tests. Due to the short and narrow panel dimension, no Johansen-related system-based tests are done as they are likely to be the most distorted here.

The Kao (1999) and Pedroni (1999, 2004) tests below are residual-based and are now standard in panel cointegration research. Both model unit-specific intercepts but differ in that Kao assumes homogeneous slope coefficients while Pedroni does not. Pedroni’s tests may also allow for heterogeneous trend terms.

Kao (1999, p. 3) specifies the following bivariate panel regression:

\[(4.10) \quad y_{it} = \alpha_i + \beta x_{it} + e_i\]

where $e_i$ is the residual on which he bases the panel cointegration tests. The Dickey-Fuller test or its augmented version is applied to the estimated residuals from (4.10) using:

\[(4.11) \quad \hat{e}_i = \rho \hat{e}_{i,t-1} + \nu_i\]

or

\[(4.12) \quad \hat{e}_i = \rho \hat{e}_{i,t-1} + \sum_{j=1}^{p} \theta_j \Delta \hat{e}_{i,t-j} + \nu_i\]
Let $t_{ADF}$ be the $t$-statistic to test if $\rho = 1$ in (4.12). Then Kao constructs the following panel cointegration test statistic, derived from the augmented Dickey-Fuller test on the residuals:

$$
ADF = \frac{t_{ADF} + \sqrt{6N}\hat{\sigma}_u/(2\hat{\sigma}_\varepsilon)}{\sqrt{\hat{\sigma}_\varepsilon^2/(2\hat{\sigma}_\varepsilon^2) + 3\hat{\sigma}_\varepsilon^2/(10\hat{\sigma}_\varepsilon^2)}}
$$

Above, the estimated variance is $\hat{\sigma}_u^2 = \hat{\sigma}_\varepsilon^2 - \hat{\sigma}_{ue}^2 \hat{\sigma}_e^2$ and the long-run conditional variance is $\hat{\sigma}_{ov}^2 = \hat{\sigma}_{ov}^2 - \hat{\sigma}_{ove}^2 \hat{\sigma}_e^2$. To obtain these, the regressors and regressands in (4.10) are specified as:

$$
(4.14)
\begin{align*}
Y_{it} &= Y_{i,t-1} + u_{it} \\
x_{it} &= x_{i,t-1} + e_{it}
\end{align*}
$$

and the covariance of $\omega = \begin{bmatrix} u_{it} \\ e_{it} \end{bmatrix}$ is estimated as:

$$
(4.15)
\hat{\Sigma} = \begin{bmatrix}
\hat{\sigma}_u^2 & \hat{\sigma}_{ue} \\
\hat{\sigma}_{ue} & \hat{\sigma}_e^2
\end{bmatrix} = \frac{1}{NT} \sum_i \sum_t \hat{\omega}_i \hat{\omega}_t
$$

while the long-run covariance is estimated as:

$$
(4.16)
\hat{\Omega} = \begin{bmatrix}
\hat{\sigma}_{ov}^2 & \hat{\sigma}_{ove} \\
\hat{\sigma}_{ove} & \hat{\sigma}_{ee}^2
\end{bmatrix} = \frac{1}{N} \sum_i \left( \frac{1}{T} \sum_t \hat{\omega}_i \hat{\omega}_t + \kappa(\hat{\omega}_i) \right)
$$

In (4.16), $\kappa$ could be any kernel function; the tests applied throughout this thesis use the Newey-West (1987) estimator.

Pedroni’s (1999, 2004) regression specification differs from (4.10) in that it permits greater heterogeneity in the panel: individual heterogeneous fixed effects, time trends and slope coefficients. The coefficients on the short-run parameters in (4.12) and on the lagged residuals in (4.11) and (4.12) can also vary with $i$. Pedroni (2004) argues in
favour of heterogeneous panels along the following lines. Firstly, if the true slope coefficients are heterogeneous and we impose homogeneity, 'then the estimated residuals for any ... [such] ... member of the panel ... will be nonstationary, even if in truth they are cointegrated' (p. 600). As in reality the slope coefficients may be expected to vary across the countries, 'the implications for constraining the coefficients to be common are unlikely to be acceptable for tests of the null of no cointegration' (ibid.). Pedroni concludes that 'one can think of the test as effectively pooling only the information regarding the possible existence of the cointegrating relationship as indicated by the stationarity properties of the estimated residuals' (ibid.). Cointegration tests in heterogeneous panel settings are currently the norm in the empirical literature.

Pedroni (1999, 2004) proposes seven panel cointegration test statistics, grouped in two depending on whether the alternative hypothesis is one of common autoregressive coefficients \( (\rho_i = \rho < 1 \text{, the panel 'within' dimension; four tests}) \) or one of individual autoregressive coefficients \( (\rho_i < 1 \text{, the group 'between' dimension; three tests}) \). These test statistics are as follows:

\[
\text{(4.17) Panel } \nu \text{ statistic:} \\
T^2 N \frac{1}{T} \left( \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\varepsilon}_{it} \hat{\varepsilon}_{it} \right)^{-1}
\]

\[
\text{(4.18) Panel } \rho \text{ statistic:} \\
T \sqrt{N} \left( \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\varepsilon}_{it} \hat{\varepsilon}_{it} \right)^{-1/2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\varepsilon}_{it} \Delta \hat{\varepsilon}_{it} - \hat{\lambda}_i
\]

\[
\text{(4.19) Panel } t \text{ statistic (non-parametric):} \\
\left( \frac{\sigma_{\hat{\varepsilon}}^2}{N} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\varepsilon}_{it} \hat{\varepsilon}_{it} \right)^{-1/2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\varepsilon}_{it} \Delta \hat{\varepsilon}_{it} - \hat{\lambda}_i
\]

\[
\text{(4.20) Panel } t \text{ statistic (parametric):} \\
\left( \frac{\sigma_{\hat{\varepsilon}}^2}{N} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\varepsilon}_{it} \hat{\varepsilon}_{it} \right)^{-1/2} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{\varepsilon}_{it} \Delta \hat{\varepsilon}_{it} - \hat{\lambda}_i
\]

\[
\text{(4.21) Group } \rho \text{ statistic:} \\
TN^{-1/2} \left( \sum_{i=1}^{N} \hat{\varepsilon}_{i-1} \hat{\varepsilon}_{i-1} \right)^{-1/2} \sum_{i=1}^{N} \left( \hat{\varepsilon}_{i-1} \Delta \hat{\varepsilon}_{i-1} - \hat{\lambda}_i \right)
\]

\[
\text{(4.22) Group } t \text{ statistic (non-parametric):} \\
N^{-1/2} \left( \sum_{i=1}^{N} \hat{\varepsilon}_{i-1} \hat{\varepsilon}_{i-1} \right)^{-1/2} \sum_{i=1}^{N} \left( \hat{\varepsilon}_{i-1} \Delta \hat{\varepsilon}_{i-1} - \hat{\lambda}_i \right)
\]

\[
\text{(4.23) Group } t \text{ statistic (parametric):} \\
N^{-1/2} \left( \sum_{i=1}^{N} \hat{\varepsilon}_{i-1} \hat{\varepsilon}_{i-1} \right)^{-1/2} \sum_{i=1}^{N} \hat{\varepsilon}_{i-1} \Delta \hat{\varepsilon}_{i-1}
\]
In (4.17) - (4.23), \( \hat{\sigma}_u^2 \) is the long-run variance of the residuals from the differenced regression in (4.10) where the slope coefficients are allowed to be unit-specific; \( \hat{\sigma}_u \) and \( \hat{\sigma}_u^* \) are the regressands in (4.11) and (4.12), respectively, but where again all slope coefficients are allowed to vary with \( i \); \( \hat{\sigma}_i^2 \) and \( \hat{\sigma}_i^* \) are the long-run and the simple (contemporaneous) variances of the residuals from (4.11), respectively; \( \hat{\sigma}_i^2 \) is the simple variance of the residuals from (4.12); and 
\[
\hat{\lambda}_i = \frac{1}{2}(\hat{\sigma}_i^2 - \hat{\sigma}_i^2).
\]
Further details are provided in Pedroni (1999, pp. 659-662). Wherever the Pedroni panel cointegration tests are performed in this thesis, the seven test statistics are reported in the same order as in (4.17) - (4.23).

So the following general panel regression model is considered in the empirical assessment of fiscal sustainability in accession Europe:

\[
TR_u = \alpha_i + \beta_i TE_u + \epsilon_u
\]

where \( TR \) and \( TE \) stand for total revenues and total expenditures as ratios to GDP, respectively, \( \alpha \) are the individual intercepts, \( \beta \) are individual slopes (\( \beta = \beta \) in the Kao tests), \( i \) denotes the unit (country) and \( t \) denotes the time dimension in the panel.

The results from the Kao and Pedroni tests performed on the series of accession Europe’s total revenues and total expenditures as shares of GDP are presented in Table 4.10.

Table 4.10 provides unambiguous evidence in favour of cointegration. A note may again be taken of possible size and power distortions in the short panel. Banerjee et al. (2004) show that Pedroni’s tests are less reliable for sample sizes below 100 periods of observations and that in such samples the parametric panel and group ADF-statistic tests perform best. Hlouskova and Wagner’s (2007) simulations confirm that and even point out that the non-ADF tests have virtually no power for \( T \leq 25 \). Thus any instances of Pedroni’s statistics’ non-rejection of the no-cointegration null might indeed just illustrate Type II errors. The Monte-Carlo simulations by Gutierrez (2003) show that for
homogeneous panels (if the accession countries may be assumed to be so) and short
time series Kao’s tests perform better than Pedroni’s.

Table 4.10. Panel cointegration (all twelve countries). Kao and Pedroni tests

<table>
<thead>
<tr>
<th>Test</th>
<th>Test type</th>
<th>Test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kao residual cointegration, homogeneous coefficients ( \beta = \beta ) across sections; ( H_0: ) No cointegration</td>
<td>Augmented Dickey-Fuller test</td>
<td>-2.907*</td>
</tr>
<tr>
<td>Pedroni residual cointegration; ( H_0: ) No cointegration ( H_1: ) Cointegration, homogeneous alternative of common autoregressive coefficients (the ‘within’ dimension)</td>
<td>Panel v-statistic test</td>
<td>1.705**</td>
</tr>
<tr>
<td></td>
<td>Panel rho-statistic test</td>
<td>-2.747*</td>
</tr>
<tr>
<td></td>
<td>Panel PP-statistic test</td>
<td>-5.046*</td>
</tr>
<tr>
<td></td>
<td>Panel ADF-statistic test</td>
<td>-3.017*</td>
</tr>
<tr>
<td>Pedroni residual cointegration; ( H_0: ) No cointegration ( H_1: ) Cointegration, heterogeneous alternative of individual autoregressive coefficients (the ‘between’ dimension)</td>
<td>Group rho-statistic test</td>
<td>-0.223</td>
</tr>
<tr>
<td></td>
<td>Group PP-statistic test</td>
<td>-3.526*</td>
</tr>
<tr>
<td></td>
<td>Group ADF-statistic test</td>
<td>-2.189**</td>
</tr>
</tbody>
</table>

Notes: * and ** denote rejection of the null at 1% and 5%, respectively. One lag of the change in residuals is used in the second-stage augmented regressions, in view of the short sample. The long-run variances are calculated using the Newey-West (1987) kernel estimator with a lag truncation equal to \( \left( \frac{T}{100} \right)^{3/4} \) as suggested in Pedroni (1995).

The cointegration between total revenues and total expenditures in accession Europe does not suffice to imply fiscal sustainability: the second necessary condition is that the cointegrating vector must be \((1, -1)\). But before proceeding to the panel cointegration estimation, two further extensions are considered to shed more light on the cointegration hypothesis. First, although inevitably blurred in a panel analysis, at least some degree of individual country inference is attempted through the following strategy. The same panel cointegration tests are applied to sub-samples of countries consisting of the full sample minus one country at a time. That is proposed as an optimal compromise between not losing too many observations and being able to focus attention on each country’s contribution to the full panel results.

The Kao and Pedroni results from the sub-samples are given in Table 4.11.
Table 4.11. Panel cointegration (eleven countries), Kao and Pedroni tests

<table>
<thead>
<tr>
<th>Test type</th>
<th>BG</th>
<th>CY</th>
<th>CZ</th>
<th>EE</th>
<th>HU</th>
<th>LV</th>
<th>LT</th>
<th>MT</th>
<th>PL</th>
<th>RO</th>
<th>SK</th>
<th>SI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kao residual cointegration,</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>homogeneous coefficients</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(β = β across sections);</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H0: No cointegration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pedroni group v-statistic</td>
<td>1.704**</td>
<td>1.540***</td>
<td>1.600**</td>
<td>1.813**</td>
<td>1.463***</td>
<td>1.664**</td>
<td>1.432***</td>
<td>1.478***</td>
<td>1.620***</td>
<td>1.755**</td>
<td>1.796**</td>
<td>1.656**</td>
</tr>
<tr>
<td>Pedroni Panel PP-statistic</td>
<td>-4.94*</td>
<td>-4.898*</td>
<td>-4.140*</td>
<td>-5.182*</td>
<td>-5.101*</td>
<td>-5.002*</td>
<td>-4.824*</td>
<td>-4.812*</td>
<td>-4.932*</td>
<td>-5.056*</td>
<td>-4.629*</td>
<td>-4.376*</td>
</tr>
<tr>
<td>Pedroni residual cointegration;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>H0: No cointegration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pedroni group rho-statistic</td>
<td>-0.250</td>
<td>-0.228</td>
<td>-0.045</td>
<td>-0.291</td>
<td>-0.239</td>
<td>-0.280</td>
<td>-0.167</td>
<td>-0.136</td>
<td>-0.532</td>
<td>-0.560</td>
<td>-0.080</td>
<td>0.045</td>
</tr>
</tbody>
</table>

Notes: *, ** and *** denote rejection of the null at 1%, 5% and 10%, respectively. One lag of the change in residuals is used in the second-stage augmented regressions, in view of the short sample. The long-run variances are calculated using the Newey-West (1987) kernel estimator with a lag truncation equal to \(\sqrt{T(100)}\) as suggested in Pedroni (1995).
The first aggregate result to note when comparing Table 4.11 to Table 4.10 is that there is no evidence that any one country is substantially different from the rest. Hence there is no reason to believe that individual countries have played a role in tilting the panel results from Table 4.10. This provides a strong empirical argument in favour of applying the panel approach to fiscal sustainability for Central and Eastern Europe. So the overall conclusion is that the accession countries combined in the panel exhibit common cointegration evidence: whether fiscal sustainability is present or not. More individual country evidence may be sought in the cointegration vector estimation below.

Another important extension to the panel cointegration tests presented so far is to relax the arguably strong assumption of cross-section independence. As previously discussed the tests by Kao (1999) and Pedroni (1999, 2004), although benchmarking the panel cointegration literature, are only ‘first generation’ tests based on the assumption of cross-section independence. To address that, while at the same time providing evidence that is econometrically justified against the small-sample dimensions, the recent sieve bootstrap panel cointegration test in Westerlund and Edgerton (2007, hereafter W-E) is applied.

Unlike the other panel cointegration tests above, this test has a null of cointegration. As argued in the panel unit root and panel cointegration literature, such null is convenient for hypothesis testing because, if not rejected, an interpretation is possible that at least one unit in the panel shows stationarity/cointegration. Such interpretation, although again limited in what it can be inferred about any particular country, is attractive as one step towards bringing the panel analysis down to the country level.

The W-E test allows dependence in the errors both within and between the cross-section dimensions. Westerlund and Edgerton (2007) demonstrate that it also has good small-sample behaviour. Therefore inference based on this test critically complements the rest of the analysis in this chapter. More generally, it also makes inroads into the panel cointegration empirical literature, and certainly in the fiscal sustainability area. With this empirical application the thesis becomes the first analysis of historical fiscal sustainability of accession Europe where the assumption of cross-country independence is relaxed.
The test is based on a regression specification analogous to (4.24), again allowing for the flexibility of heterogeneous intercepts and slopes. Collecting the predicted residuals from this regression is the first step before arriving at the bootstrap stage itself where the bootstrapped samples of total revenues and total expenditures are generated. Finally, the bootstrap test statistic is constructed corresponding to the sample counterpart:

\[
LM^{*}_{NI} = \frac{1}{NT^{2}} \sum_{n=1}^{N} \sum_{m=1}^{T} \hat{\phi}_{n}^{-2} S_{n}^{2}
\]

where \( S_{n} \) is the partial sum process of the fully-modified estimates of the residuals from (4.24) and \( \hat{\phi}_{n}^{2} \) is the long-run variance of \( u_{n} \) conditional on \( \Delta TE_{n} \); \( u_{n} \) is defined by decomposing the residuals from (4.24) as \( \varepsilon_{n} = u_{n} + v_{n} \), with \( v_{n} = \sum_{j=1}^{j=n} \eta_{n} \) and \( \eta_{n} \) independent and identically distributed with zero mean and variance \( \text{var}(\eta_{n}) = \sigma_{\eta}^{2} \) (Westerlund and Edgerton, 2007, p. 186).

These steps are repeated 2,000 times and the one-tailed bootstrap distribution is obtained. The bootstrapped critical values at the conventional levels are presented in Table 4.12. Figure 4.1 displays the kernel density estimate of the bootstrap distribution of the test statistic.

Table 4.12. Accession countries fiscal sustainability bootstrapped critical values, W-E test

<table>
<thead>
<tr>
<th>Test</th>
<th>Exogenous variables</th>
<th>99%</th>
<th>95%</th>
<th>90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westerlund and Edgerton (2007)</td>
<td>Individual intercepts, no deterministic trend</td>
<td>0.191</td>
<td>0.237</td>
<td>0.269</td>
</tr>
</tbody>
</table>
Then the test statistic from the original sample is obtained and compared with the critical values from the bootstrap distribution. This time, the null of cointegration is not rejected even at the 10% critical value (Table 4.13).

Table 4.13. Panel cointegration, W-E test

<table>
<thead>
<tr>
<th>Test</th>
<th>Exogenous variables</th>
<th>Test type</th>
<th>Test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westerlund and Edgerton (2007); no deterministic trend</td>
<td>individual intercepts, Sieve bootstrap</td>
<td>0.294</td>
<td></td>
</tr>
</tbody>
</table>

Notes: The group-mean FMOLS proposed by Pedroni (2000, 2001) used for estimating regression coefficients. The long-run variances are calculated using the Newey-West (1987) kernel estimator with a lag truncation equal to $\left\lfloor \frac{T}{100} \right\rfloor$ as suggested in Pedroni (1995).

So the support for panel cointegration, hence group-wide fiscal sustainability, suggested by the Kao and Pedroni tests, seems more robust now after the Westerlund and Edgerton test: a ‘second generation’ test having the opposite null and relaxing the cross-section independence assumption. Any conclusion that the EU accession countries have achieved fiscal sustainability will, however, be impetuous before the cointegrating parameters are estimated.

Panel cointegration vector estimates

Moving forward to the estimation of the cointegrating vector, the bivariate panel regression of (4.24) above is considered. Total expenditures stand as the regressor in compliance with the theoretical requirement for unitary coefficients there in order to have strong-form fiscal sustainability. Let $\mathbf{X}_t = (s_{1t}, \Delta T_{1t})'$ be a stationary vector with a long-run covariance matrix $\Omega = L_s L_t'$, where $L_s$ is a lower triangular decomposition of

$\mathbf{X}_t = (s_{1t}, \Delta T_{1t})'$
\( \Omega_i \), \( \Omega_i \) is estimated using the Newey-West (1987) kernel estimator with a lag truncation equal to \( \left( \frac{T}{100} \right)^{1/9} \) as suggested in Pedroni (1995). The specification in (4.24) allows for cointegrating vector heterogeneity. The covariance matrix is also decomposable as \( \Omega_i = \Omega_i^0 + \Gamma_i + \Gamma_i^\prime \), with \( \Omega_i^0 \) being a contemporaneous (simple) covariance and \( \Gamma_i \) a weighted sum of autocovariances.

