ASPECTS OF GLOBALISATION

Macroeconomic and Capital Market Linkages in the Integrated World Economy

Edited By
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Printed on acid-free paper.

This book is dedicated with much love to:-

Chryssa and Vicky - CT

Rania, Myron and Ritsa - GA

Subita and Raja – TB

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PREFACE

The field of international economics and finance has undergone rapid changes in recent years. These changes have been partly driven by new theories and econometric techniques as well as a host of new problems resulting from new developments in the world economy. Prominent among those developments is the process of integration, popularly known as globalisation. This is a multi-faceted process, forging closer links both in international markets for goods and in the markets for factors of production, particularly labour and capital. The potential importance of such developments is enormous, as exemplified in theoretical discourse, popular discussions and political debates. Many of these issues were discussed over the last couple of years in the annual conferences and seminars organised by the *UK Chapter of the International Economics and Finance Society* (IEFS-UK, http://www.iefs.org.uk/). This volume includes a sample of those contributions. The criterion of selection was that the selected papers should collectively give a fairly broad coverage of recent work in International Economics and Finance, as well as high quality and originality. The editors have shared equally in the excitement of producing this volume. Our main wish is to communicate some of the ideas and the enthusiasm evident in the literature to a broader audience, including specialist researchers, lecturers and policy makers.

CT, GA, and TB

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Chapter 1

INTRODUCTION

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Abstract: This Chapter introduces and summarises the subject-matter and the papers contained in this volume.

Key words: International macroeconomics and finance, global economic integration, European integration, labour mobility, capital mobility, foreign direct investment, European Central Bank, Eurobond markets, banking, dollarisation, South East Asian financial crisis.

The aim of this collection of papers is to provide a fairly broad sample of advanced research work related to key economic aspects of international integration. A (non-exhaustive) list of such aspects that we touch upon here includes labour and capital mobility, foreign direct investment, issues more

specifically related to European integration, global capital market linkages and banking, dollarisation, and the East Asian crises. Reflecting on the breadth of its scope, the volume is intended to serve a varied audience. Being at the forefront of research, it should appeal to academics interested in new approaches and ideas for future research. To this end, the editors have encouraged the contributors to raise new issues and have not imposed any particular orthodoxy in the approaches followed by these papers. At the same time, individual authors have been encouraged to include fairly extended review sections within their papers, so as to make them useful to a wider readership. Furthermore, many of the topics examined in this volume are policy issues and thus of direct relevance to policy makers. Finally, most papers in this collection use state-of-the-art econometrics, which reflects the recent trend in economic analysis.

We hope that the papers in this volume will provoke further research and ideas as well as contribute to the policy debate in this rich and exciting field of International Economics and Finance, concerned with the far-reaching developments of factor market integration. The diversity, breadth and scope should be positive attributes of the volume and should make it a useful source of information for graduate students, researches and policy-makers. After all, the guiding philosophy is that a proper understanding of many of the issues confronting the world economy requires the exchange of ideas across countries as well as the exchange of goods and services. We now proceed to briefly give an overview of the contributions to this volume, which can be informally divided into three broad areas.

1. FACTOR MOBILITY

The first broad area covered is theoretical and includes models of trade, factor mobility, and monetary/fiscal policy in integrated economies. The first contribution, by Tapan Biswas, is: "International Migration in A Growing World Economy A Simple Analytical Framework". This paper integrates and synthesises analytically as well as diagrammatically much of the body and the insights of the literature on international migration. The main thrust of the paper is an analysis of the causes and effects of migration. In the framework of a two-sector model, it is shown that migration can be induced by structural causes, by world capital accumulation and by changes in the terms of trade. Moreover these factors are often interrelated, for example, world capital accumulation can contribute further into migration via two different channels, first, by changing the value of relative wages; and second, by affecting the terms of trade. The analysis further extends into the role of

human capital. Indeed, the author confirms a stylised fact of international migration that skilled labour migrates easier and is poised to gain much more than the unskilled one. This may cause the well-known problem of "brain drain" often incurred by developing countries. This is an issue of recurrent importance since the late 1960s. For example, during 2000, Germany granted a five-year renewable migration status to about 20,000 IT specialists from India, in order to cover temporary domestic needs. The market structure in the developing countries may also add to the pressure of emigration. In the South, labour markets may be dominated by monopsonies where skilled workers are poorly paid due to the scarcity of alternative employment opportunities. Emigration provides a window of opportunity for them. However, the migration of skilled workers may have negative externality for the country of emigration. The simplistic view that migration increases the welfare of the country of immigration as well as that of the country of emigration is not always correct in the presence of externalities.

The next three papers in this part are on international capital mobility, challenging whether we can measure its extent via the correlation between saving and investment (as ratios over GDP). The point of departure is National Income Accounting, from which the difference between saving and investment equals the current account, and is therefore closely linked to the mobility of capital and intertemporal asset trade. In a seminal and somewhat provocative paper, Feldstein and Horioka (1980) found the correlation to be high (in fact, close to unity) and argued that this is an evidence of the lack of international capital mobility. If domestic investment is correlated with domestic saving, then there is no evidence of flow of savings across borders. A voluminous literature has since then followed and corroborated this finding. Saving-investment correlation appears to be a stylised fact. However, alongside the empirical studies, numerous arguments have been developed why the correlation should be so high without indicating lack of mobility: It may simply be the product of rational intertemporal behaviour, omitted variables (demographics, country size, etc.), or the need (enforced by markets) for countries to maintain external solvency.

The first paper, by Ahmed Alyousha and Chris Tsoukis, serves as an introduction to this topic and asks whether cointegration between saving and investment (an implication of the original Feldstein-Horioka argument) is indeed present in the data. It uses quarterly data for a sample of 7 industrialised economies for most of the post-Bretton Woods era and a battery of testing techniques. It also distinguishes between the entire sample periods and the post-1980 period (when informal accounts report that international capital mobility increased among OECD economies). The paper argues that cointegration is rather hard to establish. This has important

implications for a number of important issues in open macroeconomics. External solvency is guaranteed (but does not appear to require) a stationary current account (at least as a ratio over GDP), and from the identity CA≡S-I, this implies cointegration between saving and investment with a unitary coefficient (what the authors term *strict sense* cointegration). The failure of this is not a good sign for external solvency of the coutries in question, at least for the sample periods. This failure of cointegration and other evidence is interpreted to show an increase in capital mobility from 1980 onwards. Finally, on similar grounds, the authors criticise the validity of the intertemporal approach to the current account in its simplest formulation.

The next paper is by Daniel Levy again on the Feldstein-Horioka puzzle ("Is the Feldstein-Horioka Puzzle Really a Puzzle?"). It offers a re-interpretation of the seminal F-H finding of a close correlation between national saving and investment rates across countries by arguing that it reflects external solvency: It is argued that it follows directly from the country's external budget constraint independently of the actual degree of international capital mobility. The author uses both annual and quarterly US data and casts his arguments in modern time-series analysis. He shows that (in contradiction with the previous paper) investment and saving are indeed cointegrated. One may partially conclude from this that economics is characterised by fruitful debate and controversy, as much as by accumulation of knowledge! A point of convergence between this paper and the one that precedes it, however, is that correlation or cointegration between saving and investment is not informative for the degree of international capital mobility - in contrast to the F-H claim.

The paper by Stilianos Fountas and Chris Tsoukis on "Twin Deficits, Real Interest Rates, And International Capital Mobility" departs from the same sense of dissatisfaction with the informational content of saving-investment correlations. Instead (and following an earlier paper), it argues that the direction of causality among key variables can provide more information about the extent of capital mobility. If shocks to (domestic) investment follow those on (domestic) saving, then arguably capital mobility is low as saving constrains investment nationally. If, on the other hand, the causal direction is opposite, even with a high saving-investment correlation, mobility can be said to be high as investment opportunities attract funds worldwide, until (eventually) they raise domestic income and saving. The paper extends this argument by examining the causal relation between the current account and the real interest rate, as the latter possibly affects the external deficit differently in the case of a small, open economy (when the interest rate may be exogenous) and that of a large economy. Cointegration and causality tests reveal a variety of linkages between the variables across

countries. A number of economies (Canada, Germany, Netherlands, and increasingly the UK) appear to be small and open, while Japan and the USA are effectively closed. The budget balance is another variable brought to bear on this analysis, as causality running from it to the external deficit would support the "twin deficits" hypothesis, while running in the opposite direction it would support the "current account targeting" hypothesis. Both hypotheses receive some support in the short run.

The next paper in this part is on to the analysis of physical capital mobility and foreign direct investment. The paper by George Agiomirgianakis, Dimitrios Asteriou and Kalliroi Papathoma on the "The determinants of foreign direct investment: a panel data study for the OECD countries", has a two-fold aim. It provides a theoretical overview of the determinants of foreign direct investment and is followed by a study of panel data of 20 OECD countries for 23 years (1975-97). The findings suggest the significance of certain variables such as human capital, the trade regime, and the density of infrastructure. Positive significance of the agglomeration factor is also observed, confirming the relevant theoretical propositions.

Foreign Direct Investment is naturally very important in the wider context of economic development and outside the geographical and social confines of OECD countries. Can the lessons of this and similar studies extend beyond the OECD? The OECD countries subscribe to similar political and economic ideologies (democracy, political stability and competition). In this case, FDI is an instrument for achieving allocative efficiency and consequently, factors like human skills and infrastructure become important. Extending the results of this study to developing economies, not sharing such a background, is naturally a more challenging area. The approach and the results here should provide a good start.

2. EUROPEAN INTEGRATION

Foreign Direct Investment, a process already well established within the EU, is naturally crucial in the process of European integration as well, both from the point of view of equalising productivity and living standards across Europe, and in generating new wealth. The paper by Lawrence Zhang, "European Integration and Foreign Direct Investment", follows the previous paper by Agiomirgianakis *et al.* It investigates the determinants of Foreign Direct Investment (FDI) in Europe in the last two decades or so, with particular reference to the role played by European integration, in its real (single market) and monetary (EMU) aspects. Using bilateral panel data for 15 countries (1982-98), the author finds that exchange rate uncertainty *per se*

has had an ambiguous effect. It also finds that European integration has had an important dual effect, both coming from its "customs union" aspect and from the progress towards monetary union exemplified by the European Monetary System. The author also tests for the endogeneity of the monetary regime (i.e. for the idea that FDI and other trade flows have affected the progress of European integration); and for alternative specifications and omitted variables, like alternative measurements and inclusion of corruption indices, etc. He finds that none of the above significantly affects the results. Thus, the paper sheds important light on aspects of the ongoing process of European integration. Such information may be useful not only to incumbent members of the EU, but also (as the author notes) to prospective members, which face questions of real convergence, choice of whether to join, or not, etc.

The rising consensus, in both academic and practicing circles, about independence, credibility and indeed conservatism in monetary policy has given rise to concerns about accountability and transparency in this sphere of public policy. In response to such concerns, various Central Banks in industrialised countries have now taken measures to enhance the transparency of their policy-making procedures. Beyond issues of principle, there is the question of costs and benefits of (in)complete transparency at the operational level. In other words, whether (in)complete announcement by the monetary authority of its preferences over inflation and output stabilisation and/or about the targets for these variables, can confer benefits in terms of performance. Such issues are important everywhere, but really crucial for a newly founded authority like the European Central Bank (ECB).

The paper by Andrew Hughes Hallet and Nicola Viegi, "Transparency and the Strategic Use of Private Information in Monetary Policy: A Particular European Problem?", is indeed motivated by such considerations and is a contribution to the political economy of Central Banking. Building on the voluminous literature on policy games between the monetary and fiscal authorities, and on Central Bank (CB) independence (with special reference to ECB), the paper analyses the issue of transparency in monetary policy-making. In particular, it asks whether incomplete transparency gives a net benefit to the monetary policy-maker, and if so, whether it can shed light on the behaviour of ECB in the four years or so (as of Spring 2003) of its operation.

The paper begins by a taxonomy of (two) types of transparencies. Transparency type I refers to a known weight on output stabilisation in the CB's utility function and is termed "political transparency". Effectively it requires that the preferences of the CB over inflation versus output stabilisation be known to the private sector. Transparency type II refers to a

known target around which output is to be stabilised. This type assumes instead that the target for output, as well as that for inflation, is known with certainty and is termed *economic*. Correspondingly, incomplete transparency is categorised into the two types. The authors investigate in detail the effects of the two and whether the CB is likely to use them for its own strategic advantage.