The panel FMOLS estimator for \( \beta_i \) is given by:

\[
(4.26) \quad \beta_{NT} = N^{-1} \sum_{i=1}^{N} \left( \sum_{i'=1}^{N} (TE_{i}-TE_{i'}) \right)^{-1} \left( \sum_{i'=1}^{N} (TE_{i'-1} - TE_{i})TR_{i'-1}^{*} - T \hat{r}_{i} \right)
\]

where \( TR_{i}^{*} = \left( TR_{i} - \hat{r}_{i} \right) - \frac{\hat{r}_{i}}{L_{2i}} \Delta TE_{i} \) and

\[
\hat{r}_{i} = \hat{r}_{i}^{2i} + \hat{\Omega}_{2i} - \frac{\hat{r}_{i}}{L_{2i}} \left( \hat{r}_{i}^{2i} + \hat{\Omega}_{2i} \right)
\]

From (4.26) it follows that the estimator has an alternative construction: \( \beta_{NT} = N^{-1} \sum_{i=1}^{N} \beta_{i} \), where \( \beta_{i} \) is the FMOLS estimator applied to the \( i \)th member of the panel (Pedroni, 2001, p. 729).

The \( \bar{r} \)-statistic for this group-mean panel FMOLS estimator follows the standard normal distribution and is given by:

\[
(4.27) \quad \bar{r}_{\bar{r}} = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} \left( \beta_{i} - \beta_{0} \right) \left( \frac{\hat{r}_{i}^{2i}}{\sum_{i=1}^{N} (TE_{i} - TE_{i})^{2}} \right)^{1/2}
\]

where \( \beta_{0} \) is the true coefficient under the null hypothesis (i.e. 1 here). The results are displayed in Table 4.14. The individual FMOLS estimates and associated statistics are reported alongside the panel group-mean ones. The hypothesis of unitary coefficient(s) on total expenditures in the cointegrating regression(s) cannot be rejected at conventional significance levels.

Alternatively, the between dimension, group-mean panel DOLS estimator introduced by Pedroni (2001) is constructed by an augmentation of the cointegrating regression with differenced leads and lags of the regressor:
Considering the short length of the panel here and so potential dramatic loss of degrees of freedom, up to two leads and lags are used, but in separate applications to check the robustness of the results. The group-mean panel DOLS estimator is given by:

\[
TR_n = \alpha + \beta_1 TE_n + \sum_{k=-K}^{K} \gamma_k \Delta TE_{n+k} + \epsilon_n
\]  

(4.28)

where \( Z_n \) is a \( 2(K+1) \times 1 \) vector of regressors \( Z_n = (TE_n - \bar{TE}_n, \Delta TE_{n-K}, \ldots, \Delta TE_{n+K}) \), \( \bar{TR}_n = TR_n - \bar{TR}_1 \), and the subscript 1 outside the brackets in (4.29) indicates that only the first element of the vector is taken to estimate the pooled slope coefficient. As with the panel FMOLS estimator above, an alternative construction for the panel DOLS estimator is:

\[
\beta_{DG} = N^{-1} \sum_{i=1}^{N} \left( \sum_{n=1}^{T} Z_n Z_n' \right)^{-1} \left( \sum_{n=1}^{T} Z_n \bar{TR}_n \right)
\]  

(4.29)

Then if \( \sigma^2 \) is the long-run variance of the residuals from the DOLS regression in (4.28), the \( t \)-statistic for this group-mean panel DOLS estimator is:

\[
\tilde{t}_{DG} = \frac{1}{\sqrt{N} \sum_{i=1}^{N} (\beta_{DG,i} - \beta_0) \left( \sigma^2 \sum_{i=1}^{N} (TE_n - \bar{TE}_n)^2 \right)^{1/2}}
\]  

(4.30)

where as in (4.27) \( \beta_0 \) is the true coefficient value under the null hypothesis (i.e. 1 in this case). The results are displayed in Table 4.14. The individual DOLS estimates and associated statistics are reported alongside the panel group-mean ones. Unlike with the FMOLS estimates, the hypothesis of unitary parameter in the cointegrating vector can be rejected for most countries and so the evidence is more mixed than in the FMOLS. In the one lead/one lag specification, the panel result is still in favour of the strong-form fiscal sustainability hypothesis.

The group-mean DOLS estimate of the true parameter in the cointegration vector when two leads/two lags are specified is not statistically different from 1. As in the first DOLS application, the unitary null was often rejected for the country coefficients.
DOLS coefficient estimates, when the unit null is rejected, sometimes suggest that either revenues grew slower than expenditures with respect to GDP (Czech Republic, Estonia, Lithuania, Slovakia, Slovenia) or sometimes decreased as expenditures rose (Bulgaria, Hungary, Romania). The first scenario suggests that in those countries potentially debt could explode even though past fiscal policies have satisfied the IBC (this is exactly the ‘weak’ sustainability). As described by Quintos (1995, p. 410) ‘the deficit will still be sustainable as long as the growth rate of debt does not exceed the growth rate of the economy ... [but] ... it has serious policy implications because the government will have difficulty in marketing its debt in the long run’. The second scenario (plus the results from Malta, and perhaps Poland where although the null is rejected the estimated parameter approaches 1) does not support the sustainability hypothesis even in the ‘weaker’ sense.

Table 4.14. Panel cointegration estimation results

<table>
<thead>
<tr>
<th>Country</th>
<th>FMOLS</th>
<th>Test statistic</th>
<th>DOLS (K=1)</th>
<th>Test statistic</th>
<th>DOLS (K=2)</th>
<th>Test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bulgaria</td>
<td>-0.319</td>
<td>-0.546</td>
<td>-0.729</td>
<td>-5.216*</td>
<td>-0.770</td>
<td>-15.650*</td>
</tr>
<tr>
<td>Cyprus</td>
<td>0.832</td>
<td>-1.999</td>
<td>0.958</td>
<td>-1.012</td>
<td>0.986</td>
<td>-0.619</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>0.163</td>
<td>-0.882</td>
<td>0.387</td>
<td>-10.319*</td>
<td>0.126</td>
<td>-21.326*</td>
</tr>
<tr>
<td>Estonia</td>
<td>0.548</td>
<td>-0.398</td>
<td>0.587</td>
<td>-3.513*</td>
<td>0.615</td>
<td>-10.791*</td>
</tr>
<tr>
<td>Hungary</td>
<td>-0.128</td>
<td>-0.415</td>
<td>-0.203</td>
<td>-2.609*</td>
<td>-0.495</td>
<td>-3.410*</td>
</tr>
<tr>
<td>Latvia</td>
<td>0.431</td>
<td>-0.316</td>
<td>0.880</td>
<td>-1.036</td>
<td>0.939</td>
<td>-1.368</td>
</tr>
<tr>
<td>Lithuania</td>
<td>0.404</td>
<td>-0.949</td>
<td>0.546</td>
<td>-11.030*</td>
<td>0.533</td>
<td>-12.330*</td>
</tr>
<tr>
<td>Malta</td>
<td>1.770</td>
<td>0.078</td>
<td>1.655</td>
<td>3.447*</td>
<td>1.745</td>
<td>4.166*</td>
</tr>
<tr>
<td>Poland</td>
<td>0.743</td>
<td>-0.202</td>
<td>1.019</td>
<td>0.189</td>
<td>1.198</td>
<td>7.875*</td>
</tr>
<tr>
<td>Romania</td>
<td>0.247</td>
<td>-0.331</td>
<td>-0.330</td>
<td>-15.142*</td>
<td>-0.440</td>
<td>-15.398*</td>
</tr>
<tr>
<td>Slovakia</td>
<td>0.525</td>
<td>-0.553</td>
<td>0.644</td>
<td>-3.237*</td>
<td>0.805</td>
<td>-2.101**</td>
</tr>
<tr>
<td>Slovenia</td>
<td>0.275</td>
<td>-0.650</td>
<td>0.068</td>
<td>-26.344*</td>
<td>0.075</td>
<td>-37.111*</td>
</tr>
</tbody>
</table>

Notes: * and ** denote rejection of the null at 1% and 5%. Ho: β1 = 1. K is the number of leads/lags.

The individual country estimation results unfortunately cannot be verified by individual tests for cointegration per se because of the very short data series. Hence as with the rest of the chapter the focus is more on the panel as a whole. Overall, considering both the results from the panel cointegration tests, which support cointegration, and the panel cointegration estimators (mixed results on individual country level but still not rejecting the ‘strong’ sustainability hypothesis for the group), the conclusion is that at least some accession countries have rather achieved fiscal adjustment in keeping with the IBC definition.

Yet such conclusion should be based only on the panel as a whole, where more observations make the econometric analysis more reliable. But even then, caution is still
advisable due to small-sample size and power distortions. And the evidence is not robust enough to claim sustainability for each country individually.

4.4. Conclusion

As historical sustainability assessment requires long series which are still unavailable for the EU accession countries, this chapter proposes a novel application of panel methods for the region. The panel approach is currently making its way into the fiscal sustainability field and, with the most recent advances in panel unit roots and cointegration, the panel studies are likely to form a new body within the ‘backward-looking’ statistical tests literature.

The findings, although presented with a degree of caution, bring new insights into the macroeconomic performance of Central and Eastern Europe since the onset of transition and during the EU accession process. The formal econometric analysis broadly confirms the hypothesis of successful fiscal adjustment intuitively suggested by the descriptive data from the accession countries since the mid-1990s. The panel tests show that revenues and expenditures are cointegrated with a vector (1, -1). Overall therefore, the results are consistent with the hypothesis that the accession countries as a whole exhibit fiscal sustainability within the estimation period.

But this conclusion is only valid for the group of accession countries as a whole. After employing recently introduced methods for the estimation of long-run relationships in panels, the empirical evidence is less optimistic for each country individually. Delving into a country-level analysis, a recommended future extension when much longer series exist, would prove illuminating. Even so, the results for the panel and the implied results for individual countries (omitted one-by-one) suggest that it would be reasonable to conclude that at least some accession countries may have achieved fiscal sustainability.

The results of this chapter therefore, intriguing as they are against the background of deep structural changes and often painful economic reforms in the two decades of transition, do not confirm that all the countries have achieved fiscal sustainability. From a policy perspective, the economies in the region still need to alter their fiscal policies in
order to satisfy the intertemporal budget constraint, especially now that after the EU accession further fiscal challenges are expected. All in all, there is no justification for any complacency for the accession countries’ fiscal authorities.
The previous two chapters analysed various perspectives on the long-run fiscal sustainability of pre-2004 'old' Europe and the accession countries. But the analysis still leaves the door open for an unsolicited question: is the government budget the only area where a country’s stability could be jeopardised? Fiscal sustainability researchers are usually content to make increasingly specialised inroads into the area while abstracting from the bigger picture. Yet the economy does not consist of a government sector only and nor does fiscal sustainability guarantee that other imbalances do not occur. In the macro economy, external imbalances are the first likely candidate. It would not be surprising if the different imbalances were related to one another (as Ley, 2003, and Corsetti and Müller, 2006, suggest).

Ideally, both fiscal and external sustainability should be analysed, and be analysed together in a unified framework. From that angle, traditional analyses focusing either on fiscal or current account sustainability reveal only part of the ‘whole truth’. The existing literature, however, is surprisingly deficient in bridging the conditions for budget and external intertemporal solvency. This chapter aims to fill that gap: essentially by providing a distinct approach to model open-economy sustainability based on an examination of the relationship between private savings and private investment. I explain the rationale for this in detail in section 5.1.

A country may accumulate external debt which will match the existing current account deficit in much the same way as the dynamics of government debt matches the budget deficit through the ‘flow’ budget constraint in Chapter Two. If persistent, the current account deficits may pose a threat to external solvency and the long-run external sustainability is thus questionable. Under certain scenarios the negative balance in the current account may be a result of looser fiscal policies having encouraged net imports.
as a component of aggregate demand. Conversely, policymakers may wish to resort to fiscal tightening to reduce the current account deficit: but the ensuing short-term fiscal consolidation can possibly imply slowed economic growth, hence in the long term diminishing budget revenues and weakened fiscal sustainability. The European Central Bank acknowledges the presence of the additional source of fiscal risk stemming from ‘external imbalances, the correction of which can ... undermine fiscal sustainability’ (ECB, 2007, p. 63)

Leaving aside these two-way spillovers between the government budget and the external position, it is worth noting that external sustainability analysis alone partly deals with the fiscal stance, in the proportion of government debt which is not issued domestically. But that strictly speaking belongs to the domain of fiscal sustainability assessment as presented so far. Therefore a thorough research into whether a country’s macroeconomic policies follow a long-run path compatible with an IBC would require distinguishing between the different sectors of the economy and between the internal and external positions, including possible overlaps. Unfortunately, such categories in accounting for the debt and the sectors of the economy are not available for many countries or over long periods of observation.

Data limitations may explain the so far limited efforts to assess overall sustainability. However, the model proposed in this chapter will demonstrate how such sustainability can be studied even without disaggregated data for the different types of debt. Instead, the variables of interest turn out to be private sector savings and investment: the link in the ‘twin deficits’ macro identity. This chapter therefore provides an extension to the fiscal and current account sustainability literature with roots in the IBC, by deriving a simple testable condition for the overall sustainability of an open economy.

The open-economy sustainability model forms the theoretical contribution here. And the derived sustainability condition is empirically applied in two economic and historical contexts: of ‘old’ Europe and accession Europe. The research methods mirror those in the previous two chapters, respectively, while the research questions may be regarded both on their own and as complementing the evidence from before. The first question is whether ‘old’ Europe’s national policies have achieved sustainability in the open-economy framework, and about any Maastricht/SGP effect in that. The Central and
Eastern Europe panel is checked for the hypothesis if the forces of transition and E(M)U accession have led to a sustainable overall macroeconomy stance. Because the policy implications differ substantially from the narrower fiscal sustainability perspective, discussing them might represent a contribution as a first illustration of the concept. This chapter also provides room for certain re-interpretation of the results from the previous two chapters.

In order to set the material below in a clear literature context and to enable a faster delivery of the chapter messages, it is instructive to state what it does not do. Above all, the open-economy sustainability model is not about external sustainability: it rather upgrades the fiscal sustainability assessment which is the running theme of the thesis. External sustainability analysis, even in the trend related to the IBC arithmetic, belongs to a strand of its own. Moreover, for the reasons outlined, studying the external position separately is of little value if we are in fact interested in the overall sustainability of the economy.

Neither does the chapter deal with short-term external sustainability issues: the growing literature embodied in the works on the ‘sudden stops’ stemming from Calvo (1998) and the current account reversals as reviewed by Algieri and Bracke (2007) who assess a multitude of past adjustment episodes. The chapter models long-run sustainability conditions but is not concerned with the determinants, even if fiscal policy variables are among them, of the current account; key recent empirical contributions worth knowing there are Chinn and Prasad (2003) and Chinn and Ito (2007).

Therefore, deterministic or causal relationships between the internal and external balances also lie beyond the scope of the current research, although the external transmission mechanism of fiscal policy is central to another body of bordering literature: the one on twin deficits. While not expressly studying the twin deficit hypothesis, according to which adverse fiscal shocks deteriorate the current account balance while it benefits from fiscal consolidations (Corsetti and Müller, 2006), the results below may provide empirical arguments to twin deficit researchers about the private sector behaviour.
Private sector savings and investment are in the empirical focus now but any systematic co-movements between them should not be judged against the 'Feldstein-Horioka puzzle' (the high historical correlation between national savings and investment observed by Feldstein and Horioka, 1980). The cointegration between the two series bridges the Feldstein-Horioka evidence with the domain of external sustainability analysis (Coakley, Kulasi and Smith, 1996) but it is rather the international capital immobility which has popularly been the focus and the proposed solution to the 'puzzle'. The ensuing huge empirical research has found decreasing positive associations between national savings and investment, and that has naturally been interpreted as a sign of more efficient international capital markets and 'an end of the Feldstein Horioka puzzle' (Blanchard and Giavazzi, 2002).

It is important to realise that, although private savings and investment are major components of national savings and investment, respectively, they are by no means identical concepts. The existence (or otherwise) of any relationship between private savings and private investment carries no immediate implications for the relationship between national savings and investment. The model presented in this chapter has two distinct features: first, it involves only the private rather than total national savings and investment, and second, it does not need to assume either fiscal or current account sustainability. The sustainability criterion proposed here has no direct implications for the Feldstein-Horioka puzzle, because private and national savings (and investment) are fundamentally different. Moreover, even with fiscal sustainability in place, the economy-wide sustainability definition does not attest that cointegration between private investment and private savings can imply international capital immobility; for the latter, it is the national investment and savings relationship that matters.42

The chapter is structured as follows. The next section outlines the model but before that presents some descriptive statistics for an intuition why the open-economy approach to sustainability matters. External sustainability as defined by the intertemporal budget constraint is integral to the overall sustainability arithmetic, and is therefore also sketched out. The first empirical application on 'old' Europe's data is contained in the second section, while the third section provides another empirical application for

42 My model is therefore irrelevant to the external sustainability condition and further research is needed before supporting a proposition that the concurrent satisfaction of both the fiscal and the economy-wide intertemporal solvency constraints will also imply external sustainability.
accession Europe. The chapter then summarises the main findings and proposes ways to interpret them with a view to drawing the policy implications.

5.1. An open-economy sustainability model

Monitoring external sustainability is important even if only for fiscal policymakers. Inappropriate fiscal policies after all may be detrimental not only to the fiscal stance but may lead to external imbalances. If the private sector savings-investment balance stays unchanged, an increase in the budget deficit or a reduction of the surplus will induce a corresponding increase in the current account deficit or a reduction of the current account surplus. Expansionary fiscal policy may increase domestic interest rates, thus attracting foreign investment and appreciating the local currency, under a flexible exchange rate regime, reducing net exports and deteriorating the current account balance. On the other hand, the higher debt that results from looser fiscal policy could also make households increase their savings in the proportion in which they expect future tax increases in accordance with the Ricardian equivalence hypothesis. This will imply less domestic investment, in the proportion in which it cannot be funded by foreign capital. The latter will offset the increase in the current account deficit envisaged with the former scenario.

The transmission channels between the two balances are diverse and their effects and directions may depend, among other things, on the degree of openness of the economy, the exchange rate regime, and capital mobility. It should at least intuitively be clear at this stage that fiscal and current account sustainability are related.

That is why the descriptive statistics in Tables 5.1 and 5.2 may intrigue those who previously have limited their focus to fiscal sustainability as analysed in Chapters Three and Four. Many European countries have experienced deficits on both fronts or sometimes large current account deficits even when fiscal balances stayed in surplus.

But generally ‘old’ Europe does not reveal any pattern in the recent links between the fiscal and external balances. Neither does the advent of the Euro seem to have marked a clear shift in the current account dynamics (Table 5.1).
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>Gen. govt. fiscal</td>
<td>-5.7</td>
<td>-4.3</td>
<td>-4.8</td>
<td>-4.1</td>
<td>-3.7</td>
<td>-3.0</td>
<td>-4.2</td>
<td>-3.5</td>
<td>-3.9</td>
<td>-3.3</td>
<td>-3.6</td>
<td>-3.7</td>
</tr>
<tr>
<td></td>
<td>Current account</td>
<td>-4.4</td>
<td>-4.4</td>
<td>-0.8</td>
<td>-0.5</td>
<td>0.0</td>
<td>0.5</td>
<td>-0.0</td>
<td>-0.0</td>
<td>-0.1</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>Belgium</td>
<td>Gen. govt. fiscal</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>2.9</td>
<td>3.5</td>
<td>2.6</td>
<td>2.7</td>
<td>2.6</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>Current account</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>2.9</td>
<td>3.5</td>
<td>2.6</td>
<td>2.7</td>
<td>2.6</td>
<td>2.7</td>
</tr>
<tr>
<td>Denmark</td>
<td>Gen. govt. fiscal</td>
<td>-2.9</td>
<td>-1.9</td>
<td>-0.5</td>
<td>0.0</td>
<td>1.4</td>
<td>2.3</td>
<td>1.2</td>
<td>0.2</td>
<td>-0.1</td>
<td>1.9</td>
<td>4.6</td>
<td>3.4</td>
</tr>
<tr>
<td></td>
<td>Current account</td>
<td>0.7</td>
<td>1.4</td>
<td>0.5</td>
<td>-1.1</td>
<td>1.4</td>
<td>3.1</td>
<td>2.5</td>
<td>3.4</td>
<td>3.3</td>
<td>4.4</td>
<td>2.6</td>
<td>4.4</td>
</tr>
<tr>
<td>Finland</td>
<td>Gen. govt. fiscal</td>
<td>-6.2</td>
<td>-3.5</td>
<td>-1.2</td>
<td>1.7</td>
<td>1.6</td>
<td>6.9</td>
<td>5.0</td>
<td>4.3</td>
<td>2.3</td>
<td>2.1</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td></td>
<td>Current account</td>
<td>4.3</td>
<td>3.9</td>
<td>5.4</td>
<td>5.7</td>
<td>7.6</td>
<td>8.9</td>
<td>10.1</td>
<td>6.4</td>
<td>7.7</td>
<td>4.9</td>
<td>5.2</td>
<td>5.2</td>
</tr>
<tr>
<td>France</td>
<td>Gen. govt. fiscal</td>
<td>-5.5</td>
<td>-4.1</td>
<td>-3.0</td>
<td>-2.6</td>
<td>-1.7</td>
<td>-1.5</td>
<td>-1.6</td>
<td>-3.2</td>
<td>-4.2</td>
<td>-3.7</td>
<td>-2.9</td>
<td>-2.7</td>
</tr>
<tr>
<td></td>
<td>Current account</td>
<td>0.7</td>
<td>1.3</td>
<td>2.7</td>
<td>2.8</td>
<td>2.6</td>
<td>1.2</td>
<td>1.7</td>
<td>0.4</td>
<td>0.5</td>
<td>-0.9</td>
<td>-1.3</td>
<td>-1.3</td>
</tr>
<tr>
<td>Germany</td>
<td>Gen. govt. fiscal</td>
<td>-3.2</td>
<td>-3.3</td>
<td>-2.6</td>
<td>-2.2</td>
<td>-1.5</td>
<td>1.3</td>
<td>-2.8</td>
<td>-3.6</td>
<td>-4.0</td>
<td>-3.7</td>
<td>-3.2</td>
<td>-2.3</td>
</tr>
<tr>
<td></td>
<td>Current account</td>
<td>-1.2</td>
<td>-0.6</td>
<td>-0.5</td>
<td>-0.7</td>
<td>-1.3</td>
<td>-1.7</td>
<td>0.2</td>
<td>1.9</td>
<td>4.6</td>
<td>4.6</td>
<td>4.6</td>
<td>4.6</td>
</tr>
<tr>
<td>Greece</td>
<td>Gen. govt. fiscal</td>
<td>-9.9</td>
<td>-7.3</td>
<td>-6.5</td>
<td>-6.2</td>
<td>-5.2</td>
<td>-4.9</td>
<td>-5.3</td>
<td>-6.2</td>
<td>-7.7</td>
<td>-8.1</td>
<td>-5.1</td>
<td>-2.6</td>
</tr>
<tr>
<td></td>
<td>Current account</td>
<td>-2.2</td>
<td>-3.3</td>
<td>-3.5</td>
<td>-2.7</td>
<td>-3.6</td>
<td>-7.7</td>
<td>-7.2</td>
<td>-6.5</td>
<td>-6.4</td>
<td>-3.6</td>
<td>-7.1</td>
<td>n/a</td>
</tr>
<tr>
<td>Ireland</td>
<td>Gen. govt. fiscal</td>
<td>-2.0</td>
<td>0.0</td>
<td>1.6</td>
<td>2.2</td>
<td>2.6</td>
<td>4.6</td>
<td>0.8</td>
<td>-0.4</td>
<td>0.4</td>
<td>1.5</td>
<td>1.1</td>
<td>1.0</td>
</tr>
<tr>
<td></td>
<td>Current account</td>
<td>2.6</td>
<td>2.8</td>
<td>2.4</td>
<td>0.9</td>
<td>0.6</td>
<td>0.6</td>
<td>-0.6</td>
<td>-1.2</td>
<td>0.0</td>
<td>-0.6</td>
<td>-3.5</td>
<td>-4.2</td>
</tr>
<tr>
<td>Italy</td>
<td>Gen. govt. fiscal</td>
<td>-7.4</td>
<td>-7.0</td>
<td>-2.7</td>
<td>-3.1</td>
<td>-1.8</td>
<td>-0.9</td>
<td>-3.1</td>
<td>-3.0</td>
<td>-2.5</td>
<td>-3.5</td>
<td>-4.3</td>
<td>-4.8</td>
</tr>
<tr>
<td></td>
<td>Current account</td>
<td>2.3</td>
<td>3.2</td>
<td>2.8</td>
<td>1.6</td>
<td>0.7</td>
<td>-0.5</td>
<td>-0.1</td>
<td>-0.3</td>
<td>-1.3</td>
<td>-0.9</td>
<td>-1.6</td>
<td>-2.6</td>
</tr>
<tr>
<td>Netherlands</td>
<td>Gen. govt. fiscal</td>
<td>-4.3</td>
<td>-2.0</td>
<td>-1.3</td>
<td>-0.9</td>
<td>0.4</td>
<td>2.0</td>
<td>-0.3</td>
<td>-2.0</td>
<td>-3.1</td>
<td>-1.8</td>
<td>-0.3</td>
<td>-0.4</td>
</tr>
<tr>
<td></td>
<td>Current account</td>
<td>5.9</td>
<td>5.6</td>
<td>6.5</td>
<td>3.2</td>
<td>3.8</td>
<td>1.9</td>
<td>2.4</td>
<td>2.5</td>
<td>5.5</td>
<td>7.5</td>
<td>7.2</td>
<td>8.3</td>
</tr>
<tr>
<td>Portugal</td>
<td>Gen. govt. fiscal</td>
<td>-5.2</td>
<td>-4.5</td>
<td>-3.4</td>
<td>-3.0</td>
<td>-2.7</td>
<td>-3.0</td>
<td>-4.3</td>
<td>-2.9</td>
<td>-3.0</td>
<td>-3.2</td>
<td>-6.0</td>
<td>-4.6</td>
</tr>
<tr>
<td></td>
<td>Current account</td>
<td>-0.1</td>
<td>-4.2</td>
<td>-5.9</td>
<td>-7.2</td>
<td>-8.6</td>
<td>-10.4</td>
<td>-9.9</td>
<td>-9.8</td>
<td>-6.1</td>
<td>-8.8</td>
<td>-9.7</td>
<td>-9.4</td>
</tr>
<tr>
<td>Spain</td>
<td>Gen. govt. fiscal</td>
<td>-6.3</td>
<td>-4.6</td>
<td>-2.9</td>
<td>-3.0</td>
<td>-0.9</td>
<td>-0.9</td>
<td>-0.5</td>
<td>0.0</td>
<td>0.0</td>
<td>-0.2</td>
<td>1.1</td>
<td>1.4</td>
</tr>
<tr>
<td></td>
<td>Current account</td>
<td>0.3</td>
<td>0.2</td>
<td>0.1</td>
<td>1.3</td>
<td>-2.9</td>
<td>-3.9</td>
<td>-3.3</td>
<td>-2.9</td>
<td>-3.0</td>
<td>-4.3</td>
<td>-7.4</td>
<td>-8.5</td>
</tr>
<tr>
<td>Sweden</td>
<td>Gen. govt. fiscal</td>
<td>-6.0</td>
<td>-2.8</td>
<td>-1.0</td>
<td>-5.8</td>
<td>2.3</td>
<td>2.6</td>
<td>-0.5</td>
<td>-0.2</td>
<td>0.1</td>
<td>1.6</td>
<td>2.8</td>
<td>2.9</td>
</tr>
<tr>
<td></td>
<td>Current account</td>
<td>1.9</td>
<td>3.5</td>
<td>4.1</td>
<td>2.7</td>
<td>4.2</td>
<td>4.3</td>
<td>5.4</td>
<td>7.2</td>
<td>6.7</td>
<td>6.9</td>
<td>7.2</td>
<td>6.9</td>
</tr>
<tr>
<td>United</td>
<td>Gen. govt. fiscal</td>
<td>-5.8</td>
<td>-4.1</td>
<td>-2.1</td>
<td>0.1</td>
<td>1.2</td>
<td>4.0</td>
<td>0.9</td>
<td>-1.7</td>
<td>-3.4</td>
<td>-3.3</td>
<td>-3.4</td>
<td>-3.0</td>
</tr>
<tr>
<td>Kingdom</td>
<td>Current account</td>
<td>-1.2</td>
<td>-0.9</td>
<td>-0.1</td>
<td>-0.4</td>
<td>-2.6</td>
<td>-2.2</td>
<td>-1.6</td>
<td>-1.3</td>
<td>-1.6</td>
<td>-2.5</td>
<td>-3.2</td>
<td>n/a</td>
</tr>
</tbody>
</table>

Source: General government fiscal data as described in Table 3.1 of Chapter Three and illustrated in Figures 3.1-3.4 there. Current account data are from Eurostat.

Note: ‘n/a’ means data unavailable.

Accession Europe over the same period at first sight provides stronger arguments against overall sustainability, based on the descriptive data from Table 5.2. What is noteworthy is that the sharpest increases in the external imbalances were coupled with nearly balanced or surplus budgets in Bulgaria, Estonia and Latvia. Those three are currency board or exchange-rate targeting countries: it is tempting to suggest that under fixed exchange rates and absence of national monetary policy, fiscal policy is the only tool to restore sustainability. But what do the ratios in Table 5.1 and Table 5.2 really tell us about the open-economy (overall) sustainability?
The external sustainability dimension

The arithmetic of external (current account) sustainability assessment is analogous to the one of fiscal sustainability presented in detail in Chapter Two. The statistically testable conditions are derived from the external budget constraint, as "similarly to the government accumulating public debt because its revenues fall short of its expenditures, a country accumulates external debt when it has a current account deficit" (Ley, 2003, p. 9).

The external sustainability assessment follows exactly the IBC arithmetic of Chapter Two. The initial step is analogous to (2.3):

\[ F_t = (1 + i_t)F_{t-1} + CA_t \]

Here \( F \) is foreign debt; \( CA \) is current account deficit. In this specification \( CA \) does not include foreign debt interest and thus corresponds to the primary deficit in the budget.

---

Table 5.2. General government fiscal and current account balances, percent of GDP (accession countries)

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Bulgaria</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen. govt. fiscal</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>1.7</td>
<td>0.4</td>
<td>-0.5</td>
<td>1.9</td>
<td>0.1</td>
<td>-0.9</td>
<td>2.2</td>
<td>-1.9</td>
<td>3.3</td>
</tr>
<tr>
<td>Current account</td>
<td>-0.2</td>
<td>0.2</td>
<td>5.2</td>
<td>-0.4</td>
<td>-5.1</td>
<td>-5.6</td>
<td>-7.3</td>
<td>-5.6</td>
<td>-8.5</td>
<td>-6.6</td>
<td>-12</td>
<td>-15.7</td>
</tr>
<tr>
<td>Cyprus</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen. govt. fiscal</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>-4.2</td>
<td>-4.4</td>
<td>-2.6</td>
<td>-2.3</td>
<td>-4.4</td>
<td>-6.3</td>
<td>-4.1</td>
<td>-2.3</td>
<td>-1.5</td>
</tr>
<tr>
<td>Current account</td>
<td>-1.7</td>
<td>-4.9</td>
<td>-3.8</td>
<td>-6.3</td>
<td>-2.2</td>
<td>-4.9</td>
<td>-3.2</td>
<td>-3.7</td>
<td>-2.3</td>
<td>-5</td>
<td>-5.6</td>
<td>-5.9</td>
</tr>
<tr>
<td><strong>Czech Rep.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen. govt. fiscal</td>
<td>13.4</td>
<td>3.3</td>
<td>3.8</td>
<td>-5.0</td>
<td>3.7</td>
<td>3.7</td>
<td>5.7</td>
<td>-5.6</td>
<td>-6.6</td>
<td>-6.3</td>
<td>-2.9</td>
<td>-3.5</td>
</tr>
<tr>
<td>Current account</td>
<td>-2.5</td>
<td>-6.7</td>
<td>-6.3</td>
<td>-2.1</td>
<td>-2.4</td>
<td>-4.8</td>
<td>-5.3</td>
<td>-5.6</td>
<td>-6.2</td>
<td>-5.4</td>
<td>-1.8</td>
<td>-3.3</td>
</tr>
<tr>
<td>Estonia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen. govt. fiscal</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>-0.2</td>
<td>-0.3</td>
<td>0.4</td>
<td>2.0</td>
<td>2.3</td>
<td>3.8</td>
<td></td>
</tr>
<tr>
<td>Current account</td>
<td>-4.2</td>
<td>-8.6</td>
<td>-11.4</td>
<td>-8.7</td>
<td>-4.4</td>
<td>-5.3</td>
<td>-5.4</td>
<td>-9.8</td>
<td>-11.3</td>
<td>-12.3</td>
<td>-10</td>
<td>-15.5</td>
</tr>
<tr>
<td>Hungary</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen. govt. fiscal</td>
<td>n/a</td>
<td>n/a</td>
<td>-5.9</td>
<td>-8.5</td>
<td>-5.5</td>
<td>-2.9</td>
<td>-3.4</td>
<td>-8.2</td>
<td>-7.2</td>
<td>-6.5</td>
<td>-7.8</td>
<td>-9.2</td>
</tr>
<tr>
<td>Current account</td>
<td>-5.7</td>
<td>-3.7</td>
<td>-2.1</td>
<td>-4.9</td>
<td>-7.8</td>
<td>-8.4</td>
<td>-6.6</td>
<td>-7.1</td>
<td>-7.9</td>
<td>-8.4</td>
<td>-6.8</td>
<td>-6.6</td>
</tr>
<tr>
<td>Latvia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen. govt. fiscal</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>-0.5</td>
<td>1.5</td>
<td>-0.6</td>
<td>-5.3</td>
<td>-2.8</td>
<td>-2.1</td>
<td>-2.3</td>
<td>-1.6</td>
<td>-1</td>
</tr>
<tr>
<td>Current account</td>
<td>-0.6</td>
<td>-4.9</td>
<td>-5.6</td>
<td>-8.9</td>
<td>-8.9</td>
<td>-4.8</td>
<td>-7.6</td>
<td>-6.6</td>
<td>-8.2</td>
<td>-12.9</td>
<td>-12.5</td>
<td>-22.3</td>
</tr>
<tr>
<td>Lithuania</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen. govt. fiscal</td>
<td>-1.6</td>
<td>-3.3</td>
<td>-11.9</td>
<td>-3.1</td>
<td>-2.8</td>
<td>-3.2</td>
<td>-2.1</td>
<td>-1.5</td>
<td>-1.3</td>
<td>-1.5</td>
<td>-0.5</td>
<td>-0.3</td>
</tr>
<tr>
<td>Current account</td>
<td>-9.5</td>
<td>-8.8</td>
<td>-9.8</td>
<td>-11.6</td>
<td>-11</td>
<td>-6</td>
<td>-4.7</td>
<td>-5.1</td>
<td>-6.8</td>
<td>-7.7</td>
<td>-7.2</td>
<td>-10.8</td>
</tr>
<tr>
<td>Malta</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen. govt. fiscal</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>-9.7</td>
<td>-7.6</td>
<td>-6.1</td>
<td>-6.4</td>
<td>-5.5</td>
<td>-10</td>
<td>-5</td>
<td>-3.1</td>
<td>-2.6</td>
</tr>
<tr>
<td>Current account</td>
<td>-10.1</td>
<td>-11.1</td>
<td>-5.4</td>
<td>-5.7</td>
<td>-3.2</td>
<td>-12.4</td>
<td>-3.8</td>
<td>-2.4</td>
<td>-3.1</td>
<td>-6</td>
<td>-8.7</td>
<td>-6.7</td>
</tr>
<tr>
<td>Poland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen. govt. fiscal</td>
<td>-4.4</td>
<td>-4.9</td>
<td>-4.6</td>
<td>-4.3</td>
<td>-1.8</td>
<td>-1.5</td>
<td>-3.7</td>
<td>-3.2</td>
<td>-6.3</td>
<td>-5.7</td>
<td>-4.3</td>
<td>-3.9</td>
</tr>
<tr>
<td>Current account</td>
<td>-0.6</td>
<td>-2.1</td>
<td>-3.7</td>
<td>-7.4</td>
<td>-5.8</td>
<td>-2.8</td>
<td>-2.6</td>
<td>-2.1</td>
<td>-4.2</td>
<td>-1.6</td>
<td>-3.2</td>
<td></td>
</tr>
<tr>
<td>Romania</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen. govt. fiscal</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>-3.2</td>
<td>-4.5</td>
<td>-4.6</td>
<td>-3.3</td>
<td>-2</td>
<td>-1.5</td>
<td>-1.5</td>
<td>-1.4</td>
<td>-1.9</td>
</tr>
<tr>
<td>Current account</td>
<td>n/a</td>
<td>n/a</td>
<td>n/a</td>
<td>-6.9</td>
<td>-4</td>
<td>-3.7</td>
<td>-5.5</td>
<td>-3.3</td>
<td>-5.5</td>
<td>-8.4</td>
<td>-8.6</td>
<td>-10.4</td>
</tr>
<tr>
<td>Slovenia</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gen. govt. fiscal</td>
<td>0.4</td>
<td>2.0</td>
<td>2.3</td>
<td>9.8</td>
<td>2.4</td>
<td>-2.7</td>
<td>-2.4</td>
<td>-2.8</td>
<td>-2.7</td>
<td>-1.5</td>
<td>-1.4</td>
<td></td>
</tr>
<tr>
<td>Current account</td>
<td>0.3</td>
<td>0.2</td>
<td>0.3</td>
<td>-0.6</td>
<td>-3.3</td>
<td>2.7</td>
<td>0.2</td>
<td>1</td>
<td>-0.8</td>
<td>-2.7</td>
<td>-2</td>
<td>-2.8</td>
</tr>
</tbody>
</table>

Source: Eurostat. General government fiscal balances reproduced from Table 4.1 in Chapter Four.
Note: 'n/a' means data unavailable.
In empirical applications the current account is usually defined more narrowly in another respect: instead of what would be required under conventional balance of payments accounting, the standard research approach is to use the empirically observable net exports instead of a current account balance. The trade balance constitutes almost the whole of the current account and the near perfect positive correlation between net exports and the current account balance is put forward as an explanation why the former is always used as a proxy for the latter (Corsetti and Müller, 2006, p. 604). In the empirical or even the early theoretical models (e.g. Husted, 1992, p. 160) that distinction is rarely noted: sustainability of the trade balance is regarded as external sustainability. The model below circumvents the above confusion.