Incomplete political transparency is found to be a mixed blessing: Pretending to be more "hard-nosed", in terms of the weight it assigns to inflation stability, than the private sector expects, a CB delivers lower inflation than otherwise. (This result comes from the lower inflationary expectations.). However, it also prompts the fiscal authority to vary its policy more. This is a very interesting result in its own right, shedding some new light on the *game of chicken* between the two authorities discussed by Sargent and Wallace. In other words, the authors argue that, potentially, the ECB is thwarting the stability pact with its own actions. Because of this trade-off, however, the CB may or may not find it beneficial to restrict transparency, in effect revealing its own preferences accurately. As the authors note, we thus have a potential explanation for the ECB's strong rhetoric (and transparency reversal) in the recent past. In contrast, *the CB will never use economic transparency* as it won't affect expectations and, therefore, actual outcomes. This result is stronger, the more conservative and credibility-minded is the CB.

Saving - investment correlations are not the only way of measuring the extent of international capital market integration. Convergence of interest rates among identical financial instruments of different currency denomination is another powerful indicator of such integration. The paper by Kostas Drakos on "Eurocurrency Market Integration" addresses this interesting issue with a specific focus on the Eurocurrency market. The choice of Eurocurrency market is in line with the general interest on European financial markets in the wake of the EMU. However, it is also dictated by the fact that the Eurocurrency market is a natural test-bed for interest rate convergence since the instruments there are very similar except for their currency of denomination. The data used are at the short end of the term structure for 3 eurocurrencies (US$, DM and UK£). The study employs both the Johanssen procedure and Principal Components analysis to identify and test for common dynamic factors in the movement of interest rates. It concludes that the evidence favours integration.

3. INTERNATIONAL CAPITAL MARKET LINKAGES AND THE EAST ASIAN CRISIS

This part begins with a paper on banking, coming as a continuation of the previous paper on Eurobond markets. The banking sector plays a prominent part within the wider financial sector and, as such, its behaviour is closely linked to almost all aspects of international finance, like exchange and interest rate behaviour, stock markets, currency crises, etc., with the ramifications extending far into macroeconomics. A single paper could not even aspire to cover this entire agenda, but Mathias Beck and Charles Woolfson ("Contextualising Bank Failures: An International Comparison") have set themselves the interesting task of comparing bank failures across countries and identifying institutional and legal characteristics that favour them. The paper's starting point is the dramatic increase in such incidents in major industrialised countries in the 1990s, including a substantial number of bankruptcies of large and long-established financial institutions. A variety of theoretical arguments and explanations have been put forward to explain bank defaults. These explanations range from those that attribute the phenomenon mainly to macroeconomic factors (such as dismal economic performance, instability and business cycles, regional and sectoral downturns, etc.) to those highlighting the "mesoeconomic" factors (moral hazard attributed to the deposit insurance provisions by the authorities in many countries) and factors related to market psychology (like panics, contagion and bank runs). The authors give a balanced judgement on all these arguments, pointing out their weaknesses, particularly the fact that such factors were present before the 1990s but without anywhere near the same scale of bank failures. If such factors have limited explanatory power, then one resorts to the purely microeconomic reasons like structural weaknesses (high leverage, inadequate management structures and precarious growth rates). While plausible (particularly in the aftermath of financial deregulation in the 1980s), these developments need themselves to be explained ultimately with reference to the quality of corporate governance, regulatory oversight and overall institutional reliability.

The authors offer evidence on this insight using a panel data set for 4 countries (Canada, Germany, UK, US), 1991-7. The dependent variables are the number of banking failures per million inhabitants and the expenditures made under depositor bailing out interventions by the authorities as a proportion over GDP. The latter is intended as an (arguably imperfect) proxy for the severity of bankruptcies. There are four explanatory variables drawn from the *International Country Risk Guide*, namely the "rule of law", "quality of accounting standards", "absence of corruption" and "risk of contract

repudiation" indices. The results are fairly intuitive in that the incidence of failures is (negatively) significantly correlated with some of these variables; and the severity of failures is likewise explained by some these variables, plus (negatively) the GDP growth rate as a macro variable. Among the two dependent variables, the former is much better explained; being rather weaker in terms of explanatory power, the latter two equations serve the purpose of paving the way for future research.

The next paper, by Georgios Karras, proceeds to tackle a different but equally exciting topic which is the "The Prospect of Dollarization: Are the Americas an Optimum Currency Area?". As the author reports, there is growing (though not unequivocal) enthusiasm among certain quarters on the American continent for countries other than the US switching to the dollar - presumably with keeping the US Federal Reserve System as the Central Bank of the whole currency area. The theory of Optimum Currency Areas associated with Mundell and McKinnon has established a number of criteria for assessing the balance sheet of a common currency. The paper's main thesis is that two, among these, deserve a special emphasis and empirical investigation: Commonality of shocks is an important one, as with a common currency and monetary policy, countries lose one weapon for fighting idiosyncratic shocks. Additionally, the degree of syncronicity of country-specific shocks with that of the US is another, as the US Fed is likely to (attempt to) counter the US-specific shocks to some extent and other countries will benefit from those attempts if the syncronicity is relatively high.

The paper therefore embarks on an investigation of these two issues for 19 American countries spanning the continent for 1950-97. Panel methods are used for disentangling common from idiosyncratic shocks in GDP growth rates. Two data sets are used (PENN World Tables and IFS) covering slightly different periods; reassuringly, the results are very similar across the two sets. The evidence produced is not favourable for dollarisation, in that the country-specific shock is almost everywhere larger (and in many cases considerably so) than the common shock, so that the US monetary authority will be able to stabilise a small fraction of the total shock in various countries. Also, the country-specific shocks are almost nowhere strongly positively correlated with the US-specific shock, so that an attempt by the Fed to stabilise that will not produce much good elsewhere. The author concludes that Canada, Colombia and the Honduras are among the best candidates for dollarisation, judging by the above two criteria.

The process of dollarisation for the Americas (assuming that it gets under way) will present an interesting parallel with EMU, and the paper therefore could be beneficially read as shedding light on European developments, too.

One needs of course to be wary of the challenges facing dollarisation in the Americas: Is the US Fed ready to undertake the role of monetary authority practically for the entire continent? Is it willing to let foreign velocity shocks affect the US money market? Are other countries ready to entrust monetary policy to a foreign authority? Will they be represented in the decisions of the Fed? The questions highlight the difficulties ahead and differences with EMU. However, the methodology employed highlights the two perhaps most important criteria and could be used to order the new entrants into the EU for their readiness to proceed to EMU.

Finally, the volume ends with two papers on the Asian crisis of 1997/8 that has become the focus of much research recently. Researchers have been captivated by the momentous tide of events, and the complex interactions at many levels, namely, between processes (exchange rate movements, stock market behaviour, interest rates), between players (governments, speculators, financial investors) and between borders. The paper by Tsoukis and Alyousha on the "Genesis of the Crisis: The External Solvency of the [so-called] Tiger Economies" introduces the topic and the related literature by presenting a brief chronology of events and an overview of the search for culprits in the literature. Furthermore, the paper considers the proposition that an important cause of the 1997 Asian crisis has been the massive current account deficits and associated capital inflow into the Tiger economies up to 1997 and the building up of excessive and unsustainable external debt positions. This hypothesis is motivated by the literature review which often seems to suggest that diverse symptoms such as overvalued currencies, excessive credit expansion, careless risk management and lack of foreign exchange reserves may ultimately be attributed to excessive capital flows and external insolvency of the Tiger economies. The authors test for external (in)solvency of the 7 Tigers, using data on current accounts and current account-to-GDP ratios. They find considerable evidence of current account unsustainability and external insolvency, notably for Indonesia, Malaysia, Philippines and Thailand. Though often informal suggested and fairly simple to establish rigorously, this finding seems to have been completely ignored in the more formal literature and is argued to have profound policy implications.

The paper by Guglielmo Caporale, Nikitas Pittis, and Nicola Spagnolo, "Feedbacks between Stock Prices and Exchange Rates...", presents an interesting contrast with the previous paper insofar as it puts the blame squarely not in a single source but in the complex interactions between stock and foreign currency markets. The authors utilise daily data for a sample of six East Asian countries and a recently (1996) developed technique that extends the Granger causality concept to second moments. The paper

concludes that the evidence favours bi-causality in most cases especially in second moments. Thus, as stated, the conclusion is that the causes of the crisis do not appear to be emanating solely from one source (i.e., precarious external position, or weak internal prospects for growth), as has been argued, but seem to lie in the interaction between processes. This finding highlights again the complexities of the processes at work and appears to argue in favour of well thought out and elaborated policy proposals and rescue plans.

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Chapter 2

INTERNATIONAL MIGRATION IN A GROWING WORLD ECONOMY

A Simple Analytical Framework

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Abstract: This paper analyses various economic causes of migration using a simple diagrammatic technique. The framework of analysis is neo-classical in character and the simple two-sector model is used to explain the causes and effects of emigration from the South to the North. The same diagrammatic technique is used to explain the impact of growth in human capital, due to increase in the efficiency of labor, on migration and various issues connected with it. Factors like the level of unemployment and lack of job security also play important roles in the decision to migrate. All these issues have been discussed in the context of economic growth. Finally, the welfare effect of migration, where migration involves externalities in production, has been discussed.

Keywords: migration, growth, skills, unemployment, welfare

1. INTRODUCTION

International migration has become an important political issue in recent years. The flow of migration across the world intensified in the last decade due to several factors. Some of them are socio-political in nature and some are purely economic reasons. The migration of skilled workers rose significantly during these years. For example, in 1990 the number of H-1B visas issued by US to the citizens of China (mainland) and India were 610 and 2,697 respectively. In 1999, the corresponding figures were 5,779 and 55,047. The Schengen agreement paved the way for greater co-operation within Europe by allowing free mobility of labor within many member countries in Europe with the notable exception of UK. However, Eurostat's

Labor Force Survey reveals that the share of EU citizens in total foreign population in UK is about 40%. For Germany France and Italy, the figures are 26.5%, 33.8% and 21.3% respectively. Between 1981 and 1999, the proportion of foreigners in UK labor force jumped from 2.9% to 3.8%. This may be one of the reasons why UK is reluctant to join the Schengen countries and possibly let in non–European illegal immigrants coming via the European corridor. The recent upsurge of asylum seekers has politicized the issue of migration both in Europe and US. It is not easy to distinguish a genuine asylum seeker from an economic migrant from a desperately poor nation. The decision to emigrate is not an easy decision. What are the economic factors, which may lead some one take to such a decision? What are the economic implications of large-scale migration in both the emigrating country and the country of immigration?

International and inter-regional migration has been discussed in numerous contributions in the economics literature. Here, we shall discuss a simple analytical (diagrammatic) framework highlighting the causes and implications of international migration across the North-South divide of the international economy. The North is traditionally described as the developed, technologically advanced and capital-abundant part of the Globe which absorbs migrant workers from the South which is the poorer, technologically under-developed and relatively labor-abundant part of the Globe (see Layard *et al.*, 1992). The framework of analysis used here is neo-classical in character. In spite of the criticism that neo-classical tools are unsuitable to describe the process of development in the South, to a large extent, it can be used success fully to explain the causes and the impact of migration from the South. The diagrammatic tools used here are similar to those used in Biswas (1974) and Bandyopadhyay and Biswas (1997). Section 1 introduces the framework of the model and explains the technicalities of the diagram used throughout this paper. Understanding the use of the diagram is crucial for the paper. Section 3 discusses the implication of the growth of global capital stock on migration. Increase in the efficiency of workers, through investments in human capital, is regarded as the driving force behind economic growth in the literature on endogenous growth. Section 4 discusses the role of skill formation in international migration of labor. The level of unemployment at home is a major factor in the decision to emigrate. Section 5 deals with this issue. Section 6 examines the impact of migration on economic welfare of the home country as well as on the country of immigration when the emigration of skilled workers gives rise to negative externalities in the production of the home country. Section 7 contains concluding remarks.