In (5.1) too, for simplicity a common ‘world’ nominal interest rate is assumed. Then the procedure is as for fiscal sustainability: through a ‘flow’ external constraint, scaling to GDP, introducing a discount factor incorporating the real interest and the economy’s growth rates, to end up with:

\[
f_t = \rho^{-(j+l)} f_{t+j+l} - \sum_{i=0}^{T} \rho^{-i(1+r_t)} (\epsilon_{t+i+1})
\]

which corresponds exactly to (2.10). Current foreign debt equals the discounted future sequence of current account surpluses plus the discounted value of terminal foreign debt, all expressed as ratios of GDP. Following the arguments from Chapter Two, external sustainability requires the transversality condition that the first right-hand-side term in (5.2) be zero in the limit. Analogously to the IBC, an intertemporal external constraint is imposed. In other words, all foreign debt outstanding today should be paid off by future current account surpluses because otherwise rational foreign lenders will stop lending to a country running a Ponzi scheme against them, i.e. remaining with a non-zero terminal foreign debt.

A ‘statistical tests’ strand of the current account sustainability literature then deals with empirically testable sustainability conditions which mirror those in the fiscal (budget) sustainability counterparts: stationarity of foreign debt or of its first differences, or cointegration between imports and foreign debt interest payments, on the one hand, and exports, on the other hand. The sustainability criteria reviewed in Chapter Two, as well
as their critiques, are directly transposable into the current account sustainability
domain.

The model

It is important to recall at this stage that $F$ comprises all foreign debt, which is both
private and public (Figure 5.1). Hence, one may think of $F$ as consisting partly of $B$, the
general government debt defined in Chapter Two. This is an important issue for
empirical work, because testing for the overall solvency constraint may require data for
foreign and government debt and interest payments, as well as for the overlap between
them.

Figure 5.1. Foreign vs. government debt

Certainly data limitations play a role in choosing what type of sustainability to test for.
When there are government or foreign debt data, whether the country respects
separately the intertemporal and the external budget constraints may be duly assessed.
Analyses traditionally dealing with fiscal sustainability need not consider that part of
public debt goes to foreigners and is by virtue of that relevant to external sustainability.
This was the approach here so far too. Similarly, if the current account is the focus of
research when an open economy accumulates foreign debt, the fact that part of that debt
may be used to finance domestic public expenditures seems immaterial as to whether
the country observes the external budget constraint or not. What matters is the ability of
the country to sustain its policies in the long run without infringing upon either fiscal or
external solvency. But although the existing literature on fiscal sustainability does not
distinguish between domestic and foreign borrowing, it would be reasonable to suppose
that there could be different implications for fiscal sustainability in practice, depending on the respective proportions of debt held by residents and non-residents.

Missing data may hinder an attempt to model overall sustainability, unless the overlap in Figure 5.1 is accounted for. As claimed above, the fiscal and current account imbalances may be related and it is important to examine how they influence the macroeconomic sustainability. Budget deficits can lead to rising foreign debt: but also current account adjustments, if needed to restore long-run external sustainability, could deteriorate the fiscal stance and break a fiscal path observing the IBC thus far. With respect to that, Ahmed and Roger's (1995) analysis of 'economy-wide' sustainability is rather an empirical exception in that they are able to distinguish between government and foreign debt.

Whereas it is therefore advisable to extend the scope of analysis in an open-economy and encompass both sustainability conditions, practically no models exist for the intertemporal constraining of both the government budget and the current account balances. It is intriguing to embark on this and provide a theoretical model that is less demanding in terms of the empirically observable variables. Thus a more complete European sustainability picture will be obtained.

This section outlines a model illustrating why a country may be running continuous fiscal surpluses but if foreign debt is persistently drifting away and above government debt, overall sustainability will be at risk. The starting point is a version of the national accounts macro identity:

\[ Y = C + I - CA \]  

where \( Y \) is national income, \( C \) is consumption, \( I \) is investment and \( CA \) is the current account deficit as above. Rearranging, we get:

\[ -CA = Y - (C + I) = S - I \]

The right-hand side in (5.4) is total savings minus total investment. It may be decomposed between the private and public sectors, as:

---

43 Except for the limited efforts in a related, yet distinctly different, literature noted below.

44 The national income identity may show government expenditures separately, i.e. out of \( I \), but the relevant end result is the same.
where the subscripts \( p \) and \( g \) denote the private and the government sector variables, respectively. But \((S_g - I_g)\) equals \((T - G)\), which is the primary budget surplus (a negative budget deficit). So (5.5) becomes:

\[
(5.6) \quad D = (S_p - I_p) + CA
\]

The latter is the ‘twin deficit’ identity linking the government primary deficit to the current account deficit and the private sector savings-investment balance. To keep consistency with the analysis so far, (5.6) should be expressed in GDP ratios, in nominal terms and to highlight the argument and avoid exchange rate complications, in domestic prices.

The discussion so far is illustrated further by Table 5.3. As Chalk and Hemming (2000, p. 21) sum it up, although ‘there is not necessarily a direct correspondence between the “twin deficits” … fiscal and external sustainability are not entirely independent’. The link between the two sustainability notions is derived next.

### Table 5.3. The schematic flow of funds

<table>
<thead>
<tr>
<th>Gross National Domestic Income</th>
<th>Domestic Economy</th>
<th>Rest of the World</th>
</tr>
</thead>
<tbody>
<tr>
<td>+ Final Consumption</td>
<td>( Y )</td>
<td></td>
</tr>
<tr>
<td>+ Gross Investment</td>
<td>(-C)</td>
<td>(-C_g)</td>
</tr>
<tr>
<td>+ Exports of Goods &amp; Nonfactor Services</td>
<td>(-I)</td>
<td>(-I_g)</td>
</tr>
<tr>
<td>+ Imports of Goods &amp; Nonfactor Services</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ Net Factor Income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>+ Net Transfers</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-financial balances</td>
<td>((S-I))</td>
<td>((S-I_g))</td>
</tr>
</tbody>
</table>

Source: Adapted from Ley (2003, p. 10).

Using previous notation with the discount factor \( \rho \) assuming constant and equal interest rates, for the two classes of debt, and constant output growth rates, the twin deficit identity may be summed over all future periods and re-expressed in net present value terms:

\[
(5.7) \quad E \sum_{i=0}^\infty \rho^{-i(t)}(d_{t+i}) = E \sum_{i=0}^\infty \rho^{-i(t)}(sav-inv)_{t+i} + E \sum_{i=0}^\infty \rho^{-i(t)}(ca_{t+i})
\]
Above, (5.7) closely follows Chalk and Hemming’s (2000, p. 22) equation 39, expectation operators added for the creditors’ expectations about the country’s overall balance. The first right-hand side term in (5.7) is private savings minus private investment.

Now substituting from (2.10) but without seigniorage, to simplify and save space, and from (5.2), (5.7) turns into:

\[
\lim_{j \to +1} \rho^{-j} b_{t+j+1} - b_t = E \sum_{i=0}^{j} \rho^{-i} (s\text{av} - i\text{nv})_{t+i+1} + \lim_{j \to +1} \rho^{-j} f_{t+j+1} - f_t,
\]

or:

\[
f_t - b_t = E \sum_{i=0}^{j} \rho^{-i} (s\text{av} - i\text{nv})_{t+i+1} + \lim_{j \to +1} \rho^{-j} (f_{t+j+1} - b_{t+j+1})
\]

The twin deficit identity (5.6) is now re-expressed in terms of GDP ratios, using the previous notation and the primary deficit expression, without seigniorage, from (2.9). The current account deficit is analogously expressed to derive:

\[
b_t - \rho b_{t-1} = s\text{av} - i\text{nv} + f_t - \rho f_{t-1},
\]

or with the lag operator \(L\):

\[
b_t (1 - \rho, L) = s\text{av} - i\text{nv} + f_t (1 - \rho, L),
\]

and therefore expressing the private sector savings-investment balance as:

\[
(f_t - b_t)(\rho, L - 1) = s\text{av} - i\text{nv}
\]

It is useful now to redefine (5.9) in the following way:

\[
f_t - b_t = E \sum_{i=0}^{j} \rho^{-i} (s\text{av} - i\text{nv})_{t+i+1} + \rho' (f_0 - b_0),
\]

because \(\lim_{j \to +1} \rho^{-j} (f_{t+j+1} - b_{t+j+1}) = \rho' (f_0 - b_0)\) where \(f_0\) and \(b_0\) can be viewed as some initial values with \(\rho'\) ‘bringing’ them to the current period. The second right-hand side term in (5.13) plays the same role in deriving the empirically testable open-economy sustainability condition as the ‘bubble terms’ discussed in the seminal fiscal sustainability papers by Hamilton and Flavin (1986, p. 813, equation 9) and Haug (1991, p. 98, equation 5).
Overall, encompassing both the fiscal and current account dimensions, sustainability would be in place if the limit term in (5.9) above is zero: otherwise some terminal debt will remain. More precisely, the terminal debt would be the residual difference between foreign and government debt. That will imply, in analogy to the discussion in Chapter Two, that the country is engaged in an open-economy Ponzi game against its creditors.

Then (5.13) is expressed in the form of a testable regression as:

\[ f_t - b_t = \sum_{i=0}^{\infty} \rho^{-i}(s_t - \text{inv})_t + \rho'(f_0 - b_0) + \varepsilon_t \]

The null hypothesis is that the 'bubble term' in (5.14) is zero. This will hold whenever \( (s_t - \text{inv}) \) is stationary, because of (5.12) and under an assumption for a stationary disturbance term \( \varepsilon_t \). This points to the sufficiency of this stationarity condition. To illustrate the concept further, it is instructive to recall the empirically testable conditions from equation 10 in Hamilton and Flavin (1986, p. 815) where they also had to assume stationarity of their disturbance term. To compare more, Haug (1991) based his model on deterministic identities: equation 6 there (ibid., p. 98) is used to derive the sufficiency of his (co)integration condition. That roughly corresponds to only working with (5.13) here. Finally, the construction of the testable null here parallels Hakkio and Rush’s logic about their equation 7 (1991a, p. 432). In my model therefore, a stationarity of \( (s_t - \text{inv}) \) will suffice for ruling out a violation of the overall intertemporal constraint. The 'bubble term' will not approach zero in a dynamically efficient economy, where real interest exceeds real growth rate, unless the other terms in (5.14) are set to be stationary: hence stationarity of \( (s_t - \text{inv}) \) is a necessary condition too.

Furthermore, although trend stationarity is in this case mathematically possible, it would imply an undue economic burden on a country having to service, or at least to market, a constantly rising excess of foreign over government debt. Or if the trend is negative, fiscal sustainability could potentially be undermined with government debt constantly exceeding foreign debt. Hence, additionally imposing those economics constraints, \( (s_t - \text{inv}) \) should be stationary around a mean. As with the expenditures and revenues in
Chapter Three, however, the individual savings and investment series may be modelled with linear time trends.

To sum up, the condition to have the economy-wide sustainability is for private savings and private investment to be $C(I, I)$ with a cointegrating vector $(1, -1)$: unless they are both individually $I(0)$ which also implies overall sustainability as seen from (5.12)-(5.14). An advantage of the model developed in this chapter is that it does not assume fiscal or balance-of-payments sustainability individually. Previewing the empirical results below, it will be shown that a country may fail the fiscal sustainability definition but satisfy the open-economy macroeconomic long-run solvency constraint. It is that overall constraint that is revealed via (5.12)-(5.14), rather than the intertemporal budget constraint (fiscal sustainability) or the external constraint (current account sustainability). While fiscal sustainability requires the cointegration between the public sector revenue and expenditures so that the country will finally be without any government debt, external sustainability means eliminating any terminal foreign debt through the cointegration between the national (public plus private) savings and investment (i.e. literally the Feldstein-Horioka 'puzzle'). In contrast, the savings-investment intertemporal balance of the private economy turns out to be both necessary and sufficient for satisfying the overall sustainability condition. The data from the next two sections will be checked for compliance with the new condition.

The intuition behind this argument is straightforward: if private savings and investment do not move together in the long run, there will also be an increasing mismatch in the long-run sequences of foreign and government debt. Hence creditors should be wary about the country ending up with outstanding debt: a terminal excess of foreign over government debt, or vice versa. Thus a central role of the private sector looms up and any sustainability-related government stabilisation policies should take into account the

---

45 An important extension for future research is the 'weak' open-economy sustainability, drawing on Quintos (1995). Thus, private savings and investment may not need to be cointegrated as long as the coefficient on investment in a cointegrating regression where savings is the dependent variable lies between 0 and 1. That would however pose potential sustainability problems in the real world (the country will have to service a growing foreign debt) in much the same fashion as admitted by Quintos about her 'weak-form' condition. A related caveat is Bohn's (2007) critique: but as discussed previously in an analogous setting, it will be economically unrealistic to allow for higher orders of integration for the difference between foreign and government debt. Therefore, the strict condition of a cointegrating vector $(1, -1)$ is here taken as necessary and sufficient for an open-economy sustainability hypothesis in keeping with the intertemporal constraints.
fact that economy-wide sustainability will not be achieved without the appropriate private savings and private investment patterns.

An interesting extreme theoretical case would be when $f_0 = b_0$. Then the ‘bubble term’ would be 0 but savings and investment need not be cointegrated. That cannot be part of the research strategy however, as the values of $f_0$ and $b_0$ are empirically unobservable and because it must be very rare to have in one period foreign and government debt exactly equal. The latter argument of course also applies to the limit term in (5.9). Although ignoring that oddity for the empirical part, it may be worth to pursue it more deeply in further theoretical research.

Finally, the model just outlined should be delineated from two related pieces of literature. Ahmed and Rogers (1995) formulate an ‘economy-wide balance’ and empirically test US and UK data for it. They do not, however, analyse in detail their theoretical proposition that ‘total savings and total investment must move together’ to let the government’s fiscal and the country’s external positions satisfy the intertemporal constraints. Furthermore, as stressed at the outset above their empirical application critically depends on distinguishing between data on foreign and government debt, and interest payments or at least relevant interest rates, which are not available always. The following sections will demonstrate that for a panel of European countries, the enlarged EU, data on private savings and investment exist or are plausibly proxied and so the open-economy sustainability is assessable.

A paper by Matsubayashi (2005) has offered a model which also bears resemblance to this one. He obtains conditions for the sustainability of the current account deficits based on disaggregating the economy into private and government sectors. Whereas modelling the role of the private sector, and correspondingly also utilising the twin deficit identity, the research is targeted at the external sustainability. Admittedly, under Matsubayashi’s (2005) sustainability conditions fiscal sustainability would simultaneously be in place, and that is implicit in his model. But the shift of focus differentiates it from the approach here.

Moreover, his sustainability conditions are particularly demanding in respect of the many empirically observable series needed if an applied researcher wishes to follow the
method. In addition, the resulting policy implications may differ substantially. Whereas proposing an alternative route to assess external sustainability and highlighting the private sector's contributions, Matsubayashi (2005) therefore is related to but distinct from the open-economy sustainability model proposed here. My model suggests a simpler testable condition which, through the concern with the private sector, explicitly provides for an overall sustainability of the open economy.

The open-economy sustainability model is empirically applied next. First, sustainability in 'old' Europe is analysed and possible Maastricht/SGP effects are sought through the approaches introduced in Chapter Three.

5.2. Open-economy sustainability convergence in 'old' Europe

This section presents the first dataset used to illustrate the open-economy sustainability model in practice.

Data

The private sector savings and investment, as ratios to GDP, are mostly from the AMECO annual macro-economic database of the European Commission, presented first in the previous chapter. The database is updated as of 21 May 2007 (7 May 2007 for the GDP data). The private sector comprises the non-financial corporations (1995 ESA institutional sector S.1), financial corporations (S.12), households (S.14) and non-profit institutions servicing households (S.15).

Wherever AMECO data for private savings or private investment were available for certain years only, the full country series are recovered as explained in Table 5.4. That approach was preferred for maximum within-series consistency. If however data were unavailable for reconstructing the series at their full length only the missing observations are calculated, with AMECO data used for the rest as also explained.

Drawing on the twin deficit national accounting identity, the following savings/investment transformations are applied where needed:
• Gross private savings = gross national savings minus (a proxy for) gross general government savings

• Gross general government savings = primary balance plus (a proxy for) general government gross fixed capital formation

• Gross private investment (gross fixed capital formation) = gross fixed capital formation for the total economy minus (a proxy for) general government gross fixed capital formation

And the relevant AMECO series with their codes are:

• Gross saving at current prices, mrd, private sector. Code USGP.
• Gross national saving at current prices, mrd. Code USGN.
• Gross fixed capital formation at current prices, mrd, private sector. Code UIGP.
• Gross fixed capital formation at current prices, mrd, total economy. Code UIGT.
• GDP at current market prices, mrd. Code UVGDH. EDP reference level.

Table 5.4 describes the data, sources and adjustments. Pre-1999 data for the Euro area countries are fixed to the Euro at the irrevocable Euro conversion rate. The data series are annual, not seasonally adjusted and expressed as GDP ratios. This dataset is used for the first empirical application of the open-economy sustainability model.
<table>
<thead>
<tr>
<th>NO.</th>
<th>COUNTRY</th>
<th>DATA SPAN</th>
<th>SOURCES AND ADJUSTMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Austria</td>
<td>1970-2006</td>
<td>Private sector gross savings calculated as the difference between gross national savings (from AMECECO) and general government savings. The general government savings calculated as the sum of general government primary balance and fixed investment (the latter two taken from OECD's Economic Outlook database, via SourceOECD).</td>
</tr>
<tr>
<td>2</td>
<td>Belgium</td>
<td>1970-2006</td>
<td>Private sector gross fixed capital formation data from AMECECO.</td>
</tr>
<tr>
<td>3</td>
<td>Denmark</td>
<td>1971-2006</td>
<td>Private sector gross savings data from AMECECO.</td>
</tr>
<tr>
<td>4</td>
<td>Finland</td>
<td>1970-2006</td>
<td>Private sector gross savings calculated as the difference between gross national savings (from AMECECO) and general government savings. The general government savings calculated as the sum of general government primary balance and fixed investment (the latter two taken from OECD’s Economic Outlook database, via SourceOECD). Private sector gross fixed capital formation data from AMECECO.</td>
</tr>
<tr>
<td>5</td>
<td>France</td>
<td>1970-2006</td>
<td>Private sector gross savings calculated as the difference between gross national savings (from AMECECO) and general government savings. The general government savings calculated as the sum of general government primary balance and fixed investment (the latter two taken from OECD’s Economic Outlook database, via SourceOECD). Private sector gross fixed capital formation data from AMECECO.</td>
</tr>
<tr>
<td>8</td>
<td>Ireland</td>
<td>1970-2006</td>
<td>Private sector gross savings calculated as the difference between gross national savings (from AMECECO) and general government savings. The general government savings calculated as the sum of general government primary balance and fixed investment (the latter two taken from OECD’s Economic Outlook database, via SourceOECD). Private sector gross fixed capital formation data from AMECECO.</td>
</tr>
<tr>
<td>9</td>
<td>Italy</td>
<td>1970-2006</td>
<td>Private sector gross savings calculated as the difference between gross national savings (from AMECECO) and general government savings. The general government savings calculated as the sum of general government primary balance and fixed investment (the latter two taken from OECD’s Economic Outlook database, via SourceOECD). Private sector gross fixed capital formation data from AMECECO.</td>
</tr>
<tr>
<td>10</td>
<td>Netherlands</td>
<td>1970-2006</td>
<td>Private sector gross savings data from AMECECO. Private sector gross fixed capital formation data from AMECECO.</td>
</tr>
<tr>
<td>11</td>
<td>Portugal</td>
<td>1970-2006</td>
<td>Private sector gross savings from AMECECO from 1977 onwards. Before that, private sector gross savings calculated as the difference between gross national savings (from AMECECO) and general government savings. The general government savings calculated as the sum of general government primary balance and gross fixed capital formation (the latter two taken from Banco de Portugal’s historical statistics database, current prices). Private sector gross fixed capital formation data from AMECECO.</td>
</tr>
<tr>
<td>12</td>
<td>Spain</td>
<td>1970-2006</td>
<td>Private sector gross savings calculated as the difference between gross national savings (from AMECECO) and general government savings. The general government savings calculated as the sum of general government primary balance and fixed investment (the latter two taken from OECD’s Economic Outlook database, via SourceOECD). Private sector gross fixed capital formation data from AMECECO.</td>
</tr>
<tr>
<td>13</td>
<td>Sweden</td>
<td>1970-2006</td>
<td>Private sector gross savings calculated as the difference between gross national savings (from AMECECO) and general government savings. The general government savings calculated as the sum of general government primary balance and fixed investment (the latter two taken from OECD’s Economic Outlook database, via SourceOECD). Private sector gross fixed capital formation data from AMECECO.</td>
</tr>
<tr>
<td>14</td>
<td>United Kingdom</td>
<td>1970-2006</td>
<td>Private sector gross savings data from AMECECO. Private sector gross fixed capital formation data from AMECECO.</td>
</tr>
</tbody>
</table>

* The private sector defined as private sector and public enterprises under privatisation, current prices data; acknowledgments: Sophia Lazaretou and Alexandra Voutou from the Economic Research Department, Bank of Greece.
Empirical results: unit roots/stationarity

The strategy for research into the open-economy sustainability (convergence) mirrors that of Chapter Three. The private savings/private investment cointegration condition for the overall open-economy sustainability requires a prior testing for the orders of integration of the individual series. The next stage involves the cointegration regression of private savings on private investment applying the DOLS/DGLS estimation and checking for unit roots in the cointegrating vector. Furthermore, the evolution in open-economy sustainability is traced with the recursive estimation of the cointegrating (slope) parameter. Finally, the Maastricht effect is examined by estimating the total multiplier through an overall slope dummy as in Chapter Three.