2. THE FRAMEWORK.

We consider the world economy comprising of the North and the South. The aggregate outputs (goods and services) produced in the North and in the South are labeled as X_N and X_S respectively which are produced using labor and capital. The aggregate production functions are given as follows:

$$\begin{aligned} X_N &= F_N (L_N, K_N) \\ X_S &= F_S (L_S, K_S) \\ L &= L_N + L_S \\ K &= K_N + K_S \end{aligned} \qquad (1)$$

where, L and K stand for world-wide total capital and labor respectively. We assume that F_N and F_S are subject to constant returns to scale and satisfy the standard requirements of neo-classical production functions. Capital is perfectly mobile across the North-South divide but labor is not. We begin with the assumption that, in each country, wages are flexible and labor is fully employed in both the regions. The issue of trade unions and unemployment will be addressed later on. We assume that production in the North is relatively less labor-intensive as compared to the South. We also assume, that the terms of trade $P = P_S/P_N$ is fixed. However, given P, the trade between North and South is not necessarily balanced, i.e., usually $P.E_S \neq M_S$ (E_S and M_S stands for the exports and the imports of the South). The impact of terms of trade adjustment, due to unbalanced trade or changed demand conditions, on international migration will be discussed later. Initially, we assume that the loans and the aids from the North cover the deficiency in the balance of trade.

In figure 1, $l_S = L_S/K$ and $l_N = L_N/K$ are ratios of labor force in the two regions relative to the total capital available in the world. The line AA' represents the equation:

$$l_N + l_S = L/K \qquad (2)$$

The slope of the line AA' is -1. The line BB' represents the combinations of l_N and l_S which, under perfect mobility of capital across the North and South divide, equates wage rates in the two regions, i.e., $P.w_S = w_N$. This equality is satisfied when labor is perfectly mobile. If immigration barriers exist, this equality will not necessarily hold. This line is called the Rybczynski Locus[1]. Since, production in the South is relatively labor intensive, the slope of the Rybczynski Locus is less than -1. Within the triangle BOB', the ratio of wages $P.w_S/w_N$ is less than 1. Outside BOB', $P.w_S$

/ w_N > 1. If both labor and capital were internationally mobile, the equilibrium will be attained at C in figure 1. The slope of the line joining C to the origin will give the relative distribution of labor ($L_S \backslash L_N$) between the two regions.

3. GROWTH IN THE WORLD ECONOMY AND INTERNATIONAL MIGRATION OF LABOUR.

In figure 1, D represents the initial distribution of world labor. A larger proportion of world labor (relative to C) works in the south. We know that labor is not perfectly mobile between the North and the South. At D, $P.w_S < w_N$. Therefore given the current distribution of the world labor force, there is a pressure of migration from the South to the North. We shall call such migration due to inefficient distribution of the world labor as migration due to *structural cause* [ii]. This will happen whenever an artificial barrier is imposed on the mobility of the world labor force. For example, between the East and the West of Europe, such a barrier exists at present. With total unification of Europe, this structural cause of migration will be removed. Structural migration does not always take place from technologically less advanced regions to advanced regions. A technologically advanced region may be labor-abundant as in $D^{/}$ in figure 1. In such a case, migration will take place from a technologically advanced region to less advanced regions. The great exodus of immigrants from Europe to the plantations of America and Australia may partly be attributed to structural causes.

In this paper, we shall use the term growth of the world economy as growth of the world' s capital stock. Capital accumulation is another cause of international migration. Consider figure 1. An increase in the world capital stock will reduce L/K and shift the $AA^{/}$ curve downwards. Now, the point $C^{/}$ represents the efficient allocation labor with perfect labor mobility and initial distribution shifts from D to $D^{//}$. The shift of equilibrium from C to $C^{/}$ is stipulated by the requirement of full-employment, Eq.(2), as explained in the Heckscher-Ohlin theorem. We shall call this, *migration induced by capital accumulation*. Here, we should explain something important. It has often been argued that if the world grows richer in capital, it will be invested in the South because the wage rate is relatively lower in the South at a point like D. However, the allocation of capital is guided by the rates of return on capital. At D, the rates of return on capital are same, as capital is mobile across the countries. The additional capital stock will always be invested in a way such that the returns from investment are same in both regions. As capital stock grows across the Globe, the economy will move from D to $D^{//}$ prior to any

reallocation of the labor force. At D'', the wage rates in both the countries will increase but the ratio $P.w_S/w_N$ will decease[iii] adding to the pressure to emigrate.

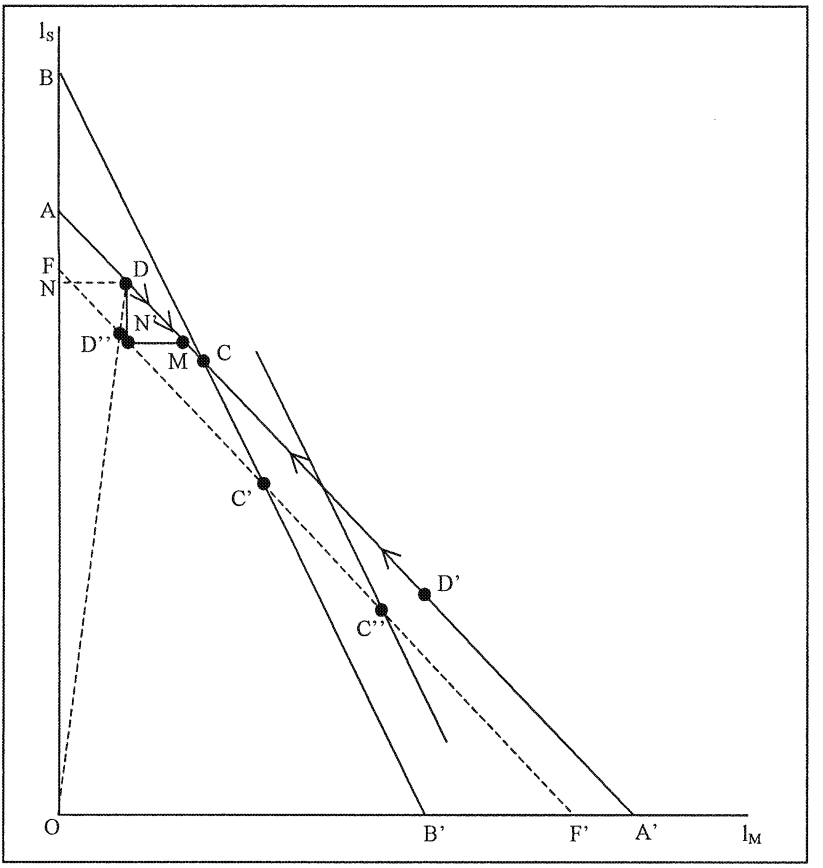

Figure 1. Migration and Capital Accumulation

Capital accumulation also has a secondary impact on migration *via* its impact on the terms of trade. In figure 1, a movement from D to C' implies a decline in X_S and an increase in X_N. One would think that this would, in the long-run, result in an improvement of the terms of trade in favor of the South. But this may not be the case. With capital accumulation, as the world economy grows richer, the relative demand for the product of North (in aggregate) may increase. Note, in absolute terms the workers in the South are better off. Therefore, a perverse income effect may actually move the terms

of trade against the South. If this happens, the $BB^{/}$ curve will shift upwards. The equilibrium will move from $C^{/}$ to $C^{//}$, which will further encourage people to emigrate.

The deterioration of the terms of trade for the South need not be only the result of a perverse income effect. So far we were assuming that trade is taking place at the current terms of trade although $P.E_S \neq M_S$. This will prevail only in the short-run with loans and aids from the North. In the long – run, growing debt burden will have its impact on the terms of trade. With the deterioration of the terms of trade for the South, the Rybczynski Locus ($BB^{/}$) will shift upwards. Migration caused by the shift of equilibrium from $C^{/}$ to $C^{//}$ is *migration due to deterioration of the terms of trade.*

4. HUMAN CAPITAL AND INTERNATIONAL MIGRATION OF LABOUR

Technological innovations affect migration. As the North gets relatively capital rich, it tries to introduce labor saving innovations to cut down the labor cost. For the same wage-rental ratio, the capital-labor ratio used in production will increase. Given the assumption of full employment, this will mean a drop in the wage-level in the North. Therefore, such innovations will reduce the pressure to migrate. Figure 2, illustrates the extreme case where the labor-saving technological innovation has swung the Rybczynski Locus $BB^{/}$ to $BB^{//}$ and has eliminated the pressure of migration leaving D as the point of equilibrium.

We have so far ignored the differences in the level of skills. A more capital- intensive process of production requires more skilled workers. Skills are acquired through investments in human capital. In recent developments in the theory of endogenous growth, it is argued that investments in human capital form an integral part of the development strategy of an economy (Lucas, 1988). The process of growth in technology is an endogenous process (Frankel, 1962 and Romar, 1986). Therefore, output per unit of physical labor can keep on increasing forever, because the human capital keeps on growing forever through investments. The growth in human capital is reflected in the growth of the skills of labor. However, the level of skills vary from one person to another and this difference in the level of skills may cause migration from one country to another where the reward for skill is higher. In the context of our analysis, suppose there are two types of workers: low-skilled and high-skilled. In figure 2, interpret labor measured in terms of efficiency. The $EE^{/}$ line has the same interpretation as the $AA^{/}$ line in figure

1, except that labor is measured in terms of efficiency units. The point D' represents the labor endowments in the two regions. North is relatively endowed with more labor in efficiency units. As previously explained, since D' lies within the Rybczynski Locus BB', the value of the return to an unit of efficient labor is relatively lower in the South. The expected earning of the skilled laborers in the South may earn more than the unskilled workers, but the chance of getting a skilled worker's job is much lower in the South than in the North. Although both types of workers from the South would like to move to the North, in terms of gain in the absolute difference in wages, the highly skilled laborers gain most because each of them has more units of skill than a poorly skilled laborer. The skilled workers will also find it easier to emigrate if they are perceived to have external effects on the skills of the low-skilled workers in the North.

What would be the effect of this brain drain? Would the world move from D' to F? If this happens, at F we shall have a world economy with same efficiency wage and a relatively high-skilled immigrant labor force in the North. However, it is likely that an out of equilibrium point like D' may be sustained as a controlled equilibrium with migration (controlled by the immigration policy of the North with only some skilled workers leaving the South to work in the North). We can cast our discussion in an endogenous growth oriented framework. Let α denote the labor-efficiency parameter and κ denote the aggregate efficient labor/capital ratio. In the long-run equilibrium, κ tends to a constant value.

$$\kappa^* = \alpha^* + L^* - K^* = 0 \qquad (3)$$

The symbol, *, is used to denote the relative growth rate. Depending on the assumptions of the endogenous growth model, $L^* - K^*$ tends to 0 in the long-run, i.e., the capital labor ration is tending to a constant value. In this case, α^* also tends to 0 in the long-run by Eq.(3), i.e., α approaches a constant value in the long-run. On the other hand, the general trend in the endogenous growth theory is to develop models where $L^* - K^*$ tends to a negative value in the long-run. This means K/L goes to infinity in the long-run. Therefore, α keeps on increasing in the long-run (through investments in human capital) and we have continuously increasing income per unit of physical labor in the steady state.

In order to discuss the equilibrium with migration in this framework, with increasing efficiency of labor force, let us assume that workers live for two periods. In the second period they enter the labor force. This is essentially in the spirit of the Samuelson-Diamond version of the neo-classical growth model with overlapping generations. Measuring labor in efficiency units, in

figure 2, F is the long-run equilibrium in the absence of any immigration control. An out-of-equilibrium point like D′ represents the initial allocation of world labor force, measured in efficiency units. The movement from D′ to F in figure 2 reflects the migration of efficient labor from the South.

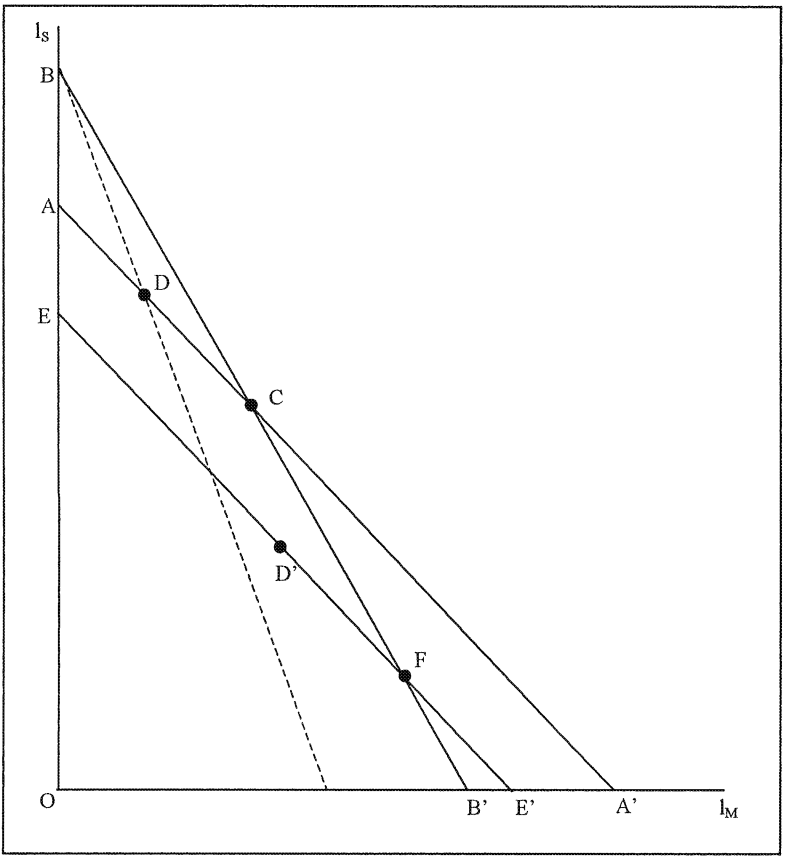

Figure 2. Migration and Human Capital

The skill composition of the immigrant labor force will depend on the immigration policy of the North. Appropriate models of endogenous growth (see Aghion and Howitt, 1998), of course, determine the locations of D′ and F. For example, the possibility of earning a higher wage by acquiring higher skills and having a better chance to migrate may enhance the young population of the South to acquire skills. This will shift the efficiency labor constraint line from EE′ to AA′. The long-run allocation of world labor force

in efficiency units will change depending on the immigration policy of the North. For an analysis of the dynamic adjustment in such a model see Wong (1997).

5. UNEMPLOYMENT AND INTERNATIONAL MIGRATION OF LABOUR

The level of unemployment is an important factor in determining the rate of emigration. According to Layard *et al* (1992), the level of unemployment is more important in determining the rate of emigration than wage differentials. In the flexible-wage full-employment model discussed so far the problem of unemployment was ignored. If we acknowledge the existence of powerful trade unions in the South, which set a minimum wage above the full-employment wage, unemployment becomes a problem. In figure 1, this effectively shifts the AA' line to FF'. The total working populations in the two regions is OF. If we normalize the world capital stock by assuming K = 1, the level of unemployment is given by FA = DN'. Now, apart from wage differentials (if there is any), unemployment adds pressure to migration. Both unemployed and employed will seek migration. As people emigrate, the level of unemployment will fall. At M full employment is restored at M, but emigration will continue till C is reached because of wage differential..

Demand for higher wages by the trade unions is not the only cause for unemployment in the South. In reality, capital is not perfectly mobile across the North-South divide. In the capital-poor South, the capital owners frequently have monopsony power in the labor markets in certain regions and with laborers having skills in producing certain types of goods. In such markets, the wage rate is less than the marginal productivity of labor. In the South, such markets are also characterized by a large number of temporary labor contracts and insecurity of employment. Apart from unemployment, insecurity of employment in such markets adds to the pressure of emigration. If capital is perfectly mobile between the North and the South, the monopsonies in the labor market will be wiped out and will remove this particular type of pressure on emigration.

Although in this paper we are concerned with the economic factors behind migration, economic factors alone do not explain the migration from the South to the North. Religious and racial conflicts, war, degrading working conditions in the labor market, absence of social security, colonial linkage and a host of other factors play important roles in the decision to emigrate. In 1996, the principal sources of immigrant labor in U.K were South Asia, Iran, Nigeria, Vietnam, South Africa, Ghana and U.S.A. It is clear that language

and political uncertainty (in case of Iran and Vietnam) are significant factors in the decision to emigrate. Similarly, in 1996, the principal sources of immigrant labor in France were Morocco, Algeria, Tunisia, Portugal, Cambodia, Turkey and Vietnam. Again, it seems that language and political uncertainty (in case of Vietnam and Cambodia) are important factors in the decision to work abroad.

6. EXTERNALITIES, MIGRATION AND ECONOMIC WELFARE

The impact of migration on the economic welfare of the North, the South and on the global welfare has been subject to a thorough debate in the literature on international trade originating from the pioneering contribution of Kemp (1966). Some have argued that international migration is to be encouraged because it leads to efficient use of world labor (see Layard *et al*, 1992). Some have been rather cautious, arguing that the country of origin may suffers a loss in national income as a result of migration (see Bhagwati and Srinivasan, 1983) if immigrant laborers are counted as a part of the country of arrival. The argument becomes more involved if we consider the externalities of immigrant labor. The immigrants expect to get a job in a foreign country because they believe that they have a particular skill or quality of performance. In some countries, e.g., USA and Canada, a large number of immigrants are accepted primarily on the basis of their skills. The loss of skills has negative externalities on the labor force in the country from where they emigrate and has positive externalities in the country where they immigrate. The loss of top level scientists, engineers and doctors from the South reduces the prospect of quality professional training in the South and raises the average skill in the North. If we consider the externalities, migration may, indeed, have a net negative effect on the South.

In figure 3, we start with the assumption that capital is immobile between the two regions. The marginal productivity schedules of laborers in the South and in the North are labeled as MP_S and MP_N. The distance, O_N-O_S, measures the world labor force. The initial endowment of laborers in the two regions is represented by A. Total output produced in the North and in the South are $ZEAO_N$ and $Z'EAO_S$. If migration is allowed uninhibited, AB gives the scale of migration from the South to the North and the total output of the world is maximized at E'. Therefore, the protagonists of free trade argue that there should be no barrier to immigration. However, if we treat the immigrant workers as citizens of North (permanent immigration), the aggregate income of those who are left in the South diminishes by the triangle $E'DW$ and the

total income of those who were originally living in the North increases by ECE/. Therefore, immigration makes he North better off and the South worse off. On the other hand if the immigrant population is treated as a part of the population of their country of origin (temporary migration), the gain from migration is split between the two countries. The North gains by ECE/ and the South gains by E/CD.

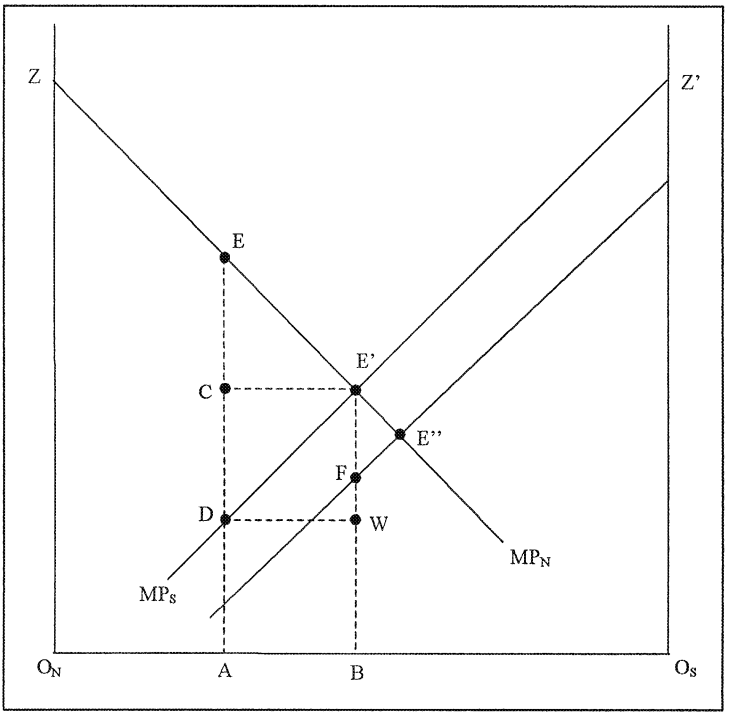

Figure 3. Migration and Welfare

It should be argued that in measuring relative welfare gains, one should look at the per capita income levels rather than total incomes. Others argue that we should look at the distribution of income and particularly the wage rate of the workers. In the absence of any barrier to migration, the workers left behind in the South have higher wages. Also since the marginal productivity of labor is higher, the per capita output in the South (given the standard properties of the neo-classical production function and a drop in capital-labor ratio) is also higher. Therefore, it should be argued that even if

emigrant workers are not counted in the population of the South, the South is still better off as a result of migration.

If emigration has negative externality on the performance of the labor force (because the emigrants are usually the more skilled professional workers), the MP_S curve shifts downwards. For the sake of simplicity, assume that all workers in the North are skilled so that immigration does not affect the MP_N curve. The new equilibrium with migration is E''. Although, the capital-labor ratio goes still higher up in the South, the per capita production function shifts downwards. If the negative externality effect is strong enough, the per capita output of the workers will go down. It is possible that with a smaller level of immigration, such that the positive effect of an increase in the capital-labor ratio outweighs the negative externality effect, the gain in income of the South may be positive. The North is also better off with some immigration, in comparison with E. Suppose, the North and the South mutually agree to have an immigration quota, AB, with a downward shift in MP_S due to negative externality. However, this will give rise to illegal immigration as the workers in the South benefits from emigrating to the North. The producers in the North will also have an incentive to employ illegal immigrants.

If capital is internationally mobile, capital flight takes place along with migration. By the standard neo-classical assumption, $\delta^2 X_i / \delta L_i \delta K_i > 0$. Therefore, emigration reduces the marginal productivity of labor in the South and causes capital flight. The effect of capital flight on the marginal productivity of labor in the South is similar to that of negative externality. However, the North is faced with a dilemma. If it does not allow immigration, capital may move from the North to the South if the productivity of capital is higher in the South. If it allows mass immigration, then wages in the North will fall and this will antagonize the labor unions in the North. Ramaswami (1968) in his seminal contribution argued for a controlled immigration policy, which may actually increase the welfare of the North. However, he did not address the issue of externality in his model For further generalizations of Ramaswami's work see Bhagwati and Srinivasan (1983) and Jones (1990).

7. CONCLUDING REMARKS

We have looked into the principal economic causes of migration and the implications of migration in the context of a growing world economy. Recently, the political causes of migration (seeking asylum due to political violence in the home country) and illegal immigration have raised concerns.

For most countries, so far, the proportion of such migrants is not high. The debate is mainly focussed on the conflict of rights: the human right of seeking asylum from political violence and the right of a country to control the influx of refugees. The claim for a refugee status circumvents the need to satisfy the criterion for immigration set by the country of immigration and may be viewed as pressurising a country to accept a group of people as immigrants. On the other hand, the refugees and illegal immigrants may be quite useful to the economy of a country. They are quite often employed in low-paying jobs, which fail to attract local people. Kule *et al* (2000) analyses the effects of Albanian migration into Northern Greece. These people, often illegal migrants and employed temporarily, take on jobs which are unattractive to local people and generate profits for the local Greek employers. The Albanians gain experience in the job. When they go back, this experience helps them in finding jobs or in starting a new business. Agiomirgianakis and Zervoyanni (1999, 2001) sets up a microeconomic model to show that, in the presence of a strong trade union, illegal immigration may be beneficial to the economy. They argue this is the reason why some countries are rather reluctant to tighten the rules of immigration and seek for illegal immigrants.

As we have seen, the immigration policies must take into account the political and social considerations and the conflict of interest between the workers and the employers. In the simple neoclassical world, free movement of labor across the Globe enhances the global welfare. However, with selective immigration in the presence of positive externalities of skilled workforce, migration may increase the inequality of income between the North and the South.

NOTES

[i] The Rybczynski Locus is different from the well-known Rybczynski Line. The Rybczynski Line is drawn on the commodity space whereas the Rybczynski Locus is drawn on the sectoral allocation space of a factor of production assuming the other factor to be perfectly mobile between the sectors. In the context of imperfect capital mobility the Rybczynski Locus is the iso-profitability locus. The properties of the Rybczynski Locus has been discussed in Biswas (1972). For applications of the Rybczynski Locus see Biswas (1974) and Bandyopadhyay and Biswas (1997). Since the Rybczynski Locus considers the sectoral allocation of one factor of production relative to the total amount of the other factor, it is very helpful in comparative static analysis of steady-state growth equilibria.

[ii] The structural causes may be religious, racial or of other types. In this paper we are concerned only with economic causes. Higher wages, better health care and social security systems, availability of jobs matching the skill of a worker may be regarded as structural

(economic) causes of migration because they stem from the differences in the structures of the two economies.