Table 5.5 and Table 5.6 contain the results from testing the individual series in their levels and first differences, respectively, for the unit root/stationarity nulls. For robustness, again both trend specifications are used. For the majority of cases the series appear $I(1)$. Perhaps least ambiguous under the PPERRON tests, that conclusion can tentatively be adopted and compared with the findings later.
Table 5.5. Unit root/stationarity tests: private investment and private savings (levels)

<table>
<thead>
<tr>
<th>Country</th>
<th>Serie</th>
<th>Tests with trend&lt;sup&gt;(1)&lt;/sup&gt;</th>
<th>Tests without trend&lt;sup&gt;(1)&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DFGLS&lt;sup&gt;LAG&lt;/sup&gt;</td>
<td>DFGLS&lt;sup&gt;LAG&lt;/sup&gt;</td>
</tr>
<tr>
<td>Austria</td>
<td>inv</td>
<td>-2.033 (1)</td>
<td>-1.560 (2)</td>
</tr>
<tr>
<td></td>
<td>sav</td>
<td>-1.518 (1)</td>
<td>-0.814 (3)</td>
</tr>
<tr>
<td>Belgium</td>
<td>inv</td>
<td>-1.933 (1)</td>
<td>-1.933 (1)</td>
</tr>
<tr>
<td></td>
<td>sav</td>
<td>-3.623** (5)</td>
<td>-1.780 (1)</td>
</tr>
<tr>
<td>Denmark</td>
<td>inv</td>
<td>-2.316 (1)</td>
<td>-1.050 (5)</td>
</tr>
<tr>
<td></td>
<td>sav</td>
<td>-3.543** (1)</td>
<td>-3.543** (1)</td>
</tr>
<tr>
<td>Finland</td>
<td>inv</td>
<td>-3.376** (1)</td>
<td>-1.717 (4)</td>
</tr>
<tr>
<td></td>
<td>sav</td>
<td>-2.367 (1)</td>
<td>-2.367 (1)</td>
</tr>
<tr>
<td>France</td>
<td>inv</td>
<td>-2.617 (1)</td>
<td>-1.032 (5)</td>
</tr>
<tr>
<td></td>
<td>sav</td>
<td>-1.073 (1)</td>
<td>-1.073 (1)</td>
</tr>
<tr>
<td>Germany</td>
<td>inv</td>
<td>-2.005 (1)</td>
<td>-1.591 (2)</td>
</tr>
<tr>
<td></td>
<td>sav</td>
<td>-2.698 (2)</td>
<td>-1.813 (1)</td>
</tr>
<tr>
<td>Greece</td>
<td>inv</td>
<td>-2.762 (1)</td>
<td>-2.762 (1)</td>
</tr>
<tr>
<td></td>
<td>sav</td>
<td>-1.496 (1)</td>
<td>-1.110 (2)</td>
</tr>
<tr>
<td>Ireland</td>
<td>inv</td>
<td>-3.382** (9)</td>
<td>-1.481 (4)</td>
</tr>
<tr>
<td></td>
<td>sav</td>
<td>-1.598 (1)</td>
<td>-1.598 (1)</td>
</tr>
<tr>
<td>Italy</td>
<td>inv</td>
<td>-1.422 (1)</td>
<td>-1.422 (1)</td>
</tr>
<tr>
<td></td>
<td>sav</td>
<td>-1.953 (1)</td>
<td>-1.953 (1)</td>
</tr>
<tr>
<td>Netherlands</td>
<td>inv</td>
<td>-2.511 (1)</td>
<td>-1.584 (1)</td>
</tr>
<tr>
<td></td>
<td>sav</td>
<td>-2.624 (1)</td>
<td>-1.890 (4)</td>
</tr>
<tr>
<td>Portugal</td>
<td>inv</td>
<td>-3.773* (1)</td>
<td>-1.344 (6)</td>
</tr>
<tr>
<td></td>
<td>sav</td>
<td>-1.911 (1)</td>
<td>-0.574 (5)</td>
</tr>
<tr>
<td>Spain</td>
<td>inv</td>
<td>-1.232 (1)</td>
<td>-1.232 (1)</td>
</tr>
<tr>
<td></td>
<td>sav</td>
<td>-1.774 (1)</td>
<td>-1.774 (1)</td>
</tr>
<tr>
<td>Sweden</td>
<td>inv</td>
<td>-3.269*** (1)</td>
<td>-3.269*** (1)</td>
</tr>
<tr>
<td></td>
<td>sav</td>
<td>-2.591 (1)</td>
<td>-2.591 (1)</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>inv</td>
<td>-3.673** (1)</td>
<td>-3.673** (1)</td>
</tr>
<tr>
<td></td>
<td>sav</td>
<td>-3.635** (1)</td>
<td>-3.104 (7)</td>
</tr>
</tbody>
</table>

Notes: * inv and sav stand for private investment and private savings, respectively, as shares of GDP. ** and *** denote rejection of the null at 1%, 5% and 10%. In DFGLS, the 5% and 10% critical values are from Cheung and Lai (1995), while the 1% critical values are interpolated from the ones presented by Elliott, Rothenberg and Stock (1996). In KPSS, the critical values are taken from Kwiatkowski et al. (1992). In PPERRON, the critical values are linearly interpolated from the ones in Fuller (1976).

<sup>(1)</sup> Both tests with and without a trend include a constant term.
<sup>(2)</sup> Lag order selected according to the minimum Schwarz information criterion.
<sup>(3)</sup> Lag order selected according to the minimum Ng-Perron (2001) modified Akaike information criterion.
<sup>(4)</sup> Same lag order used as determined by either the modified Akaike information criterion if lag at most 3 there, or if otherwise: by the minimum Schwarz information criterion from the DFGLS test. In PPERRON, that is set to correspond to Newey-West truncation lags window used in calculating the standard error (i.e. correction for serial correlation of up to that lag order). 3 lags in the cases of private investment (levels, trend) for Ireland and again private investment (levels, no trend) for the Netherlands.
<sup>(5)</sup> The rho statistic in the PPERRON test, $H_0: \rho = 1$.
<sup>(6)</sup> The brackets report the number of lags selected for each test statistic.

177
Table 5.6. Unit root/stationarity tests: private investment and private savings (first differences)

<table>
<thead>
<tr>
<th>Country</th>
<th>Series</th>
<th>Tests with trend(1)</th>
<th>Tests without trend(1)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>DFGLS (9,0)</td>
<td>DFGLS (9,0)</td>
</tr>
<tr>
<td>Austria</td>
<td>$A_{inv}$</td>
<td>-0.011 (1) -2.019 (3)</td>
<td>0.0652</td>
</tr>
<tr>
<td></td>
<td>$A_{sav}$</td>
<td>-0.485 (1) -4.845 (1)</td>
<td>0.0334</td>
</tr>
<tr>
<td>Belgium</td>
<td>$A_{inv}$</td>
<td>-2.637 (1) -2.637 (1)</td>
<td>0.0579</td>
</tr>
<tr>
<td></td>
<td>$A_{sav}$</td>
<td>-1.634 (2) -1.201 (4)</td>
<td>0.131***</td>
</tr>
<tr>
<td>Denmark</td>
<td>$A_{inv}$</td>
<td>-4.316 (1) -4.316 (1)</td>
<td>0.0449</td>
</tr>
<tr>
<td></td>
<td>$A_{sav}$</td>
<td>-3.198*** (1) -3.198*** (1)</td>
<td>0.0408</td>
</tr>
<tr>
<td>Finland</td>
<td>$A_{inv}$</td>
<td>-3.299*** (1) -3.299*** (1)</td>
<td>0.0662</td>
</tr>
<tr>
<td></td>
<td>$A_{sav}$</td>
<td>-4.631 (1) -4.631 (1)</td>
<td>0.0301</td>
</tr>
<tr>
<td>France</td>
<td>$A_{inv}$</td>
<td>-3.292*** (1) -0.850 (8)</td>
<td>0.0698</td>
</tr>
<tr>
<td></td>
<td>$A_{sav}$</td>
<td>-3.285*** (1) -1.677 (4)</td>
<td>0.103</td>
</tr>
<tr>
<td>Germany</td>
<td>$A_{inv}$</td>
<td>-3.776* (1) -2.568 (2)</td>
<td>0.0836</td>
</tr>
<tr>
<td></td>
<td>$A_{sav}$</td>
<td>-2.830 (1) -2.830 (1)</td>
<td>0.0592</td>
</tr>
<tr>
<td>Greece</td>
<td>$A_{inv}$</td>
<td>-3.145*** (1) -0.951 (9)</td>
<td>0.057</td>
</tr>
<tr>
<td></td>
<td>$A_{sav}$</td>
<td>-0.648* (1) -1.772 (3)</td>
<td>0.0808</td>
</tr>
<tr>
<td>Ireland</td>
<td>$A_{inv}$</td>
<td>-3.561*** (3) -0.851 (8)</td>
<td>0.077</td>
</tr>
<tr>
<td></td>
<td>$A_{sav}$</td>
<td>-3.544* (1) -1.408 (4)</td>
<td>0.096</td>
</tr>
<tr>
<td>Italy</td>
<td>$A_{inv}$</td>
<td>-4.007* (1) -4.007* (1)</td>
<td>0.0636</td>
</tr>
<tr>
<td></td>
<td>$A_{sav}$</td>
<td>-3.697 (1) -0.784 (4)</td>
<td>0.143</td>
</tr>
<tr>
<td>Netherlands</td>
<td>$A_{inv}$</td>
<td>-3.532 (3) -3.235 (1)</td>
<td>0.0952</td>
</tr>
<tr>
<td></td>
<td>$A_{sav}$</td>
<td>-3.512*** (1) -1.060 (8)</td>
<td>0.0763</td>
</tr>
<tr>
<td>Portugal</td>
<td>$A_{inv}$</td>
<td>-3.697*** (1) -0.881 (9)</td>
<td>0.0503</td>
</tr>
<tr>
<td></td>
<td>$A_{sav}$</td>
<td>-4.130 (1) -4.130 (1)</td>
<td>0.037</td>
</tr>
<tr>
<td>Spain</td>
<td>$A_{inv}$</td>
<td>-3.561*** (1) -3.561*** (1)</td>
<td>0.0519</td>
</tr>
<tr>
<td></td>
<td>$A_{sav}$</td>
<td>-3.077*** (1) -3.077*** (1)</td>
<td>0.0446</td>
</tr>
<tr>
<td>Sweden</td>
<td>$A_{inv}$</td>
<td>-3.159*** (1) -3.159*** (1)</td>
<td>0.064</td>
</tr>
<tr>
<td></td>
<td>$A_{sav}$</td>
<td>-5.236 (2) -3.892* (2)</td>
<td>0.0243</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>$A_{inv}$</td>
<td>-3.766** (1) -3.766*** (1)</td>
<td>0.0414</td>
</tr>
<tr>
<td></td>
<td>$A_{sav}$</td>
<td>-3.516*** (1) -3.516*** (1)</td>
<td>0.0472</td>
</tr>
</tbody>
</table>

Notes: $A_{inv}$ and $A_{sav}$ stand for the first differences of private investment and private savings, respectively, as shares of GDP.  
* ** and *** denote rejection of the null at 1%, 5% and 10%. In DFGLS, the 5% and 10% critical values are from Cheung and Lai (1995), while the 1% critical values are interpolated from the ones presented by Elliott, Rothenberg and Stock (1996). In KPSS, the critical values are taken from Kwiatkowski et al. (1992). In PPFERRON, the critical values are linearly interpolated from the ones in Fuller (1976).

(1) Both tests with and without a trend include a constant term.
(2) Lag order selected according to the minimum Schwartz information criterion.
(3) Lag order selected according to the minimum Ng-Perron (2001) modified Akaike information criterion.
(4) Same lag order used as determined by either the modified Akaike information criterion if lag at most 3 there, or if otherwise: by the minimum Schwarz information criterion from the DFGLS test. In PPFERRON, that is set to correspond to Newey-West truncation lags window used in calculating the standard error (i.e. correction for serial correlation of up to that lag order). 3 lags in the cases of private investment (levels, trend) for Ireland and again private investment (levels, no trend) for the Netherlands.
(5) The $\rho$ statistic in the PPFERRON test, $H_0: \rho = 1$.
(6) The brackets report the number of lags selected for each test statistic.
Empirical results: cointegration

Compliance with the open-economy sustainability model should be checked against the complexity of results from the unit root and stationarity tests above and the cointegration analysis below. Now the overall sustainability perspective is applied for a first time on ‘old’ Europe’s private sector data. As in Chapter Three, the research strategy is to explore not only if the data support sustainability but when that sustainability has been achieved, if at all, over the period since 1970.

Open-economy sustainability will be confirmed if private savings and private investment are cointegrated with a vector (1, -1). This implies that the estimated coefficient on the private investment series must equal 1 in the savings-investment cointegrating regression where private savings are the dependent variable. It is also worth reminding the ‘weak’ fiscal sustainability conditions following Quintos (1995) which, if transposed to the open-economy sustainability model, generate two further opportunities. First, private savings and private investment may not necessarily be cointegrated as long as the coefficient on the investment series lies between 0 and 1. Second, in the case when the two series are not cointegrated the coefficient on private investment in the regression needs to equal 1. However, as discussed these weaker conditions are sub-optimal in that the country may find it increasingly difficult to service the excess of foreign over government debt (or vice versa). Analogously, in Table 2.A.1 the results conforming to Quintos’s (1995) weak-form sustainability conditions are documented as a lack of sustainability.

Table 5.7 presents the first cointegration results about the private savings and investment, following the specifications and the arguments behind them from Chapter Three.

The cointegrating coefficient on the investment series ($\beta$) is statistically significant and positive but below 1 in Austria, rejecting the unit root in the cointegrating vector, and in France, without rejecting the non-stationarity of the vector. These two countries therefore possibly comply with the weaker sustainability criterion. Greece satisfies another weak-form definition: the coefficient on the regressor is not statistically different from unity but there is no savings-investment cointegration.
The findings in Table 5.7 reject overall sustainability in Belgium, the Netherlands and Spain, where the estimated slope coefficients are statistically insignificant, and in Denmark, Finland, Germany, Italy, Portugal, Sweden and the United Kingdom, where the same coefficients lie outside the (0, 1) interval.

Ireland is the only country in ‘old’ Europe which appears to satisfy the economy-wide intertemporal solvency constraint: private savings and investment are cointegrated with a unitary cointegrating parameter. Since the two series do not drift apart, the Irish policies may continue unchanged into the future with no remaining terminal debt and the long-run open-economy constraint will be observed.

Thus in almost the whole of ‘old’ Europe overall sustainability, encompassing the budget and the external positions, has not been achieved over the entire observed period. Furthermore, compared to the results in Table 3.4 the new evidence may yield policy implications hinting at the role played by the private sectors in the countries under consideration. Despite their weak-form fiscal sustainability, most economies now fail to display any open-economy sustainability. It is only the weak-form fiscal sustainability of Ireland which turns into strong-form macroeconomic sustainability constraining intertemporally the budget and the current account. That suggests that the private sector there from 1970 until 2006 played a stabilising role to offset a possibly unsustainable fiscal performance by the government. On the contrary, for the rest of ‘old’ Europe the results reveal the need for future changes in the behaviour of the private sector in order to attain the overall solvency, given that the governments failed the strong-form fiscal sustainability definition in Chapter Three. As in the ‘statistical tests’ strand of fiscal sustainability literature, however, the concrete policy measures required ex ante are hard to advise.
Table 5.7: Cointegration analysis without breaks (private savings and private investment)

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>AT</th>
<th>BE</th>
<th>DK</th>
<th>FI</th>
<th>FR</th>
<th>DE</th>
<th>GR</th>
<th>IE</th>
<th>IT</th>
<th>NL</th>
<th>PT</th>
<th>ES</th>
<th>SE</th>
<th>GB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DGLS (1); DGLS (1); DGLS (1); DOLS; DGLS (1); DGLS (1); DGLS (1); DGLS (1); DGLS (1); DGLS (1); DGLS (1); DGLS (1); DGLS (1); DGLS (1); DGLS (1); DOLS</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Estimated equation:**

\[ SAV_t = \alpha + \beta INV_t + \varepsilon_t \]

<table>
<thead>
<tr>
<th>( C )</th>
<th>( \alpha )</th>
<th>( \beta )</th>
<th>( \varepsilon_t )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>( F-Wald ) test, ( H_0: \beta = 0 )</th>
<th>( [p-value] )</th>
<th>( [p-value] )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>( t-ADF ) on ( \varepsilon_t )</th>
<th>( [3% \text{ critical value}] )</th>
<th>( [3% \text{ critical value}] )</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Notes:** Standard errors in parentheses. Annual data from 1970 (1971 in Denmark) to 2006. 

1. DOLS order of the autocorrelation correction. 
2. * and ** denote significance at the 1%, 5% and 10% level, respectively. 
3. \( SAV \) and \( INV \) stand for private savings and private investment, respectively, as shares of GDP. 
4. ADF is the Augmented Dickey-Fuller test (lag order selected using the minimum Schwarz information criterion; cointegration test critical values from MacKinnon, 1991, Table 1). 

---

Table continues...

---

**181**
Figures 5.2-5.15 contribute to understand in more depth ‘old’ Europe’s overall sustainability from a historical perspective. The figures can illustrate how sustainability in an open-economy context changes over time and thus demonstrate any convergence, i.e. the more precise timing of sustainability. The recursive estimation of the slope coefficients should help detect any Maastricht/SGP effects. The technical details correspond to those explained about Figures 3.10-3.23 in Chapter Three.

The recursive cointegration results overwhelmingly confirm no sustainability across the time periods. The estimated 95% confidence band for the coefficient in Austria (Figure 5.2) varies between 0 and 1, hence suggesting weak-form open-economy sustainability, only after 2000. Evidence in favour of weak-form sustainability is also provided by the recursions in France (Figure 5.6) after 1994 and Greece (Figure 5.8) between 1996 and 1999. In the rest of the countries the 95% confidence bands, or parts of them, always lie below 0 or above 1, therefore signifying absence of sustainability. The point estimate of the coefficient in Ireland (Figure 5.9) is stable around unity since the end of the 1980s, thus supporting the strong-form sustainability hypothesis, but its 95% confidence band leaves the (0, 1) interval required under at least the weak-form definition.

Not only is the prevailing recursive evidence against open-economy sustainability, but Figures 5.2-5.15 show scant support for any convergence towards it since 1985. Perhaps only Greece and Ireland show gradual improvement, without necessarily achieving long-run sustainability, with their coefficients rising to approach unity.

A positive Maastricht effect, that is a jump or at least stabilisation in the coefficients in or right after 1992, without automatically resulting in sustainability, might be inferred only about Denmark (Figure 5.4), Italy (Figure 5.10) and Spain (Figure 5.13). The rest of ‘old’ Europe exhibits either no visible Maastricht regime change or even a slightly negative effect as in Finland (Figure 5.5), France and Germany (Figure 5.7).

In summary, the recursive analysis broadly confirms the pessimistic cointegration evidence from Table 5.7, but this time for the time horizon since 1985. If compared to Figures 3.10-3.23, it uncovers deterioration from the widespread weak-form fiscal sustainability of Chapter Three to the persistent lack of sustainability in terms of the overall intertemporal solvency constraint.
Figure 5.2. Austria: convergence in open-economy sustainability

Figure 5.3. Belgium: convergence in open-economy sustainability

Figure 5.4. Denmark: convergence in open-economy sustainability
Figure 5.5. Finland: convergence in open-economy sustainability

Figure 5.6. France: convergence in open-economy sustainability

Figure 5.7. Germany: convergence in open-economy sustainability
Figure 5.8. Greece: convergence in open-economy sustainability

Figure 5.9. Ireland: convergence in open-economy sustainability

Figure 5.10. Italy: convergence in open-economy sustainability
Figure 5.11. Netherlands: convergence in open-economy sustainability

Figure 5.12. Portugal: convergence in open-economy sustainability

Figure 5.13. Spain: convergence in open-economy sustainability
The hypothesis of practically non-existent Maastricht effect, as seen from the recursions, is further explored through the estimation of the total multiplier of Maastricht effect. Following the method introduced in Chapter Three, the model is augmented with overall slope dummies for the whole period after 1992 (Table 5.8).

The total multiplier associated with Maastricht is significantly positive, but with estimated values not suggesting substantial regime changes, in Denmark, France and the Netherlands. The slope dummy is statistically insignificant in Belgium, Finland, Germany, Ireland and Sweden, which implies no Maastricht effect there. It is significantly negative in the cases of Austria, Greece, Italy, Portugal, Spain and the UK, meaning that Maastricht may have even spurred policy deterioration leading to the violation of the overall sustainability criterion. Certainly it may be reasoned that the
Maastricht Treaty targeted fiscal rather than external or overall sustainability; hence it could be less surprising that little or no Maastricht effect is detected according to the total multiplier results in Table 5.8.

The estimated overall slope \((\beta + \phi)\) rules out any macroeconomic sustainability because it is either statistically insignificant (in Belgium, Finland and the Netherlands) or outside the \((0, 1)\) range (in Denmark, Germany, Greece, Portugal, Spain, Sweden and the UK). Insofar as Quintos’s (1995) conditions can be transposed about the long-run sustainability incorporating the budget and the current account, weak-form sustainability is implied by Austria’s overall slope, which is significantly positive but smaller than 1. Also France and Ireland turn out to be weak-form sustainable: their overall slopes are not statistically different from 1 but their private savings and investment do not cointegrate.

If explicitly modelling the Maastricht break, the evidence supports the economy-wide sustainability hypothesis only in Italy. There, the estimated overall slope is not statistically different from unity at the 10% significance level and the unit root in the cointegrating regression is rejected.

Compared to Table 5.7, the results in Table 5.8 become more pessimistic in Ireland and Greece but the prevailing evidence against open-economy sustainability in the EU14 is confirmed unchanged. Italy’s outcome is noteworthy: the model with an exogenously selected break in 1992 favours the sustainability hypothesis, unlike the no-break results from Table 5.7. In comparison to Chapter Three where the total multiplier associated with Maastricht was considered, most countries lapse from weak-form fiscal into no macroeconomic sustainability. Again only Italy seems to have achieved the overall sustainability despite the weak-form result if analysing just the fiscal dimension. It may be argued that perhaps the private sector in that country has begun to save more; that calls for deeper research into the particular Italian experience.
Table 5.8. Cointegration analysis with a break (private savings and private investment)

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>AT</th>
<th>BE</th>
<th>DK</th>
<th>FI</th>
<th>FR</th>
<th>DE</th>
<th>GR</th>
<th>IE</th>
<th>IT</th>
<th>NL</th>
<th>PT</th>
<th>ES</th>
<th>SE</th>
<th>GB</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>DGLS (1); DGLS (1); DGLS (2); DOLS</td>
<td>DGLS (1); DGLS (1); DGLS (1); DGLS (1); DGLS (1); DGLS (1); DGLS (1); DGLS (1); DGLS (1); DGLS (1); DGLS (1); DGLS (2); DGLS (1); DGLS (1); DGLS (2)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Estimated equation:

\[ SAV_t = \alpha + \beta INVT + \phi(D)INVT + \varepsilon_t \]

<table>
<thead>
<tr>
<th>( \alpha )</th>
<th>0.065</th>
<th>0.223</th>
<th>0.271</th>
<th>0.217</th>
<th>-0.026</th>
<th>0.258</th>
<th>0.297</th>
<th>-0.017</th>
<th>-0.078</th>
<th>0.179</th>
<th>0.651</th>
<th>0.212</th>
<th>0.336</th>
<th>0.375</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0.014)**</td>
<td>(0.023)*</td>
<td>(0.030)**</td>
<td>(0.040)*</td>
<td>(0.024)**</td>
<td>(0.028)**</td>
<td>(0.039)**</td>
<td>(0.027)**</td>
<td>(0.036)**</td>
<td>(0.055)**</td>
<td>(0.064)*</td>
<td>(0.020)*</td>
<td>(0.085)**</td>
<td>(0.047)*</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>( INVT )</th>
<th>0.705</th>
<th>0.149</th>
<th>-0.567</th>
<th>-0.105</th>
<th>1.125</th>
<th>-0.256</th>
<th>-0.033</th>
<th>1.015</th>
<th>1.540</th>
<th>0.295</th>
<th>-1.848</th>
<th>0.012</th>
<th>-1.102</th>
<th>-1.280</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0.176)*</td>
<td>(0.134)**</td>
<td>(0.165)*</td>
<td>(0.174)*</td>
<td>(0.130)**</td>
<td>(0.156)*</td>
<td>(0.176)*</td>
<td>(0.172)*</td>
<td>(0.300)**</td>
<td>(0.268)*</td>
<td>(0.099)*</td>
<td>(0.522)**</td>
<td>(0.290)*</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>( D^2INV(D-1_{1992-2006}) )</th>
<th>-0.033</th>
<th>-0.029</th>
<th>0.158</th>
<th>0.020</th>
<th>0.136</th>
<th>-0.016</th>
<th>-0.484</th>
<th>0.006</th>
<th>-0.189</th>
<th>0.090</th>
<th>-0.375</th>
<th>-0.183</th>
<th>-0.016</th>
<th>-0.101</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0.017)*</td>
<td>(0.023)*</td>
<td>(0.028)*</td>
<td>(0.091)*</td>
<td>(0.030)*</td>
<td>(0.017)*</td>
<td>(0.060)*</td>
<td>(0.043)*</td>
<td>(0.031)*</td>
<td>(0.056)*</td>
<td>(0.223)*</td>
<td>(0.023)*</td>
<td>(0.127)*</td>
<td>(0.030)*</td>
<td></td>
</tr>
</tbody>
</table>

F-Wald test, \( H_0: \beta + \phi = 0 \) | 15.27 | 0.89 | 5.61 | 1.11 | 11.645 | 3.28 | 6.21 | 43.75 | 43.11 | 1.59 | 52.14 | 3.16 | 3.12 | 20.63 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>([p-value])</td>
<td>0.00*</td>
<td>0.355*</td>
<td>0.027**</td>
<td>0.747*</td>
<td>0.082*</td>
<td>0.019**</td>
<td>0.001*</td>
<td>0.218*</td>
<td>0.00*</td>
<td>0.00*</td>
<td>0.001*</td>
<td>0.087***</td>
<td>0.089***</td>
<td>0.001*</td>
</tr>
</tbody>
</table>

F-Wald test, \( H_0: \beta + \phi = 1 \) | 3.63 | 47.89 | 66.65 | 17.37 | 2.89 | 71.79 | 50.89 | 0.02 | 2.91 | 4.03 | 109.60 | 148.07 | 11.21 | 61.32 |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>([p-value])</td>
<td>0.068*</td>
<td>0.00*</td>
<td>0.00*</td>
<td>0.001*</td>
<td>0.101*</td>
<td>0.00*</td>
<td>0.00*</td>
<td>0.894*</td>
<td>0.100*</td>
<td>0.055***</td>
<td>0.001*</td>
<td>0.00*</td>
<td>0.00*</td>
<td>0.001*</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>([p-value])</td>
<td>0.01**</td>
<td>0.01**</td>
<td>0.01**</td>
<td>0.01**</td>
<td>0.01**</td>
<td>0.01**</td>
<td>0.01**</td>
<td>0.01**</td>
<td>0.01**</td>
<td>0.01**</td>
<td>0.01**</td>
<td>0.01**</td>
<td>0.01**</td>
<td>0.01**</td>
</tr>
</tbody>
</table>

|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|


1 DOLS order of the autocorrelation correction.

** and *** denote significance at the 1%, 5% and 10% level, respectively.

\( SAV_t \) and \( INVT \) stand for private savings and private investment, respectively, as shares of GDP.

ADF is the Augmented Dickey-Fuller test (lag order selected using the minimum Schwarz information criterion; cointegration test critical values from MacKinnon, 1991, Table 1).
So the general conclusion from 'old' Europe is that the data very rarely support the open-economy overall sustainability definition: both across countries and along the time dimension for each country. For a first time subjected to an analysis of the economy-wide budget constraint, most of the Western European economies seem to be on paths which are not sustainable. This suggests that previous literature, which focussed more narrowly either on fiscal or external sustainability rather than overall sustainability, may need reconsideration, as it may have provided a misleading and possibly overoptimistic assessment of sustainability in these economies.

5.3. Open-economy sustainability in EU accession countries: a panel (co)integration perspective

I turn next to the accession countries of Central and Eastern Europe: has the dual pressure of transition and EU accession led to overall sustainability there? The data from Central and Eastern Europe are presented first, followed by the first empirical application of the open-economy sustainability model for accession Europe.

Data

Accession Europe's private savings and private investment data are mostly from the AMECO database. The transformations and codes are as explained in the data section about 'old' Europe above. The series are annual, scaled to GDP and not seasonally adjusted. Table 5.9 describes the sources and adjustments.
<table>
<thead>
<tr>
<th>NO.</th>
<th>COUNTRY</th>
<th>DATA SPAN</th>
<th>SOURCES AND ADJUSTMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bulgaria</td>
<td>1995-2006</td>
<td>Private sector gross savings calculated as the difference between gross national savings and government gross savings (both from Eurostat). Private sector gross fixed capital formation data from AMECO.</td>
</tr>
<tr>
<td>2</td>
<td>Cyprus</td>
<td>1995-2006</td>
<td>Before that, private sector gross savings calculated as the difference between gross national savings (from AMECO) and general government savings. The general government savings calculated as the sum of consolidated central government primary balance and capital expenditure (the latter two taken from IMF Staff Country Report No. 00/123, Table A12, p. 65). Gross fixed capital formation from AMECO from 1998 onwards. Before that, private sector gross fixed capital formation calculated as the difference between gross fixed capital formation for the total economy (from AMECO) and consolidated central government capital expenditure (the latter taken from IMF Staff Country Report No. 00/123, Table A12, p. 65).</td>
</tr>
<tr>
<td>3</td>
<td>Czech republic</td>
<td>1995-2006</td>
<td>Private sector gross savings data from AMECO. Private sector gross fixed capital formation data from AMECO.</td>
</tr>
<tr>
<td>4</td>
<td>Estonia</td>
<td>1995-2006</td>
<td>Private sector gross savings data from AMECO. Private sector gross fixed capital formation data from AMECO.</td>
</tr>
<tr>
<td>5</td>
<td>Hungary</td>
<td>1995-2006</td>
<td>Private sector gross savings calculated as the difference between gross national savings (from AMECO) and general government savings. The general government savings calculated as the sum of general government primary balance and fixed investment (the latter two taken from OECD’s Economic Outlook database, via SourceOECD). Private sector gross fixed capital formation calculated as the difference between gross fixed capital formation for the total economy (from AMECO) and general government fixed investment (the latter taken from OECD’s Economic Outlook database, via SourceOECD).</td>
</tr>
<tr>
<td>6</td>
<td>Latvia</td>
<td>1995-2006</td>
<td>Private gross savings data from AMECO. Private sector gross fixed capital formation data from AMECO.</td>
</tr>
<tr>
<td>7</td>
<td>Lithuania</td>
<td>1995-2006</td>
<td>Private gross savings data from AMECO. Private sector gross fixed capital formation data from AMECO.</td>
</tr>
<tr>
<td>8</td>
<td>Malta</td>
<td>1995-2006</td>
<td>Private sector gross savings calculated as the difference between gross national savings (from AMECO) and general government gross savings (available directly from Eurostat). Private sector gross fixed capital formation calculated as the difference between gross fixed capital formation for the total economy (from AMECO) and general government gross fixed capital formation (available directly from Eurostat).</td>
</tr>
<tr>
<td>9</td>
<td>Poland</td>
<td>1995-2006</td>
<td>Private gross savings data from AMECO. Private sector gross fixed capital formation data from AMECO.</td>
</tr>
<tr>
<td>10</td>
<td>Romania</td>
<td>1995-2006</td>
<td>Private sector gross savings data until 2000 taken from IMF Staff Country Report No. 06/169 (Table 4, p. 74) and for 2006 from IMF Staff Country Report No. 07/219 (Table 8, p. 35)<em>. Private sector gross fixed capital formation data until 2005 taken from IMF Staff Country Report No. 06/169 (Table 4, p. 74) and for 2006 from IMF Staff Country Report No. 07/219 (Table 8, p. 35)</em>.</td>
</tr>
<tr>
<td>11</td>
<td>Slovakia</td>
<td>1995-2006</td>
<td>Private gross savings data from AMECO. Private sector gross fixed capital formation data from AMECO.</td>
</tr>
<tr>
<td>12</td>
<td>Slovenia</td>
<td>1995-2006</td>
<td>Private gross savings calculated as the difference between gross national saving (from AMECO) and gross saving for the general government (current prices, source: Statistical Office of the Republic of Slovenia). Private sector gross fixed capital formation calculated as the difference between gross fixed capital formation for the total economy (from AMECO) and for the general government (current prices, source: Statistical Office of the Republic of Slovenia). The Slovenian data are fixed to the Euro at the country’s irrevocable Euro conversion rate.</td>
</tr>
</tbody>
</table>

* The Romanian authorities have introduced a new budget classification with the 2006 budget and that is reflected in the 2006 ratio.
Empirical results: panel unit roots/stationarity

Because of the short time series from the accession countries, for the reasons and motivation presented in Chapter Four the panel approaches to (co)integration remain the only plausible research methods here. The empirical strategy shadows the previous chapter, all efforts being made to mitigate possible small-size power and size distortions as well as to extract as much individual country inference as a panel analysis allows. As previously discussed, the countries in the region have much in common to allow for a group-wise analysis. But it is not less true that the countries also differ, hence the analysis should benefit from the recent advances in the panel cointegration literature for testing and estimation of heterogeneous panels.

As motivated in the previous chapter, the panel unit root test of Breitung (2000) and the panel stationarity test of Hadri (2000), with two trend specifications each, were employed to analyse accession Europe's open-economy sustainability. The evidence on orders of integration of the panel time series in levels and in first differences is presented in Tables 5.10-5.13.

Table 5.10. Panel unit root/stationarity results: private savings (levels)

<table>
<thead>
<tr>
<th>Test</th>
<th>Exogenous variables</th>
<th>Test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breitung (B)</td>
<td>individual intercepts</td>
<td>-0.310</td>
</tr>
<tr>
<td>H₀: Unit root (common unit root process)</td>
<td>individual trend &amp; intercept</td>
<td>-0.849</td>
</tr>
<tr>
<td>Hadri (H)</td>
<td>individual intercepts</td>
<td>4.126*</td>
</tr>
<tr>
<td>H₀: Stationarity (common unit root process)</td>
<td>individual trend &amp; intercept</td>
<td>6.578*</td>
</tr>
</tbody>
</table>

Notes: * denotes rejection of the null at 1%. The modified Akaike information criterion is used for automatically selecting the lag numbers in the B tests (preset from 0 to 1, in view of the short sample). The tests assume asymptotic normality. In the H test, the heteroscedastic consistent Z-statistic is used.

Table 5.11. Panel unit root/stationarity results: private investment (levels)

<table>
<thead>
<tr>
<th>Test</th>
<th>Exogenous variables</th>
<th>Test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breitung (B)</td>
<td>individual intercepts</td>
<td>-1.431***</td>
</tr>
<tr>
<td>H₀: Unit root (common unit root process)</td>
<td>individual trend &amp; intercept</td>
<td>0.979</td>
</tr>
<tr>
<td>Hadri (H)</td>
<td>individual intercepts</td>
<td>5.385*</td>
</tr>
<tr>
<td>H₀: Stationarity (common unit root process)</td>
<td>individual trend &amp; intercept</td>
<td>5.089*</td>
</tr>
</tbody>
</table>

Notes: * and *** denote rejection of the null at 1% and 10%. The modified Akaike information criterion is used for automatically selecting the lag numbers in the B tests (preset from 0 to 1, in view of the short sample). The tests assume asymptotic normality. In the H test, the heteroscedastic consistent Z-statistic is used.

The private savings and investment panels overwhelmingly support a unit root hypothesis for the levels data. The Breitung test, being among the best performing panel
unit root tests in small samples as noted in Chapter Four, cannot reject the null in the investment series without trend at the 1% or 5% significance levels. So the analysis proceeds to checking the first-differenced panel series (Tables 5.12 and 5.13).