[iii] Using Eq.(1.12) in Jones (1971) we can obtain the following relationship:

$$w_S^* - w_N^* = (\Delta\theta_{LN}\,\theta_{LS})^{-1}(\theta_{KS} - \theta_{KN})K^*$$

We have used * to denote the relative growth rate. Δ is always positive. θ_{LN} is the share of wages in the total output of the North and so on. Since the production in the South is less capital intensive, the term within the second bracket is negative. Hence, a rise in K reduces w_S/w_N.

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Chapter 3

SAVING - INVESTMENT COINTEGRATION REVISITED:

Implications For Capital Mobility, External Solvency And The Intertemporal Approach To The Current Account

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Abstract: We test for cointegration between gross saving and investment rates using a battery of techniques and quarterly data for a sample of 7 industrialised economies for a) the post-war period; and b) the 1980s and 1990s and employing an extensive range of testing methods. We find the saving and investment ratios to be cointegrated in only a minority of cases. This finding has important implications for the resolution of the "Feldstein-Horioka puzzle", for external solvency of the economies in question and for the validity of the intertemporal approach in international macroeconomics.

Keywords: Saving, investment, cointegration.

1. INTRODUCTION

The relationship between saving and investment, either in levels or in ratios over GDP, has figured prominently in applied work in the last two decades, for reasons related to their central place in macroeconomics. Through the basic National Income Accounting Identity, the difference between saving and investment equals the current account and is therefore intimately linked to intertemporal asset trade and to the mobility of capital across national boundaries. It is argued (Feldstein and Horioka, 1980) that the correlation between the two variables indicates the degree of international capital mobility. Furthermore, concerns over external solvency are also related to the saving-investment relationship, particularly cointegration, since current account stationarity ensures solvency (see Trehan and Walsh, 1991; Coakley, Kulasi and Smith, 1996; Levy, this Volume). Relatedly, the intertemporal approach in international macroeconomics (see Obstfeld and Rogoff, 1996) implies that the current account should, under some assumptions, be stationary, so saving-investment cointegration can be used as a test of the basic theory.

Thus, the magnitude of the saving-investment correlation has been quite extensively investigated (see Obstfeld, 1995; Coakley, Kulasi and Smith, 1998). Most of the empirical work, though, has been based on cross-section data (country long averages) which yield the highest (often insignificantly different from one) and most robust estimates. Time series evidence is at once scarcer and also provides a much more varied picture across countries (see e.g. the above references and Taylor, 1996). This serves to point out that cross-section work conceals country diversity and that only time-series evidence is informative about *individual* country experience in all respects, be it capital mobility, external (in)solvency or current account forward-lookingness. Cross-section analyses may also be more prone to an omitted variable bias: Certain key variables like demographic characteristics, persistent growth or country size may account for the cross-country correlation of saving and investment in ways however that are uninformative about the issues of concern identified above (see the discussions and references in Obstfeld, 1995; Coakley *et al.*, 1998; Tsoukis and Alyousha, 1999). Sinn (1992) argues that cross-section estimates are biased towards accepting a unit coefficient in a regression of investment on saving.

To avoid the spurious saving-investment correlations generated by the typical presence of unit roots in the samples under consideration without resorting to differencing and the associated loss of long-term information, time-series work has increasingly focused on the question of cointegration (Miller, 1988; Gulley, 1992; Argimon and Roldan, 1994; Ahmed and Rogers,

1995; Ghosh, 1995; Jansen, 1996; Coakley, Kulasi and Smith, 1996; Coakley and Kulasi, 1998; Levy, this Volume).[i] However, with the exception of the directly contradictory papers by Miller, Gulley and Levy (all focusing on the US only) and the ambiguous results (as far as current account stationarity is concerned) of Ghosh (1995), all other papers employ annual data on which we comment below. The evidence has been somewhat mixed but not outright negative from these studies. It has been even more positive from panel cointegration studies (e.g. Coakley, Kulasi and Smith, 1996); however, as Coakley *et al.* (1998) note, the pooled estimates are similar to the cross-section estimates because the cross-section variation dominates the total variation and the individual time-series coefficients vary considerably. In view of the importance of the saving-investment relationship and the uncertain state of knowledge on its magnitude, more work on the issue seems warranted, focusing on more countries and more time-disaggregated data.

In this study, we investigate saving-investment cointegration employing an array of unit root tests, as the results are often test-specific. We use quarterly data, in contrast to most related literature, so as to minimise the distortion usually identified with temporally aggregated data and the associated risk of spurious cointegration (see Christiano and Eichenbaum, 1987). Additionally, the power of test on the integration property has been shown to be monotonic on the data span (Perron, 1989; Lahiri and Mamingi, 1995). Hence, one way of interpreting the results of this paper, and one of its contributions, is through the effect of using time-disaggregated data. To preamble, the frequency of the data used in most of the aforementioned studies and their cut-off points (which are typically at the end of 1980s or beginning of 1990s) may explain the difference with our, rather more negative, results.

Our sample consists of 7 countries that are a representative mix of industrialised economies, reflecting various experiences of large or small open economies. This is important, as the former are expected to display a closer relationship between the two, according to the basic Feldstein-Horioka insight. Our sample, both in terms of countries and time period, was the widest possible given the availability of quarterly data (mainly for GNP, which is required for the construction of the saving series, see below). It is, in fact, larger than most of the work focusing on quarterly data, either in the Feldstein-Horioka or intertemporal approach traditions (for the relevant references, see the surveys by Coakley, Kulasi and Smith, 1998; and Obstfeld and Rogoff, 1996).

Because of increasing financial market integration that has taken place in the developed world roughly in the last 25 years,[ii] but also since the data spans the Bretton Woods era in which capital controls were maintained to

support the fixed exchange rate arrangements (Obstfeld and Taylor, 1997)[iii], we perform separate tests for the whole of our post-war sample and for the sub-sample spanning the 1980s and 1990s and present the results accordingly. This is done in Section 2 which presents the results of the empirical work. Section 3 is devoted to drawing the implications of the evidence on cointegration in terms of capital mobility; current account sustainability; and the validity of the intertemporal approach in international macroeconomics. Finally, Section 4 concludes.

2. UNIT ROOT TESTS

Our sample consists of quarterly seasonally adjusted data for 7 industrialised economies for the best part of the post-war era: Australia (1959III-97II), Canada (1957IV-98I), Germany (1978II-94II), Japan (1957IV-97IV), Netherlands (1977I-98I), United Kingdom (1957IV-98I) and United States (1957IV-98I). This is a representative sample of industrialised economies in the sense that they range from small open economies to larger ones and even to ones like the USA or Japan that may be considered as quasi-closed by the magnitude of their current account-GDP ratios. Our variables are the gross investment-to-GDP and gross saving-to-GDP ratios (IR and SR, respectively).[iv] The series used in their construction were obtained from the IMF *International Financial Statistics*.[v] As pointed out, in view of the fact that financial liberalisation has occurred mostly since 1980 on a major scale, we present two sets of results for the whole sample and for the post-1980I sub-sample and the presentation is organised accordingly.

2.1 Testing for univariate and multivariate unit roots: The whole sample

The integration property is determined by the Dickey-Fuller and the non-parametrically adjusted Dickey–Fuller (Phillips and Perron, 1988) tests. (1) gives the ADF regression considered in this paper:

$$\Delta x_t = \beta + \alpha x_{t-1} + \sum_{i=1}^{k} \lambda_i \Delta x_{t-1} + \varepsilon_t \qquad (1)$$

Δ is the difference operator, x can be any of the ratio series. The data on all series are fitted to (1) except that of the Netherlands saving ratio where a

trend is added. The truncation lag parameter (k) is determined using the general-to-specific strategy of Ng and Perron (1995); an upper bound on the lag size was set at 8. Additionally, as the series are seasonally adjusted, tests on the integration property are carried out at the zero frequency.[vi] The results on the integration properties for the whole sample period are presented in Table (1). The ADF results show that all series are integrated process of order one except that of the Netherlands saving ratio. The non-parametrically-adjusted ADF test confirms this result and also rejects the null that the Netherlands and UK investment ratios are integrated processes. With the exception of these three series, the unit root results are generally consistent with the findings of the studies listed in the Introduction who used annual data.

Table 1: Univariate Unit Root Tests (whole sample)

Country	Sample period	ADF		Non-parametrically adjusted ADF	
		IR	SR	IR	SR
Australia	59III-97II	-1.298	-1.482	-1.857	-1.610
Canada	57IV-98I	-2.416	-1.645	-2.757	-1.277
Germany	78II-94II	-2.302	-0.276	-2.817	-0.315
Japan	57IV-97IV	-2.390	-2.404	-2.096	-2.274
Netherlands	77I-98I	-2.817	-4.179*	-4.127*	-3.601*
UK	57IV-98I	-2.014	-2.069	-3.086*	-1.988
USA	57IV-98I	-2.785	-2.381	-2.420	-1.480

Notes: All the non-parametrically adjusted ADF corrections are based on the Newey-West method of adjustment and used Bartlett weights for window size 10. A * and ** indicate significance at the 5% and 10% levels, respectively.

Visual inspection of the plot of the German saving-GDP ratio suggests that a structural break in this series may have occurred in the early 1990s (plot available on request). This may be the product of German re-unification and the rise in government expenditure that accompanied it. As is well known, a structural break in the deterministic component of any series results in the loss of power in standard unit root tests.[vii] For such a process, the discrimination between the true and the spurious integration property becomes a problem of model selection (see Hatanaka, 1996). Perron (1990)

and a set of other studies suggest respecifying the model by adding dummy variable(s) to (1) to account for the break. We follow the method of Perron and Vogelsang (1992), which is appropriate for a non-trending series, for two reasons. First, the series is not trending so it will be counter-intuitive to think that the DGP of the trend function was the source of the break. Second, a model allowing for such a break was estimated and neither the trend nor the dummy variable for the break was significantly different from zero.

The data shows that the fall in the saving ratio was gradual, so we estimate an "innovational outlier" autoregressive model (see Perron and Vogelsang, 1992):

$$x_t = \mu + \delta DU_t + \theta D(TB) + \alpha x_{t-1} + \sum_{i=1}^{k} c_i \Delta x_{t-i} \qquad (2)$$

where $D(TB)_t = 1$ if $t = T_B + 1$ and zero otherwise. T_B is the time of the break. The dummy variable $DU_t = 1$ if $t > T_B$ and zero otherwise. The timing of the break is tested for by minimising the t-statistics for testing for δ=0 in equation (2) as suggested by Perron and Vogelsang (1992). The lag truncation parameter is chosen using the Ng-Perron recursive procedure. The recursive t-statistic shows t_δ to be at a minimum at the third quarter of 1991. The results are presented in Table (2) and show that the test fails to reject the null hypothesis that the German SR series is an integrated process of order one.

Table 2: Unit Root Tests on Germany's Saving ratio: 1978II-1994II

Model	Test Statistic	Minimum t_δ at:
Perron_ Vogelsang Innovational Outlier	-2.472	1991III

Notes: The test statistic of this table is compared with the critical values given in Table (4) in Perron and Vogelsang (1992).

As both tests on the unit root provide very similar results, the cointegration tests are conducted for all countries except the Netherlands. Inference on the multivariate unit root is based on four tests. These are Johansen's likelihood ratio test (Johansen, 1988, 1991), the Granger and

Engle (1987) two-step residual-based test using ADF and non-parametrical adjustment to ADF, and the Kremers *et al.* (1992) test. The last test suggests testing for cointegration in the error correction framework and allows for more efficient use of the available information.[viii] The use of the four tests is inspired by the fact that each test may not be enough by itself.[ix] In other words, we regard the various cointegration as complementary rather than as perfect substitutes and we accordingly draw our conclusions based on the consensus of their results.

The order of each VAR and autoregressive distributed lag in the Kremers *et al.* (1992) test is determined using the Schwarz Bayesian Information Criterion (BIC) in order to avoid the possibility of over-parameterisation usually associated with the other criteria.[x] For the two-step tests, the Ng-Perron data-dependent procedure is used to determine the size of the autocorrelation correction. Additionally, t-ratios for all but the Johansen approach are presented , in comparison with the 5% critical valued given in MacKinnon (1991). The results are presented in Table (3).

Table 3: Multivariate Unit Root Tests (Whole Sample)

Country	Likelihood Ratio Test			Two-step residual -based tests		Kremers-Ericsson-Dolado
	Hypo-Thesis	Maximum Eigenvalue	Trace	ADF	on-para etrically djusted DF	
Australia	R = 0 R ≤ 1	36.829* 3.575	40.403* 3.575	-4.993*	-3.583*	-4.520*
Canada	r = 0 r ≤ 1	11.437 2.803	14.240 2.803	-3.575*	-5.237*	-3.316**
Germany	r = 0 r ≤ 1	10.931 0.021	10.952 0.021	-2.520	-4.617*	-2.025
Japan	r = 0 r ≤ 1	6.683 2.949	9.811 2.949	-2.009	-4.211*	-2.210
UK	r = 0 r ≤ 1	12.422* 0.002	12.424* 0.002	- 3.117**	-4.191*	-3.368**
USA	r = 0 r ≤ 1	9.221 7.029	16.250 7.029	-2.827	-3.564*	-2.478

Notes: An * and ** indicate significance at the 5% and 10% levels, respectively. The order of the VAR and ADL of the Kremers-Ericsson-Dolado test are determined by using the BIC. The figures for the Kremers-Ericsson-Dolado test are the t-ratio statistics on the coefficient of the disequilibrium term.

The four tests confirm the presence of a long run relationship between the investment and saving ratios for Australia and the UK. The results for both countries were taken one step further by testing for unitary coefficients (-1, 1) on the cointegrating vector; this restriction amounts to stationarity of the current account. The theoretical restriction was tested using the Johansen procedure and the results failed to reject the null of unit-cointegrating parameters for the UK but did reject the null with Australian data. For Canada, all cointegration tests rejected the null of no cointegration except for the Johansen test. For Japan, only the Phillips-Perron test rejected the null hypothesis that the cointegration vector is part of the null space. Finally, for the USA, only the non-parametrically adjusted ADF rejected the null of no cointegration.[xi] Obviously, the results of the four tests are in harmony in the cases of Australia and the UK and allow us to state confidently that each of the Australian and British cointegration space is made of one cointegrating vector. However, considerable ambiguity remains with respect to Canada, Germany and Japan.

With the structural break shown in the German saving ratio, the implicit assumption of standard tests that the cointegrating vector is time-invariant fails. Hence, the long run relationship is re-estimated Implicit in the standard cointegration tests is in the case of Germany using Gregory and Hansen's (1996) residual-based test. The null was the cointegrating vector is time-invariant against the alternative that the long run vector had a break in its deterministic setup. For this test, the data is fitted to the *level shift* (Model 1) and *regime shift* (Model 4) but not the *level shift with trend* as the saving ratio is not a trending series. Model 1 refers to the case of a jump in a parallel fashion in the equilibrium relationship while Model 4 allows the cointegrating vector to rotate as well as to shift in parallel fashion. The Models are:

$$\text{M1:}\quad y_{1t} = \mu_1 + \mu_2 \varphi_{t\tau} + \alpha^T y_{2t} + e_t, \qquad t = 1,\ldots n. \tag{3}$$

$$\text{M4:}\quad y_{1t} = \mu_1 + \mu_2 \varphi_{t\tau} + \alpha_1^T y_{2t} + \alpha_2^T y_{2t} \varphi_{t\tau} + e_t \tag{4}$$

where α^T is the transpose of α. Both y_{1t} and y_{2t} are I(1), $\tau \in (0,1)$, and the test is carried out for the null that μ_1 and α are time-invariant. The dummy variable is defined to be $\varphi_{t\tau} = 1$ if $t > [\tau]$, otherwise zero. The timing of the break in (3) and (4) is taken to be conditional on the finding of

the univariate test for a structural break. This is due to findings that the power of the test is highest at this point (Gregory *et al.*, 1996).[xii] Compared to the critical values provided in their Table (1), the results on the Gregory-Hansen t-test statistic failed to reject the null that the cointegration relation is time-invariant (see Table 4). This result confirms the result obtained by standard Dickey-Fuller tests (see Table 3). Thus, based on various cointegration tests, as Gregory and Hansen (1996) recommends, we conclude that the German saving and investment ratios do not enter a long run relation. Similar results were obtained using the Campos *et al.* (1996) test for both types of the error correction model.[xiii]

Table 4: Gregory-Hansen Cointegration Tests for Structural Break in the Cointegrating Vector (German SR): Whole Sample

Model	Test Statistic
Model 1 (C)	-2.761
Model 4 (C/S)	-3.148

Note: The 5% critical values given by the response surface in Gregory and Hansen (1996), Table (1), is –4.61.

The results of the whole sample cast considerable doubt on saving-investment cointegration. Cointegration with unitary vector coefficients (what will from now on be called *strict-sense* cointegration) is only established for the UK. These results are more ambiguous than what can be regarded as the consensus arising from previous work referred to above. We next examine whether that picture changed substantially starting from the early 1980s.

2.2 Testing for univariate and multivariate unit roots: From 1980I onwards

Similar tests and strategies were followed in testing for capital mobility for the post-1979IV era. The univariate integration tests point to similar results as those obtained for the whole sample using the Dickey-Fuller tests (see Table 5). For the non-parametrically adjusted ADF tests, the difference with the whole sample results are confined to four cases, namely that the tests rejected the unit root null for: (a) the Canada, Germany and UK investment ratios; and (b) Japan's saving ratio. For the German saving ratio, the test for structural break failed to reject the null of unit root (see Table 6).

As in the case of the whole sample, cointegration analyses are carried out for all countries using the four tests (the results are shown in Table 7). The results for this period find a less pronounced long-run relation between the two ratios. The likelihood ratio test rejected the null of no cointegration for Germany and failed to reject it for all other countries. In both two-step residual-based tests, the null is rejected using Australian data. The non-parametrically adjusted ADF test rejected the null for three more countries, Canada, Germany and the US. Finally, the Kremers-Ericsson-Dolado test failed to reject the null for any country.

Table 5: Univariate Unit Root Tests (1980I to end)

Country	ADF		Non-parametrically adjusted ADF	
	IR	SR	IR	SR
Australia	1.584	-2.143	-2.135	-2.699
Canada	-2.622	-1.917	-3.251*	-2.039
Germany	-2.677	-0.324	-3.059*	-0.376
Japan	-1.560	-2.545	-1.885	-2.982*
Netherlands	-2.681	-3.017*	-3.926*	-3.385*
UK	-2.720	-2.400	-2.359	-2.092
USA	-1.960	-1.946	-2.491	-1.536

Notes: All the non-parametrically adjusted ADF corrections are based on the Newey-West method of adjustment and used Bartlett weights for window size 10. A * and ** indicate significance at the 5% and 10% levels, respectively.

Table 6: Unit Root Tests on Germany's Saving ratio: 1980I-1994II

Model	Test Statistic	Minimum t_δ at:
Perron_ Vogelsang Innovational Outlier	-2.301	1991III

Notes: Critical values from Table (4) of Perron and Vogelsang (1992).

As the German saving ratio has a break, that long run relationship is re-tested with the Gregory-Hansen (1996) method (see Table 8). The result from this test failed to reject the null of no cointegration. Thus, the results for the post-1980I period cast even more shade on the existence of cointegration, with the two vectors established for the whole sample now lost. Only the

German pair now shows fairly strong signs of being cointegrated. Tests on the size of coefficients, however, rejected strict-sense cointegration.

Table 7: Multivariate Unit Root Tests (1980I to end)

Country	Likelihood Ratio Test			Two-step residual -based tests		Kremers-Ericsson-Dolado
	Hypothesis	Maximum Eigenvalue	Trace	ADF	Non-para-metrically adjusted ADF	
Australia	r = 0 r ≤ 1	12.371 2.876	15.247 2.876	-5.042*	-6.704*	-2.752
Canada	r = 0 r ≤ 1	7.245 2.538	9.783 2.538	-2.454	-3.441*	-2.176
Germany	r = 0 r ≤ 1	14.170** 0.009	14.178** 0.009	-2.717	4.512*	2.310
Japan	r = 0 r ≤ 1	9.651 1.946	11.596 1.946	-1.508	-2.033	-2.464
UK	r = 0 r ≤ 1	6.558 3.964	10.522 3.964	-1.614	-1.444	-1.983
USA	r = 0 r ≤ 1	6.114 4.530	10.644 4.530	-1.815	-3.527*	-1.815

Notes: An * and ** indicate significance at the 5% and 10% levels, respectively. The order of the VAR and ADL of the Kremers-Ericsson-Dolado test are determined by using the BIC. The figures for the Kremers-Ericsson-Dolado test are the t-ratio statistics on the coefficient of the disequilibrium term.

Table 8: Gregory-Hansen Cointegration Tests for Structural Break in Cointegrating Vector (German SR): 1980I-1994II

Model	Test-Statistic
Model 1 (C)	-3.901
Model 4 (C/S)	-3.240

Note: The 5% critical value from Gregory and Hansen (1996), Table (1), is –4.61.

3. IMPLICATIONS

3.1 International capital mobility

The seminal paper by Feldstein and Horioka (1980; henceforth FH) suggested using the correlation between the two ratios as an indicator of the degree of capital mobility across countries. Perfect capital mobility may be defined as unfettered international trade in assets. Reasons for its failure include official restrictions, transactions costs, or taxes and various forms of home country bias in portfolio formation (see FH, 1980; Obstfeld, 1986; Stulz, 1986; and the discussion in Tsoukis and Alyousha, 1999). The FH insight is that, in closed economies, the availability of saving effectively determines the number of investment projects, hence the correlation should be high; in contrast, in open economies, saving and investment are separated and can deviate from one another through a non-zero current account, hence the correlation will be small. Given the important consequences of international capital mobility in a number of theoretical and policy-related respects,[xiv] a voluminous literature tended to verify the original FH finding of a persistently high correlation in the post-war era. In the face of increasing liberalisation in OECD economies in the post-Bretton-Woods period, this constitutes the celebrated FH puzzle.[xv] This literature and the criticisms levelled against as a valid approach to the measurement of capital mobility are nicely surveyed by Obstfeld (1995), Taylor (1996), the companion paper Tsoukis and Alyousha (1999) and, most comprehensively of all, Coakley, Kulasi and Smith (1998).

As Coakley *et al.* (1998) note, with respect to capital mobility, both findings of cointegration and the lack of it may be interpreted in diametrically opposite ways. According to one line of reasoning similar in spirit to the original FH insight, cointegration with unitary coefficients in the vector is synonymous to a close relationship and therefore signifies a closed economy and lack of mobility. Gundlach and Sinn (1992) argue along these lines; they suggest therefore that an I(1) current account constitutes evidence of mobility. In contrast, according to Coakley *et al.* (1998), an I(0) current account guarantees external solvency (see the next subsection); this is enforced by competitive international capital markets which therefore implies mobility. In a yet a third suggestion, because it may only reflect this external constraint, the finding of cointegration between saving and investment is uninformative about the degree of international capital mobility; see Sinn (1992) and Coakley *et al.* (1996). It is perhaps safest of all to suggest that

lack of strict-sense cointegration implies that substantial external balances are accumulated, *de facto* entailing mobility.

Our results may be summarised as showing cointegration firmly established in only a couple of countries (Australia, UK) for the whole of the sample; in only one of them is cointegration established in its strict sense, i.e. with unitary coefficients. For the post-1980I sub-period, the two cointegrating pairs are lost and only Germany appears now to be close to (non-unitary) cointegration. Additionally, causality tests carried out in the companion paper (Tsoukis and Alyousha, 1999) indicate causality to run from saving to investment (indicating lack of mobility) in the former case; and from investment to saving for Germany post-1980I, indicating mobility. On the basis of the instances of cointegration falling and of those causality results, one could interpret our findings as suggesting that capital mobility increased in the post-Bretton-Woods era. Apart from anecdotal information and the direct measurements mentioned above, this accords with the findings of Gundlach and Sinn (1992) which finds the instances of I(1) current account to have increased post-1973; and Hussein (1998) which reports slightly lower cointegration coefficients post-1970.[xvi] However, the absolute degree of mobility is difficult to gauge.

3.2. Implications for external solvency: Are intertemporal budget constraints satisfied?

Among the reasons that have been suggested as sources of the high correlation, is the possibility that, because of the intertemporal budget contraint any economy faces, saving and investment are bound together in the long run. If this is the case, then both cross-section correlations (with data averaged over long periods) will be high (Jansen, 1997) and long-term time-series of saving and investment will be cointegrated (Coakley *et al.*, 1996; Levy, 2003, this Volume). Furthermore, since it is a stationary current account that ensures external solvency (Coakley *et al.*, 1996; Trehan and Walsh, 1991),[xvii] *strict* cointegration should hold (from the identity CA≡S-I, in obvious notation). On this score, the predominant failure of strict-sense cointegration evidenced in our data is not encouraging. It contradicts the more positive results of Trehan and Walsh (1991) and Ahmed and Rogers (1995) on the UK and US (see also the references in those papers). Our results are consistent with casual observation suggesting that several of the economies in our sample (including the US) have been running considerable current account deficits in recent years. However, according to the Trehan-Walsh (1991) analysis, current account stationarity is only a *sufficient*

condition for the economy-wide intertertemporal budget constraint to be met and its failure does not conclusively imply external insolvency.