Table 5.12. Panel unit root/stationarity results: private savings (first differences)

<table>
<thead>
<tr>
<th>Test</th>
<th>Exogenous variables</th>
<th>Test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breitung (B)</td>
<td>individual intercepts</td>
<td>-3.188*</td>
</tr>
<tr>
<td>H0: Unit root (common unit root process)</td>
<td>individual trend &amp; intercept</td>
<td>-4.229*</td>
</tr>
<tr>
<td>Hadri (H)</td>
<td>individual intercepts</td>
<td>1.960**</td>
</tr>
<tr>
<td>H0: Stationarity (common unit root process)</td>
<td>individual trend &amp; intercept</td>
<td>10.008*</td>
</tr>
</tbody>
</table>

Notes: * and ** denote rejection of the null at 1% and 5%. The modified Akaike information criterion is used for automatically selecting the lag numbers in the B tests (preset from 0 to 1, in view of the short sample). The tests assume asymptotic normality. In the H test, the heteroscedastic consistent Z-statistic is used.

Table 5.13. Panel unit root/stationarity results: private investment (first differences)

<table>
<thead>
<tr>
<th>Test</th>
<th>Exogenous variables</th>
<th>Test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breitung (B)</td>
<td>individual intercepts</td>
<td>-2.610*</td>
</tr>
<tr>
<td>H0: Unit root (common unit root process)</td>
<td>individual trend &amp; intercept</td>
<td>-3.664*</td>
</tr>
<tr>
<td>Hadri (H)</td>
<td>individual intercepts</td>
<td>0.692</td>
</tr>
<tr>
<td>H0: Stationarity (common unit root process)</td>
<td>individual trend &amp; intercept</td>
<td>5.587*</td>
</tr>
</tbody>
</table>

Notes: * denotes rejection of the null at 1%. The modified Akaike information criterion is used for automatically selecting the lag numbers in the B tests (preset from 0 to 1, in view of the short sample). The tests assume asymptotic normality. In the H test, the heteroscedastic consistent Z-statistic is used.

As discussed in Chapter Four about the test size and power distortions, not all results from Tables 5.12 and 5.13 may be given equal weight based on the reported test statistics. Remembering the high tendency of the Hadri (2000) test to commit Type I errors according to Hlouskova and Wagner’s (2006) findings, the preference here goes for the Breitung test.

Therefore, since the prevailing evidence is that the panels of private savings and private investment are I(1), the analysis moves on to the panel cointegration tests. As the open-economy sustainability model requires, the series should be cointegrated with a vector (1, -1), i.e. with a unitary parameter estimate on the private investment in a cointegration regression where savings are the dependent variable. If they are not, and because as seen the two series are hardly I(0), the panel of accession countries' data will not support the hypothesis of compliance with the overall long-run solvency constraint.
Empirical results: panel cointegration tests

The popular panel cointegration tests by Kao (1999) and Pedroni (1999, 2004), introduced in the previous chapter, are now employed first. The following panel regression model is considered in the empirical analysis of open-economy sustainability of accession Europe:

\[(5.15) \quad SAV_t = \alpha_i + \beta_i INV_t + \epsilon_t \]

where \(SAV\) and \(INV\) stand for private savings and private investment, respectively, as ratios to GDP, \(\alpha_i\) are the individual intercepts, \(\beta_i\) are individual slopes (\(\beta_i = \beta\) in Kao’s test), \(i\) denotes the unit (country) and \(t\) denotes the time (year) dimension.

Neither the Kao nor the Pedroni results presented in Table 5.14 are able to reject the null of no panel cointegration. Accession Europe will disclose economy-wide sustainability in Quintos’s (1995) weak-form version at most, only if one of two further conditions is satisfied: if the slopes in the panel regression of (5.15) are estimated to equal 1 or to be positive but less than 1.

<table>
<thead>
<tr>
<th>Test</th>
<th>Test type</th>
<th>Test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kao residual cointegration, homogeneous coefficients ((\beta_i = \beta) across sections); (H_0: No\ cointegration)</td>
<td>Augmented Dickey-Fuller test</td>
<td>-0.356</td>
</tr>
<tr>
<td>Pedroni residual cointegration; (H_0: No\ cointegration)</td>
<td>Panel v-statistic test</td>
<td>1.052</td>
</tr>
<tr>
<td>(H_1: Cointegration, \text{homogeneous alternative of common autoregressive coefficients (the ‘within’ dimension)})</td>
<td>Panel rho-statistic test</td>
<td>0.136</td>
</tr>
<tr>
<td>Pedroni residual cointegration; (H_0: No\ cointegration)</td>
<td>Panel PP-statistic test</td>
<td>0.257</td>
</tr>
<tr>
<td>(H_1: Cointegration, \text{heterogeneous alternative of individual autoregressive coefficients (the ‘between’ dimension)})</td>
<td>Panel ADP-statistic test</td>
<td>1.013</td>
</tr>
<tr>
<td>Pedroni residual cointegration; (H_0: No\ cointegration)</td>
<td>Group rho-statistic test</td>
<td>1.382</td>
</tr>
<tr>
<td>(H_1: Cointegration, \text{heterogeneous alternative of individual autoregressive coefficients (the ‘between’ dimension)})</td>
<td>Group PP-statistic test</td>
<td>0.544</td>
</tr>
<tr>
<td>Pedroni residual cointegration; (H_0: No\ cointegration)</td>
<td>Group ADP-statistic test</td>
<td>0.174</td>
</tr>
</tbody>
</table>

Notes: One lag of the change in residuals is used in the second-stage augmented regressions, in view of the short sample. The long-run variances are calculated using the Newey-West (1987) kernel estimator with a lag truncation equal to \(\left(\frac{T}{100}\right)^{2/9}\) as suggested in Pedroni (1995).

Before embarking on the panel regression estimation however, the analysis delves one step deeper into extracting some individual country inference. As discussed, such an exercise is inherently difficult in a panel context when the individual series are too
short. Being unable to assess each country separately, an alternative strategy is proposed as in Chapter Four: to construct sub-samples, taking one country out at a time, and compare the results with the full-sample evidence from Table 5.14. Table 5.15 presents the corresponding test statistics.

The comparison of results between Tables 5.14 and 5.15 indicates that no individual country seems to have stood out, i.e. to ‘distort’ the inference when included in the full panel. But such a categorical conclusion cannot be verified econometrically because of insufficient country observations for an individual analysis: rather, it illustrates this ‘12 minus 1’ alternative research route.

The panel cointegration evidence will be incomplete if one of the strongest assumptions behind the Kao and Pedroni tests, that of cross-sectional independence, is not relaxed. This issue was discussed in more detail in the previous chapter. For robustness again, the recent sieve bootstrap panel cointegration test by Westerlund and Edgerton (2007) is applied.

The ‘second generation’ panel cointegration test of Westerlund and Edgerton (2007) complements the inference so far and provides another empirical benchmark for future open-economy sustainability research, in the panel cointegration domain. As underlined previously, the W-E test has an alternative null of cointegration which could prove to be particularly insightful: if not rejected, at least one country in the panel must have observed the economy-wide long-run sustainability criterion.

The test is general enough to ‘accommodate correlation both within and between the individual cross-sectional units’ (ibid., p. 189) and is demonstrated to perform well in small samples. The panel cointegration test statistic is checked at the conventional critical levels from a one-tailed distribution bootstrapped after 2,000 replications from the sample counterpart. The bootstrapping of the critical values follows the strategy explained in Chapter Four for generating Table 4.12 and Figure 4.1. The bootstrapped critical values based on the panel of private savings and private investment data from accession Europe are presented in Table 5.16. Figure 5.16 displays the kernel density estimate of the bootstrap distribution of the test statistic.
## Table 5.15. Panel cointegration (eleven countries), Kao and Pedroni tests

**Test statistic, full panel without:**

<table>
<thead>
<tr>
<th>Test</th>
<th>Test type</th>
<th>BG</th>
<th>CY</th>
<th>CZ</th>
<th>EE</th>
<th>HU</th>
<th>LV</th>
<th>LT</th>
<th>MT</th>
<th>PL</th>
<th>RO</th>
<th>SK</th>
<th>SI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kao residual cointegration, homogeneous coefficients ($\beta = \beta$ across sections); $H_0$: No cointegration</td>
<td>Augmented Dickey-Fuller test</td>
<td>-1.135</td>
<td>-0.196</td>
<td>-0.253</td>
<td>-0.280</td>
<td>-0.341</td>
<td>-0.881</td>
<td>-0.278</td>
<td>-0.111</td>
<td>-0.016</td>
<td>-0.456</td>
<td>-0.143</td>
<td>-0.189</td>
</tr>
<tr>
<td>Pedroni residual cointegration; $H_0$: No cointegration</td>
<td>Panel v-statistic test</td>
<td>1.230</td>
<td>1.006</td>
<td>1.029</td>
<td>1.045</td>
<td>0.972</td>
<td>0.733</td>
<td>0.960</td>
<td>1.086</td>
<td>0.963</td>
<td>1.137</td>
<td>0.965</td>
<td>0.944</td>
</tr>
<tr>
<td></td>
<td>Panel rho-statistic test</td>
<td>-0.542</td>
<td>0.148</td>
<td>0.146</td>
<td>0.175</td>
<td>0.158</td>
<td>0.217</td>
<td>0.174</td>
<td>0.235</td>
<td>0.201</td>
<td>0.045</td>
<td>0.431</td>
<td>0.143</td>
</tr>
<tr>
<td></td>
<td>Panel PP-statistic test</td>
<td>-0.628</td>
<td>0.271</td>
<td>0.254</td>
<td>0.269</td>
<td>0.296</td>
<td>0.052</td>
<td>0.324</td>
<td>0.476</td>
<td>0.439</td>
<td>0.146</td>
<td>0.720</td>
<td>0.263</td>
</tr>
<tr>
<td></td>
<td>Panel ADF-statistic test</td>
<td>0.326</td>
<td>0.988</td>
<td>1.073</td>
<td>1.061</td>
<td>0.981</td>
<td>-0.187</td>
<td>1.153</td>
<td>1.426</td>
<td>1.149</td>
<td>1.099</td>
<td>1.257</td>
<td>1.099</td>
</tr>
<tr>
<td>Pedroni residual cointegration; $H_0$: No cointegration</td>
<td>Group rho-statistic test</td>
<td>0.978</td>
<td>1.434</td>
<td>1.313</td>
<td>1.316</td>
<td>1.443</td>
<td>1.306</td>
<td>1.401</td>
<td>1.384</td>
<td>1.336</td>
<td>1.204</td>
<td>1.426</td>
<td>1.337</td>
</tr>
<tr>
<td></td>
<td>Group PP-statistic test</td>
<td>-0.211</td>
<td>0.686</td>
<td>0.452</td>
<td>0.454</td>
<td>0.805</td>
<td>0.383</td>
<td>0.708</td>
<td>0.774</td>
<td>0.668</td>
<td>0.308</td>
<td>0.715</td>
<td>0.514</td>
</tr>
<tr>
<td></td>
<td>Group ADF-statistic test</td>
<td>-0.538</td>
<td>0.156</td>
<td>0.256</td>
<td>0.039</td>
<td>0.055</td>
<td>-0.361</td>
<td>0.630</td>
<td>0.497</td>
<td>0.301</td>
<td>0.022</td>
<td>0.161</td>
<td>0.785</td>
</tr>
</tbody>
</table>

Notes: One lag of the change in residuals is used in the second-stage augmented regressions, in view of the short sample. The long-run variances are calculated using the Newey-West (1987) kernel estimator with a lag truncation equal to \( \left( \frac{T}{100} \right)^{1/9} \) as suggested in Pedroni (1995).
Table 5.16. Accession countries open-economy sustainability bootstrapped critical values, W-E test

<table>
<thead>
<tr>
<th>Test</th>
<th>Exogenous variables</th>
<th>99%</th>
<th>95%</th>
<th>90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westerlund and Edgerton (2007)</td>
<td>individual intercepts, no deterministic trend</td>
<td>0.328</td>
<td>0.338</td>
<td>0.364</td>
</tr>
</tbody>
</table>

Figure 5.16. Accession countries open-economy sustainability bootstrap distribution, W-E test statistic

Then in Table 5.17 the test statistic obtained from the original sample is compared with the bootstrapped critical values.

Table 5.17. Panel cointegration, W-E test

<table>
<thead>
<tr>
<th>Test</th>
<th>Exogenous variables</th>
<th>Test type</th>
<th>Test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Westerlund and Edgerton (2007); H0: Cointegration</td>
<td>individual intercepts, no deterministic trend</td>
<td>Sieve bootstrap</td>
<td>0.242*</td>
</tr>
</tbody>
</table>

Notes: * denotes rejection of the null at the one-tailed 1% bootstrapped critical value. The group-mean FMOLS proposed by Pedroni (2000, 2001) used for estimating regression coefficients. The long-run variances are calculated using the Newey-West (1987) kernel estimator with a lag truncation equal to $4\left(\frac{T}{100}\right)^{2/9}$ as suggested in Pedroni (1995).

And the strong rejection of the panel cointegration null, now that the assumption of cross-sectional independence is taken away, confirms the evidence from Table 5.14 above. The accession countries most probably have not achieved open-economy sustainability if looking at the data from the past twelve years. Such a conclusion is unsurprising when compared to the intuition suggested initially by the seemingly large and varied macroeconomic imbalances illustrated by Table 5.2. Considering also the
pessimistic evidence from 'old' Europe above, the whole evidence points to a pan-
European absence of open-economy overall sustainability.

Still having the option open for Quintos’s (1995) weak-form sustainability, however, an
estimation of the panel regression is needed before reaching the final verdict. That
estimation is performed next.

**Empirical results: the panel regression estimation**

The bivariate panel regression with private savings the dependent variable and private
investment the regressor is estimated by the FMOLS and DOLS estimators first
introduced in Chapter Four. The motivation for choosing these estimators was also
discussed there. The results from the estimations of the current panel are given in Table
5.18.

<table>
<thead>
<tr>
<th>Country</th>
<th>FMOLS</th>
<th>Test statistic</th>
<th>DOLS (K=1)</th>
<th>Test statistic</th>
<th>DOLS (K=2)</th>
<th>Test statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Panel</td>
<td>0.307</td>
<td>-1.467</td>
<td>0.302</td>
<td>-14.480*</td>
<td>-0.567</td>
<td>-20.269*</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>0.378</td>
<td>-0.603</td>
<td>0.163</td>
<td>-4.922*</td>
<td>-0.162</td>
<td>-10.660*</td>
</tr>
<tr>
<td>Cyprus</td>
<td>0.512</td>
<td>-0.074</td>
<td>0.111</td>
<td>-0.784</td>
<td>-10.149</td>
<td>-14.106*</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>0.368</td>
<td>-0.464</td>
<td>0.650</td>
<td>-6.678*</td>
<td>0.647</td>
<td>-9.099*</td>
</tr>
<tr>
<td>Estonia</td>
<td>0.462</td>
<td>-0.283</td>
<td>0.901</td>
<td>-0.403</td>
<td>1.189</td>
<td>2.900*</td>
</tr>
<tr>
<td>Hungary</td>
<td>0.732</td>
<td>-0.061</td>
<td>1.049</td>
<td>0.324</td>
<td>0.924</td>
<td>-0.617</td>
</tr>
<tr>
<td>Latvia</td>
<td>0.322</td>
<td>-0.639</td>
<td>0.377</td>
<td>-6.981*</td>
<td>0.395</td>
<td>-5.751*</td>
</tr>
<tr>
<td>Lithuania</td>
<td>-0.406</td>
<td>-0.419</td>
<td>-0.827</td>
<td>-4.051*</td>
<td>-0.853</td>
<td>-4.123*</td>
</tr>
<tr>
<td>Malta</td>
<td>0.365</td>
<td>-0.255</td>
<td>0.947</td>
<td>-0.635</td>
<td>1.110</td>
<td>3.014*</td>
</tr>
<tr>
<td>Poland</td>
<td>0.313</td>
<td>-0.482</td>
<td>-0.016</td>
<td>-7.680*</td>
<td>0.087</td>
<td>-8.171*</td>
</tr>
<tr>
<td>Romania</td>
<td>0.315</td>
<td>-0.325</td>
<td>-0.648</td>
<td>-7.793*</td>
<td>-1.132</td>
<td>-12.425*</td>
</tr>
<tr>
<td>Slovakia</td>
<td>-0.199</td>
<td>-1.209</td>
<td>0.147</td>
<td>-8.883*</td>
<td>0.241</td>
<td>-9.639*</td>
</tr>
<tr>
<td>Slovenia</td>
<td>0.423</td>
<td>-0.267</td>
<td>0.769</td>
<td>-1.660***</td>
<td>0.923</td>
<td>-0.538</td>
</tr>
</tbody>
</table>

Notes: * and *** denote rejection of the null at 1% and 10%. \(H_0: \beta = 1\). \(K\) is the number of leads/lags.

The test statistics for the estimated parameter on the panel private investment series
easily reject the unit null in the DOLS but not in the FMOLS specification. Only in the
one lead/lag DOLS, however, the estimated panel parameter lies between 0 and 1, hence
possibly implying weak-form overall sustainability regardless of whether the panel
series were cointegrated or not, following Quintos (1995). Most individual country
parameter estimates in the one lead/lag DOLS specification also lie between 0 and 1. In
the two leads/lags DOLS specification, the panel estimate is below 0, whereas half of
the individual parameter estimates are outside the \((0, 1)\) interval, hence suggesting no
sustainability whatsoever. As far as the FMOLS results are concerned, the non-rejection
of the unit null means that another of Quintos’s (1995) weak sustainability conditions may be satisfied: that in the absence of cointegration, the parameter estimate on private investment in the savings-investment regression must equal 1.

Nevertheless, as discussed before weak-form sustainability even if partly confirmed by Table 5.18, may well be regarded as a lack of sustainability. Therefore, despite these further panel regression estimation results, the pessimistic inference from the cointegration tests above is central to the conclusion that the panel of EU accession countries reveals no open-economy sustainability.

A few further notes help clarify the interpretation of the findings from Table 5.18. Whereas the estimators adopted here are flexible enough to yield individual country estimates, and these are largely in line with the respective panel ones, due to the short series for each country the performance of the individual estimators may be quite unsatisfactory. This is of course a reason to focus exclusively on the panel result and regard the country results of secondary importance, as perhaps only complementing the discussion about Table 5.15 vs. Table 5.14.

Also, it is instructive to remind that the ‘group mean FMOLS has satisfactory size and power properties ... for small panels if \( T \) is larger than \( N \)’ (Maeso-Fernandez et al., 2006, p. 507). That condition is not fulfilled here; hence the preference may go for the DOLS estimator. As for the latter, the loss of degrees of freedom when \( K = 2 \) admittedly gives further preference towards the one lead/lag specification. All in all however, the panel DOLS estimate when \( K = 1 \) almost coincides with the panel FMOLS one.

One may now surmise the following. If long-run economy-wide sustainability in keeping with the intertemporal constraint matters and is taken as a criterion, any remaining optimism about Central and Eastern Europe from Chapter Four should disperse. At least some countries from the region may have positioned their economies on fiscally sustainable paths: but in the open-economy setting, it would appear that overall sustainability is not present, and that these countries continue to be subject to significant macroeconomic imbalances. The presentiment from Table 5.2 is confirmed.
5.4. Conclusion

This chapter underlines the need to extend the traditional theories of fiscal and external sustainability to the broader setting of the economy as a whole. It also provides first empirical applications based on newly constructed European datasets, to illustrate how the research agenda from the previous two chapters should be extended. The testable sustainability condition put forward is simple and empirically more accessible in terms of data requirements than other related propositions in the literature.