3.3. Implications for the intertemporal approach in international macroeconomics

Finally, saving-investment (non)cointegration has important implications for the intertemporal optimising model in international macroeconomics (Razin, 1995; Obstfeld and Rogoff, 1996). In its core, this approach is built on intertemporally satisfied budget constraints and forward-looking behaviour. According to it, as a buffer between saving and investment, the current account will be shaped by the motives to smooth and tilt consumption over time and by their implications on national saving (see e.g. Obstfeld and Rogoff, 1996, eq. 4.16). The smoothing component implies a stationary current account, while the consumption-tilting component builds a (stochastic) trend into it; this possibility is recognised in empirical work by Ghosh (1995). Moreover, even this more realistic setup relies on implausibly stringent assumptions like a representative agent, the absence of durable goods and inelastic labour supply. Despite its lack of realism, but because of its tractability, the baseline model of the stationary current account has been subjected to some empirical scrutiny but with mixed, if not negative, results (see Obstfeld and Rogoff, 1996). Our findings of general lack of strict cointegration cast yet more doubt on the validity of the simplest intertemporal current account model, but this cannot be held as conclusive evidence against the theory at large.

4. CONCLUSIONS

This paper addresses the question of (gross) saving-investment cointegration for a representative sample of 7 industrialised countries for the post-war period (in almost all cases running up to 1997 and beyond). Unlike most time series work in this area, we use quarterly data that increases the power of unit root tests. Our sample of countries was the widest one permitted by the availability of the required quarterly series. We employ an extensive array of unit root tests (univariate and multivariate) that may be considered complementary, as argued in the main text. Thus, the thrust of the paper is to offer as wide information on the relationship in question as possible with quarterly data and to draw the implications of the findings.

The results for two periods (full sample and post-1980I) raise considerable ambiguity about cointegration between the saving and

investment ratios. Cointegration in the whole sample was firmly established only in the cases of Australia and the UK. In the post-1980I sample, cointegration is lost in those two cases but established for Germany. Thus, there is disagreement with various authors who have found cointegration (though, voices of dissent are at least a considerable minority, as argued in the Introduction) based on annual data mostly up to the late 1980s; the different data frequency together with different cut-off points may explain the difference in the results. Some panel data studies have also suggested (panel) cointegration: For example Coakley, Kulasi and Smith (1996) use a panel data set of 23 OECD economies, 1960-92. Here, as argued the cointegrating relationship probably picks up the cross-section variation and masks individual country experience. Of the two cases of cointegration for the whole sample, the tests cannot reject the hypothesis of strict cointegration (unitary coefficients) for one, which then amounts to the stationarity of the current account (as ratio over GDP), too.

Regarding the implications for capital mobility, we have noted that both cointegration and the lack of it are open to intepretation. Given that cointegration appears to become scarcer in the post-Bretton-Woods era and the causality links of the findings in Tsoukis and Alyousha (1999), one can tentatively argue that our evidence verifies the casual observation that capital has increasingly flown more freely in the last 20 years or so. This is in line with other tentative suggestions in the literature, notably by Obstfeld (1995) and Taylor (1996). The prevailing lack of cointegration is not a favourable omen for external solvency. On this, our evidence contradicts some papers which suggest cointegration. Our results raise at least the possibility of current account unsustainability, as assessed at present, of some of the most advanced industrial economies, consistently with their having run considerable current account positions for some time. However, by virtue its stationarity, current account sustainability was ensured for the UK for the whole sample period. Finally, the issue of whether intertemporal budget constraints are satisfied is directly related to the essence of the intertemporal approach to the current account. We argued that lack of cointegration does not lend support to the simplest intertemporally optimising model. Though this is the only version of the model that has been empirically tested, it is based on implausibly stringent assumptions so that a stationary current account may not be required for the validity of the theory (for instance, when consumption-tilting is present).

NOTES

[i] Additionally, Trehan and Walsh (1991) and Gundlach and Sinn (1992) test directly for the stationarity of the current account with mixed results; on the same score, Taylor's (1996) results are more encouraging. Using data from 23 economies, Hussein (1998) generally rejects the coefficient of investment on saving being one, using appropriate methods to account for possible simultaneity bias.

[ii] Financial market integration has been spurred and accompanied by improved communication and transactions technologies, the creation of new financial products and financial deregulation. Direct evidence of greater international financial market integration post-1975 is offered by Mathieson and Rojas-Suarez (1994) and Grilli *et* al. (1995).

[iii] Obstfeld and Taylor (1997) identifies the Bretton-Woods era with relatively low levels of international capital mobility.

[iv] It has been pointed out that the inclusion of depreciation in both ratios may induce a spurious correlation. We would argue, however, that this is not a problem in our context: Cointegration is only established in a minority of cases, so widespread correlation, let alone spurious, does not seem likely. Moreover, in one of the cases where cointegration is established, tests show the coefficients of the cointegrating vector to be unitary (with opposite signs), so that depreciation cancels out.

[v] The series were private consumption c (line 96f), government consumption g (91f), investment i (gross fixed capital formation 93e+change in stocks 93i), GDP (99b.c) and GNP (99a). Then IR≡i/GDP, SR≡(GNP-c-g)/GDP. The US data require a slight adjustment since they are given as government consumption+fixed capital formation (91ff) and private fixed capital formation (93ee).

[vi] Ghysels and Perron (1996) demonstrates that unit root tests at a higher than zero frequency for seasonally adjusted series can be very misleading.

[vii] In a seminal paper, Perron (1990) found that when the true data generating process (DGP) is I(0) with the mean value subjected to a change, a unit root test that does not account for the change in the intercept will fail to reject the null of I(1) even when the null is not true.

[viii] Pesaran et al. (1996) develops a similar test and shows that it is a very useful strategy to test for the long-run relationship when we are not sure if the series are I (1) or I(0) processes.

[ix] We share the view presented in Gregory and Hansen (1996) that "empirical investigations will be best served by using a number of complementary statistical tests." Empirical support for using a multiplicity of cointegration tests can be found, for instance, in Gonzalo and Lee (1998) which recommends supplementing the likelihood ratio test with the residual-based test whenever the integration order of the series is not clear.

[x] Indeed, Mills and Prasad (1992) demonstrates that BIC and its variants out-perform other criteria in determining the correct lag size.

[xi] The cointegration results on US data hold true even for 10% significance level.

[xii] Based on their Monte Carlo evidence, Gregory and Hansen (1996) recommend using such information to test for a structural break in the cointegrating relation. This procedure is similar to the steps followed in Campos *et al.* (1996). They first test for a structural break

in the marginal process and then proceed to carry out the cointegration test. Their long run tests are conducted within the ECM framework.

[xiii] We do not present these results here for economy of space. They can be obtained from the authors upon request.

[xiv] These include the question of growth convergence across countries, the ability to diversify away consumption risks, the incidence of taxation, the ability of macroeconomic policy to have domestic effects, etc.

[xv] The puzzle arises since financial market liberalisation in the 1980s and 1990s mostly in developed countries (see e.g. Mathieson and Rojas-Suarez, 1994; and Grilli *et al.*, 1995), coexists with evidence of capital immobility.

[xvi] For other tentative evidence of increasing capital mobility, see Obstfeld (1995) and Taylor (1996).

[xvii] In an interesting formal analysis, Trehan and Walsh (1991) show that with a variable real interest rate, stationarity of the current account is a sufficient condition for long-run external solvency. The essence of the their argument is that a stationary around a mean current account produces a *linearly* growing (in an expected sense) net external balance; after discounting by an *exponentially* growing discount factor, the transersality condition is met and solvency is ensured.

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Chapter 4

IS THE FELDSTEIN-HORIOKA PUZZLE REALLY A PUZZLE?

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Abstract: Using the framework of a dynamic intertemporal optimization model of an open economy, it is shown that the long-run investment-saving correlation follows directly from the economy's dynamic budget constraint and this does not depend on the degree of international capital mobility. Therefore, unless the budget constraint is violated, the time series of investment and saving should be cointegrated, and this should be true for any degree of capital mobility. Using an improved econometric technique, which encompasses the tests used by previous authors and avoids some of the pitfalls associated with their tests, I show that their conflicting findings can be explained by a simple but important, omitted variables problem. Using annual and quarterly post-war U.S. data, I find that investment and saving are cointegrated in levels as well as in rates, regardless of the time period considered, as predicted by the model.

Keywords: Capital Mobility, Investment-Saving Correlation, Dynamic Budget Constraint, Integration and Cointegration, Omitted Variables

1. INTRODUCTION

There is strong empirical evidence that domestic investment (I) and national saving (S) are correlated.[1] Much of the evidence is based on cross-section regressions of multi-year average data and therefore, this is considered to be a long-run phenomenon. This finding, also known as the

Feldstein-Horioka (1980) puzzle, has received significant attention because Feldstein and Horioka interpret it as evidence of low international capital mobility. In a closed economy, investment must be financed by saving. In an open economy, however, some of the investment may be financed by foreign saving and therefore, saving and investment could move independently from each other. Thus, the high *I-S* correlation, Feldstein and Horioka argue, suggests that capital might not be mobile. This conclusion, however, is in contrast with the deregulation of capital markets and increased integration of world financial markets in the last 30 years. Also, studies measuring capital mobility directly using PPP and various interest parity conditions, conclude that capital is very mobile.[2]

Knowing the true degree of capital mobility is important for several reasons. For example, the effect of fiscal policy crucially depends on the extent of capital mobility. In addition, an economy's access to capital markets can reduce the cost of adjustment to external shocks. Also, capital mobility determines the rate at which incomes converge. Further, perfect capital mobility is often assumed to hold in macroeconomic models. Capital immobility would call into question this common practice.[3]

The existing time series studies of *I-S* comovement report conflicting results. For example, Miller (1988) finds that saving and investment in the US are cointegrated during the fixed, but not during the flexible exchange-rate period, and concludes that increased capital mobility since the 1970s may have severed the *I-S* link. Gulley (1992) uses an improved test and finds that saving and investment are not cointegrated in either period. Otto and Wirjanto (1989) also conclude that saving and investment in the U.S. are not cointegrated. Alyousha and Tsoukis (in this volume) use data that cover a longer time horizon but they also find no cointegration.

This chapter claims that there is nothing puzzling in the Feldstein and Horioka's finding. The neoclassical growth model predicts that, in the steady state, investment and saving would be proportional to output.[4] It would be puzzling, therefore, if we did *not* find high *I-S* correlation.[5]

Most optimization-based dynamic models of open economy also predict that investment and saving should be correlated in the long run. Optimizing individuals face intertemporal budget constraint, which implies that, in the long run, current account balances should add up to zero as current account surpluses or deficits cannot be sustained forever. Thus, in the long run, investment and saving would be correlated, regardless of the degree of capital mobility, as long as the intertemporal budget constraint is not violated. A test of *I-S* cointegration, therefore, is merely a test of country's economic solvency.

It follows that the time series of investment and saving should be cointegrated, and this would be true for any degree of capital mobility. Using an improved econometric technique which encompasses the tests used by the above authors and avoids some of the pitfalls associated with their tests, I show that their conflicting findings can be explained by a simple, but important, omitted variables problem. In particular, using annual and quarterly post-war U.S. data, I demonstrate that even if investment and saving are not cointegrated in a bivariate setup, they are cointegrated when output is added to the system. In order to allow for the possibility of structural breaks in the *I-S* relationship, I consider the entire post-war sample period as well as its several sub-periods. It turns out that the cointegration finding is robust regardless of the time period considered.

Thus, the U.S. data do not violate the intertemporal budget constraint and so the U.S. economy is solvent. The main conclusion is that the observed long-run *I-S* correlation cannot be useful in measuring the degree of long-term capital mobility.

The chapter is organized as follows. In the next section I derive the long-run implication of the intertemporal budget constraint of an open economy and discuss its interpretation in the context of the empirical findings reported below. In section 3, I discuss omitted variables problem in cointegration tests. In section 4, I discuss the integration tests and present their results. The cointegration test results are reported in section 5. The paper ends with a brief summary and concluding remarks in section 6.