Emphasising the key role of the private sector according to the open-economy sustainability model should not undermine the need for fiscal prudence by the authorities. If a terminal excess of foreign over government debt is to be avoided, the private sector needs to save continuously more than it invests. But it is equally possible to infer from the twin deficit identity that if foreign debt starts to exceed government debt, the latter may be allowed to 'catch up', leaving the private sector balance unchanged. Whether this will be possible without violating fiscal sustainability, is doubtful. But the private sector behaviour itself is not completely independent from the fiscal stance, and therefore fiscal policies matter in all scenarios.

If on the other hand terminal government debt is not to exceed terminal foreign debt, fiscal consolidation policies are clearly needed: either so as to avoid a deterioration in the twin deficits, or to achieve an improvement in \((f_t - b_t)\), or to intervene if in some period government debt 'jumps'. If government debt goes up, the private sector can also contribute to restoring the positive difference between foreign debt and government debt by either continuously keeping its investment above savings, or by a one-time rise in investment, causing a rise in foreign indebtedness. But a higher foreign debt offsetting a higher government debt, although satisfying the mathematics of the twin deficit adjustments, may be problematic for purely external sustainability considerations. Or, foreign debt may stay unchanged with rising private investment if the government investment financed by borrowing abroad is proportionately crowded out: in that scenario the government debt may still end up exceeding the external debt. Broadly speaking, the fiscal authorities should again watch closely the overall balance.
Finally, it should be emphasised that the links between overall macroeconomic imbalances (lack of sustainability) and remedial policy measures are as tenuous as are the links from fiscal or external non-sustainability to policy. The ‘statistical tests’ strand of the sustainability literature experiences the same limitations in its policy implications, irrespective of whether we consider fiscal, external or overall sustainability.

The results from the empirical sections deserve attention on their own but also provide the benefit of hindsight for Chapters Three and Four. For ‘old’ Europe, sustainability seems an unrealised goal no matter if the fiscal balance is considered alone or in a unified analytical framework with the current account. Neither have Maastricht, the SGP or the adoption of the Euro been instrumental in shaping sustainable policies: little sustainability in the EU14 countries is confirmed across both ‘closed-’ and open-economy specifications.

For accession Europe, the twelve years of data unveil instability which is judged here through the overall sustainability criterion. The more optimistic discussion about the accession countries could remind the need for rapid enhancements in technology and infrastructure there which has required much faster private investment growth, thus skewing the savings-investment balance and as a result violating the open-economy sustainability. But the recent times of large private investment may pay off in the future and restore that sustainability. Also, the years of structural reforms and general economic uncertainties may have lowered savings in Central and Eastern Europe, and the new consumer credit access may have dissuaded households from saving: but these may also turn out temporary phenomena. So one may hope that with future longer time series from a possibly ‘more settled’ post-accession period, an open-economy sustainability analysis will prove more favourable for that group of countries.
The fiscal stance is sustainable if today's government debt outstanding can be repaid eventually without any need for the government to change its fiscal policies in the indefinite future. According to this definition, the solvency of the Treasury will not be jeopardised as long as the current government debt equates to the present value of future budget surpluses, or their excess over deficits. Such an intertemporal budget constraint may be respected even if in some periods the budget is not balanced; hence the government may still run deficits for some time and safely finance them with new debt. Series of past fiscal data can be tested statistically for compliance with the constraint. Assuming that the same fiscal policies which have generated the historical data will continue, the long-run fiscal sustainability is confirmed when the tests prove that the intertemporal budget constraint has so far been observed.

This definition of fiscal sustainability is adopted here and applied to the European Union countries. The first aim of the thesis is to research whether fiscal policies in Europe have been sustainable: but the overall evidence, across a multitude of empirical methods and the diverse economies from both 'old' and accession Europe, is pessimistic. Even if solvency is not an urgent concern, changes in the public finances are necessary if there are deviations from the path of long-run sustainability, hence the analysis is a timely reminder of the need for fiscal reforms in Europe. The long-run fiscal sustainability should not cease to be a priority because fiscal policy changes may be difficult to implement. Recently Joaquin Almunia, the Economic and Monetary Affairs Commissioner, argued that the rising ‘pressure on age-related expenditures, and consequently on public finance positions, reinforces the need to keep fiscal policies in check and maintain a focus on the longer-term sustainability of public finances’ (EC, 2008a). Persistently loose fiscal policies pose a threat to price stability but the adverse effects may run the other way round too. As the European Commission acknowledged
last summer, ‘the current economic juncture with strong inflationary pressures is reducing the room for manoeuvre in the conduct of policies’ (EC, 2008b). The global competitive pressures may necessitate tax cuts in Europe and further impede the fiscal consolidations needed for restoring fiscal sustainability.

To support the achievement of sustainable public finances, the Treaty of Maastricht in 1992 and the SGP in 1997 introduced two numerical fiscal rules in the EU. These rules constrain national deficits and debts and apply to all Member States, even though the enforcement mechanism is stronger for the EMU members. The first rule allows cyclical fluctuations in the budget within a reference value of 3 percent for the ratio of planned or actual government deficit to GDP at market prices. The second provision is that the gross general government consolidated debt at nominal value should not exceed 60 percent of GDP at market prices. The Maastricht/SGP rules reflect an alternative view on fiscal sustainability: they limit deficits and debt in the short run instead of ‘waiting’ for future budget surpluses to pay out accumulated debt and satisfy the intertemporal budget constraint in the long run. Whereas such exact numerical fiscal rules are easy to monitor and may justify concrete fiscal adjustments, and are therefore attractive for policy purposes, it is intriguing to see if they have brought long-run fiscal sustainability. The existing empirical literature disagrees about how effective Maastricht and the SGP have been in bringing public finances in line with the intertemporal constraint. So the second aim of this thesis is to check the hypothesis that the fiscal rules in Europe played a role in any particular timing of fiscal sustainability. Empirically verifiable in the EU15 group of countries where long fiscal time series exist, that hypothesis is not confirmed. The imposition of the fiscal rules in Europe cannot be given credit for any fiscal consolidations along the road to the single currency to achieve fiscal sustainability in the long run.

In 2004 and 2007 the European Union enlarged with twelve new members from Central and Eastern Europe. The third research question of this thesis is whether, based on the accession countries’ historical record, fiscal policies in the region can be categorised as ‘sustainable’. Those countries have undergone remarkable fiscal adjustments but even after their EU entry fiscal challenges remain. The new members must comply with the rules of the SGP and do not have an ‘opt out’ clause regarding the eventual adoption of the Euro. The dual pressures of transition from central planning and accession to the EU
have necessitated a thorough makeover of the institutions and changes in the fiscal practices; hence that region of Europe provides a unique field for empirical analysis. Yet fiscal sustainability studies on the accession countries have been rare, arguably due to data limitations resulting from the very short time series available there. This thesis fills a sizeable gap in the literature with an application of the formal methods of fiscal sustainability assessment to the twelve EU accession countries. An original dataset is compiled to cover more countries with longer data series than ever before, and new breakthroughs in the econometrics of panel time series, themselves only recently employed in the fiscal sustainability area, are exploited. Thus one of the first and certainly the most exhaustive fiscal sustainability analysis for accession Europe so far is made possible. The panel as a whole turns out to confirm fiscal sustainability: nevertheless, caution is advised because of possible small-sample size and power distortions. And the evidence is not robust enough to claim that each country individually has been sustainable since the mid-1990s.

The economy does not consist of a government sector only and therefore fiscal sustainability does not guarantee that other imbalances do not occur. A country with sustainable public finances may nonetheless run persistent current account deficits, accumulate foreign debt and compromise its external solvency. The negative balance in the current account may be a result of looser fiscal policies but the external imbalances in turn present an additional source of risk to fiscal sustainability. The government may wish to curtail domestic demand to reverse the current account balance but this may weaken the fiscal sustainability in the long term. Acknowledging that both fiscal and external sustainability should be analysed together and in a unified framework, the fourth main aim of this thesis is to bridge the conditions for budget and external intertemporal solvency. The existing literature contains practically no models for the intertemporal constraining of the economy-wide balance. That has required the derivation of an original model which is theoretically sound and not particularly demanding in terms of the empirically observable variables. The thesis thus upgrades traditional fiscal sustainability studies and, by encompassing both the government sector and the external position, essentially yields a framework for testing open-economy sustainability in the long-run. The condition for compliance with the overall intertemporal constraint turns out to be that private savings and private investment move together in the long run. So the sustainability-related government stabilisation
policies should take into account the role of the private sector. The first empirical application of the model reveals that in almost the whole of 'old' Europe economy-wide sustainability is not achieved over the last nearly four decades. Maastricht and the Pact have not led to transition towards more economy-wide long-run sustainability. When the open-economy sustainability assessment is performed on data from the twelve accession countries, the empirical results disperse any optimism remaining from the previous narrower focus on fiscal sustainability in that region of Europe.

As the preceding chapters unfold, the thesis addresses these four aims of the research agenda. The contents of the thesis sequentially deal with whether 'old' Europe has achieved long-run fiscal sustainability, any Maastricht/SGP effects in that respect, the formal fiscal sustainability analysis of accession Europe and the extension to open-economy sustainability.

In summary, Chapter Two outlines the foundations of fiscal sustainability analysis and prepares the subsequent empirical applications with a context of the theoretical literature and a choice of research methods. After presenting the simple arithmetic of the intertemporal budget constraint, the chapter sub-divides the literature into two main approaches: the 'constrained sustainability' and the 'statistical tests'. The chapter reviews some theoretically designed sustainability indicators and legislated practical fiscal rules, including the Maastricht/SGP and the UK budgetary rules. An advantage of the 'statistical tests' approach is the more direct targeting of the intertemporal budget constraint condition. The statistical tests serve well the research questions of the thesis because they enable the research into the power of the European fiscal framework to align public finances with the definition of long-run fiscal sustainability. The chapter presents Hamilton and Flavin's (1986) framework which is recognised as the genesis of the 'statistical tests' approach. Further works which have remained seminal even among the most recent empirical studies are then presented before the chapter discusses the criticism by Bohn (1991b and 1995) that fiscal sustainability should be studied statistically in a stochastic setting. The chapter puts forward arguments for the continued empirical application of the stationarity and cointegration conditions for fiscal sustainability, in spite of the recent critique of Bohn (2007) who challenges the necessity of these conditions. A special section in the chapter finally outlines another literature trend: the nonlinear fiscal adjustments.
The hypothetical gradual convergence towards or away from fiscal sustainability is the main subject of Chapter Three. The empirical applications in it address the two sequential research questions: have the EU15 countries achieved long-run fiscal sustainability, and if so have they become more sustainable due to Maastricht and the SGP. The thesis favours the following testable fiscal sustainability criterion: cointegration between total revenues and total expenditures, along with unitary cointegrating parameter on the latter. This criterion remains necessary and sufficient even in a stochastic environment and it accommodates the proposed research strategy. The assessment of the evolution in sustainability utilises a few complementary approaches: cointegration regressions, recursive estimations of the slope parameters, and tests for Maastricht regime shifts. The study is based on annual general government series of total revenues and total expenditures, as shares of GDP, from fourteen 'old' Europe countries between 1970 and 2006. The comprehensive statistical assessment of the fiscal performance of 'old' Europe provides no evidence that long-run fiscal sustainability has been attained. And the UK outcome is particularly negative. Neither does Maastricht, the Pact, or the actual advent of the Euro seem to have mattered in streamlining any efforts to run public finances in keeping with the intertemporal constraint. In other words, no convergence in fiscal sustainability in 'old' Europe is evident since the early 1990s.

With Chapter Four the thesis covers for the first time all the twelve EU accession countries with an original set of annual data on total revenues and total expenditure, as shares of GDP, from 1995 until 2006. The variety of panel time series methods exceeds any of the European panel sustainability studies so far. This chapter also stands out because it relaxes for the first time in accession Europe the strong assumption of cross-sectional independence in the panel data. The panel unit root and panel stationarity tests suggest that the series of revenues and expenditures are rather I(1). Then the panel cointegration tests following Kao (1999) and Pedroni (1999, 2004) provide evidence in favour of cointegration. When applied to sub-samples of countries, made up of the full sample minus one country at a time, the Kao and Pedroni tests show that all the accession countries exhibit similar cointegration evidence. When the arguably strong assumption of cross-section independence is relaxed and the recent sieve bootstrap panel cointegration test in Westerlund and Edgerton (2007) is performed, the support
for a cointegrated panel seems robustly confirmed. The combined evidence from the panel cointegration tests and the group-mean panel FMOLS and DOLS estimators of Pedroni (2001) confirms fiscal sustainability for the panel as a whole. The results suggest that at least some accession countries have rather achieved fiscal adjustment in keeping with the long-run sustainability definition. But the short and narrow dimensions of the panel call for extra caution in the interpretation of results. Furthermore, the evidence does not suffice to prove any fiscal sustainability in individual countries: in that respect, more country-level analyses are required. The latter will not be possible until future much longer data series from the region become available.

Chapter Five is devoted to the model relating fiscal and external solvency. A simple testable condition for the overall sustainability of an open economy is derived: private savings and private investment should be $C(1, 1)$ with a cointegrating vector $(1, -1)$, unless they are both individually $I(0)$ which also implies overall sustainability. The relevant datasets from ‘old’ and accession Europe are then constructed, with the same time spans and frequency as in the previous two chapters, respectively, and the condition for having economy-wide sustainability is first empirically checked. Almost everywhere in ‘old’ Europe the evidence is that the private savings and private investment drift apart. Hence, some terminal debt will remain and the intertemporal open-economy constraint will be violated if the existing policies continue unchanged. In the model where no Maastricht regime change is explicitly considered, only Ireland displays strong-form macroeconomic sustainability. With an exogenously selected break in 1992, Italy confirms economy-wide sustainability. Compared to the findings from Chapter Three, most economies lapse from weak-form fiscal sustainability into no overall sustainability, but Italy stands out: its earlier weak fiscal sustainability evidence gives way to an economy-wide sustainability. That suggests that the private sector of that country in the period from 1970 until 2006 played a stabilising role to offset a possibly unsustainable performance by the government, given that the strong-form fiscal sustainability definition is violated in Chapter Three. When the recursive approach to sustainability from Chapter Three is extended to the open-economy sustainability model, no Maastricht/SGP effects are visually detected. Finally, the study of the accession countries demonstrates that the panel as a whole seems to have deviated off the long-run overall equilibrium consistent with the economy-wide long-run solvency constraints. This contrasts with the fiscal sustainability result of Chapter...
Four. Likewise, whereas the thesis surmises that some Central and Eastern European economies may have exhibited fiscal sustainability individually, in the open-economy setting the imbalances prevail.

To recapitulate briefly, the thesis extends the existing literature in the following theoretical and empirical ways. It provides new individual country fiscal sustainability assessments for a comprehensive set of fourteen ‘old’ EU members and the results can be compared with previous studies of those economies. The thesis proposes a way to assess fiscal sustainability convergence over time and provides its first empirical application on ‘old’ Europe to sift out the true contributions of the Maastricht/SGP rules to long-run fiscal sustainability. The thesis is by far the most comprehensive so far in analysing fiscal sustainability in the accession countries, with its original dataset, an application of recent advances in the panel (co)integration literature and robustness checking through a diverse research agenda. The thesis puts forward a theoretical model incorporating the current account in an economy-wide sustainability analysis, and the model is illustrated with separate empirical applications on ‘old’ Europe, including an adaptation of the gradual convergence assessment, and accession Europe.

Some policy implications from the thesis are worth summarising. The first one to note is that since most countries over most of the period reviewed have not complied with the fiscal sustainability definition, policy changes are to be expected if authorities are keen to restore long-run sustainability. For Western Europe in particular, the empirical analysis sheds new light on the rationale behind the European fiscal rules. One may however claim that the results above do not immediately relate to the efficiency of the fiscal rules but rather remind that the fiscal arrangements under Maastricht and SGP do not necessarily conform to the definition of long-run sustainability. For Central and Eastern Europe, the formal econometric analysis cannot confirm the hypothesis of successful fiscal adjustment for each country individually, and fiscal discipline at the national level is advisable in order to satisfy the intertemporal budget constraint. Chapter Five emphasises the importance of extending traditional fiscal sustainability theory to the open-economy world and so the key role of the private sector is highlighted: but nevertheless, there remains a need for fiscal prudence by the authorities. The lack of compliance with the open-economy sustainability condition prevails in the full ensemble of the enlarged European Union: across countries, periods
and research methods. The latter confirms that the macroeconomic balances are
dynamic and rather fragile.

The thesis, however, deals with historical data and is therefore backward-looking and
by definition limited in what it can suggest as concrete recommendations for future
changes in policy. Whereas admittedly this is a generic limitation of the ‘statistical
tests’ strand of fiscal sustainability literature, the thesis is not safeguarded against other
possible limitations too. These are mostly rooted in certain technical aspects around the
empirical strategies applied here. In Chapters Three and Five, although the data series
span nearly four decades and should suffice to examine long-run statistical relationships
between macroeconomic variables, in the recursive estimations the time series are
sometimes not particularly long. That may have affected the robustness of the
econometric inference. In Chapters Four and Five, although the research strategy
justifies a focus on the cointegration conditions for fiscal/overall sustainability, the
initial panel unit root/stationarity tests do not allow for the strong assumption of cross-
sectional independence to be relaxed. In Chapters Four and Five, even if the panel
approach is the only feasible way to extend the sustainability assessment into the region
of accession Europe, the otherwise potentially very revealing individual country
evidence can be suggested only within limits. Not least, although the rich evidence from
the first empirical applications of the original open-economy sustainability model is
duly discussed, a more intuitive insight into the rationale behind open-economy
sustainability may be pursued and the policy implications thereof may need to be
considered in further directions.

It is indeed the future research directions which may address some of the afore-
mentioned weaknesses of this study. Future work may also extend the contributions of
this thesis and equip fiscal sustainability practitioners with tools to tackle better the
complexities of the real world and uncover larger portions of life’s ‘whole truth’. For
example, more country-specific analysis in ‘old’ Europe, especially where longer time
series of data are available, may elucidate some issues only briefly hypothesised for
individual countries in Chapters Three and Five. Certainly in accession Europe, when
future longer national data series become available, individual country analyses need
also be attempted. The open-economy sustainability model outlined in Chapter Five
may be deepened in at least two theoretical directions. First, although the weak-form
fiscal sustainability conditions following Quintos (1995) are referred to in the economy-
wide analyses of the thesis, a formal mathematical proof may be worth trying. Second, even if rarely likely in the true data generating processes, further theoretical research may explore in more depth the ‘oddity’ of having foreign debt exactly offsetting government debt in one particular time period. If the latter occurs, it is possible that in the long run the difference between foreign and domestic debt will equal zero, implying an adjustment in the twin deficit identity. Furthermore, as new literature has emerged to study fiscal sustainability under the condition of multicointegration (Leachman et al., 2005), an analogous open-economy empirical analysis may be performed if the private savings and private investment exhibit different orders of integration. Last but not least, the research into both fiscal and open-economy sustainability may proceed with incorporating nonlinearities in the fiscal policy, following another recent trend in the literature. Whereas space and time limits have confined this thesis to the linear world, a future extension beyond it may alter the evidence regarding the convergence in fiscal and open-economy sustainability in Europe.
BIBLIOGRAPHY


Blanchard, Olivier Jean (1990) Suggestions for a New Set of Fiscal Indicators. OECD Economics Department Working Papers No. 79: OECD.


Choi, In (2002) Combination Unit Root Tests for Cross-Sectionally Correlated Panels. In Dean Corbae, Steven N. Durlauf and Bruce E. Hansen (eds.),


Croce, Enzo and V. Hugo Juan-Ramón (2003) Assessing Fiscal Sustainability: A Cross-


Comparative Economics 34, 499-517.