2. INTERTEMPORAL BUDGET CONSTRAINT

Consider a dynamic optimization model of an open economy with a budget constraint of the form:

$$\frac{dB_t}{dt} = \rho_t B_t + C_t + G_t + I_t - Y_t, \qquad (1)$$

where ρ is time varying world interest rate, B is foreign debt, C is consumption, G is government expenditure, I is investment, and Y is output. According to (1), the change in foreign debt equals spending minus production, where spending includes interest payments on the existing debt. The idea behind this constraint is that an economy may borrow from abroad to pay for excess spending, or it may lend to a foreign country to accommodate excess production. Thus, world capital markets enable the economy to accommodate temporary imbalances between production and spending.

It is well known that the intertemporal budget constraint given in (1) is actually a nonhomogenous differential equation. Integrating forward yields:

$$B_t = A\psi_t^{-1} + \psi_t^{-1}\int_t^{\infty} \psi_s (Y_s - C_s - G_s - I_s)\, ds\,, \qquad (2)$$

where A is set to zero, and $\ln \psi_t = -\int_0^t \rho_s\, ds$, where ψ_t is the discount factor applied to the returns of the time t-period into the future. In a similar fashion, $\ln \psi_s = -\int_0^s \rho_v\, dv = -\int_t^{t+s} \rho_v\, dv$, which is used in deriving (2). The discount factor $\psi_t^{-1}\psi_s$ gives the time t-value of a dollar to be delivered at time s.

Now let us assume that the $\lim_{t \to \infty} (\psi_t B_t) = 0$, which is the non-Ponzi game condition. This prevents the representative agent from incurring ever-increasing debt by continuously borrowing without a limit. At the same time, however, the assumption does not impede the agent's ability to incur a temporary debt to accommodate temporary imbalance between production and spending.

The above budget constraint can be used to relate the long-run *I-S* comovement to current account stationarity. Assume $\rho_s = \rho, \forall s$. Then ψ_t becomes the standard continuous-time discount factor with constant interest rate, $\ln \psi_t = -\int_0^t \rho\, ds = -\rho t$. In this case (2) can be rewritten as:

$$\mathrm{e}^{-\rho t} B_t = \int_t^{\infty} \mathrm{e}^{-\rho s} (Y_s - C_s - G_s - I_s)\, ds\,, \qquad (3)$$

which, using the fact that $\mathrm{e}^{-\rho t} = \int_t^{\infty} \rho \mathrm{e}^{-\rho s}\, ds$ can be further rewritten as

$$\int_t^{\infty} \mathrm{e}^{-\rho s} (Y_s - \rho B_s - C_s - G_s - I_s)\, ds = 0\,, \qquad (4)$$

where $Y_s - \rho B_s$ denotes the net income of domestic residents, the *GNP*. But $S = GNP - C - G = Y - \rho B - C - G$, which follows from the national income accounting. Therefore, in (4), the term in parentheses equals $S - I$, which in turn equals the current-account deficit.

Thus, a long-run *I-S* correlation is equivalent to a stationarity of current account deficit. Therefore, if investment and saving are cointegrated, it is an indicator of the country's economic solvency. As Obstfeld (1991), Alyousha and Tsoukis (in this volume) and Coakley, et al. (1996) emphasize, in a model with a variable real interest rate, stationarity of current account is sufficient for external solvency. The implication of (4), however, is that in a

model with a constant real interest rate, stationarity of current account is both necessary and sufficient for economic solvency.

3. OMITTED VARIABLES IN COINTEGRATION

Since investment and saving tend to be non-stationary, Miller (1988), Otto and Wirjanto (1989), and Gulley (1992) use the cointegration methodology to study the *I-S* relationship in the post-war U.S. All three use Engle and Granger's (1987) two-step estimation method, but report conflicting findings. Miller (1988) finds that the series are cointegrated prior to 1971, during the fixed exchange rate period, but not after 1971, during the flexible exchange rate regime. Otto and Wirjanto (1989) and Gulley (1992), however, find that the series are not cointegrated in either period.

Because investment and saving must be cointegrated, these conflicting findings may be due to an omitted variable. Consider a situation where y, x_1, and x_2 are all $I(1)$, but their linear combination is $I(0)$. In other words, I assume that the time series of y, x_1, and x_2 are cointegrated, which means that $y = \beta_1 x_1 + \beta_2 x_2 + \varepsilon$, where $\varepsilon \sim I(0)$. Now, suppose that that we inadvertently omit x_2 and run $y = \beta_1 x_1 + \mu$. Since $\mu = (\beta_2 x_2 + \varepsilon) \sim I(1)$, we would mistakenly conclude that y and x_1 are not cointegrated.

This example suggests the possibility that the conflicting results reported in the above studies may be caused by omission of some important variable. According to the neoclassical growth model, a natural candidate for a missing variable is output because in that model, investment and saving are proportional to output.

4. INTEGRATION TEST RESULTS

To test for stationarity, Miller (1988) uses the Augmented Dickey-Fuller (ADF) unit root test:

$$\Delta x_t = \gamma x_{t-1} + \sum_{i=1}^{4} \phi_i \Delta x_{t-i} + \varepsilon_t \qquad (5)$$

However, Gulley (1992) correctly claims that the exclusion of the constant is appropriate only if the mean of the series is zero, which is not the case for saving or investment. Therefore he modifies (5) by adding a constant,

$$\Delta x_t = \alpha_1 + \gamma x_{t-1} + \sum_{i=1}^{4} \phi_i \Delta x_{t-i} + \varepsilon_t \qquad (6)$$

and tests for $\gamma = 0$.

However, this version of the ADF test is not problem-free either. The reason is that the tabulated distribution of the unit root test statistic for version (6) depends crucially on the assumption that $\alpha_1 = 0$. That is, it has the Dickey-Fuller distribution only when there is no drift term in the data-generating process of x_t. If the true $\alpha_1 \neq 0$, then the statistic for testing the null hypothesis $\gamma = 0$ is asymptotically distributed as $N(0,1)$, and, in finite samples, its distribution may or may not be well approximated by the Dickey-Fuller distribution.[6] Therefore, if the drift parameters in the data-generating processes of investment and saving are non-zero, then using version (6) of the test is inappropriate.

To avoid the dependence of the distribution of the test statistic on the value of α_1, MacKinnon (1991) suggests adding a linear time trend to (6),

$$\Delta x_t = \alpha_0 t + \alpha_1 + \gamma x_{t-1} + \sum_{i=1}^{4} \phi_i \Delta x_{t-i} + \varepsilon_t, \qquad (7)$$

under the assumption that there is no trend in the data-generating process.

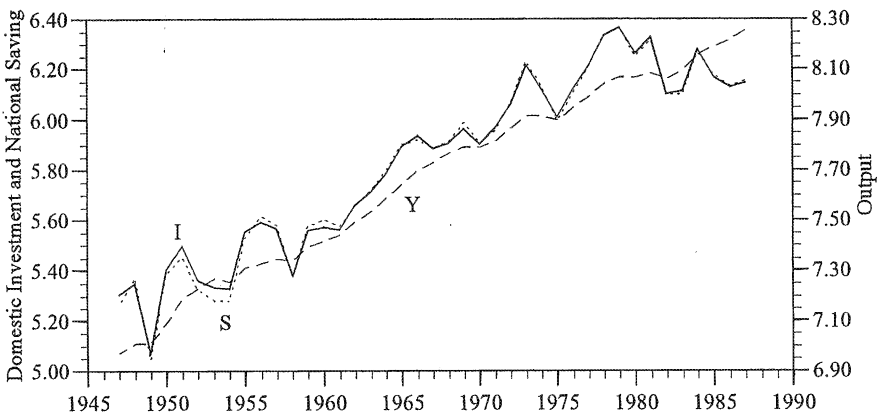

Figure 1. Investment, Saving, and Output in Levels, Annual Data, 1947–87

I use (7) to examine the unit-root properties of the time series of saving, investment, and output. Along with (7), I have used Box-Pierce, Ljung-Box, and Lagrange Multiplier tests (not shown to save space) to verify that the error terms in the unit-root test regressions are not serially correlated.

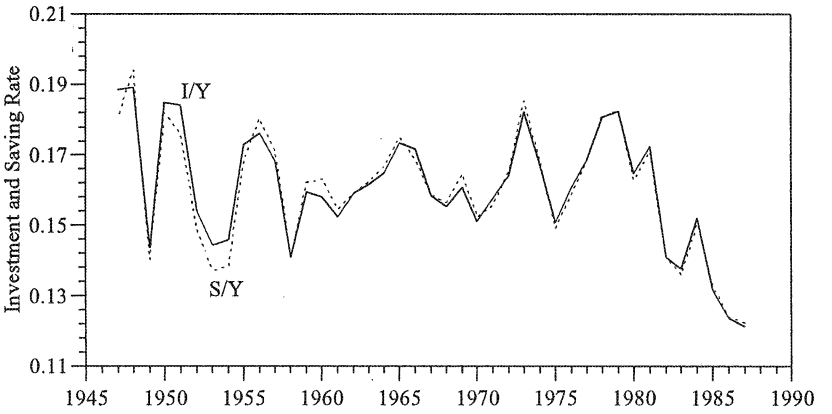

Figure 2. Investment and Saving Rates, Annual Data, 1947–87

I use quarterly and annual data for 1947–1987. The quarterly data are identical to those used by Miller (1988), Otto and Wirjanto (1989), and Gulley (1992). I study the *I-S* relationship both, in levels and in rates.[7]

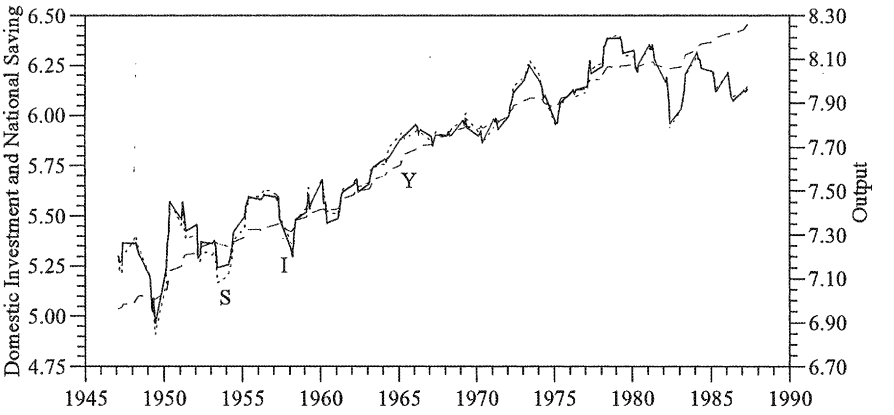

Figure 3. Investment, Saving, and Output in Levels, Quarterly Data, 1947:1–87:3

The source of the data on national saving, domestic investment, and output is the US-NIPA Tables of the Bureau of Economic Analysis.

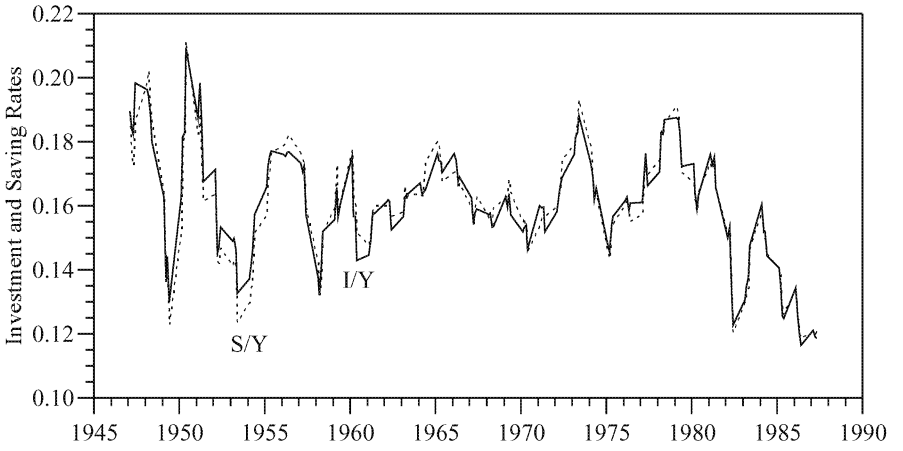

Figure 4. Investment and Saving Rates, Quarterly Data, 1947:1–87:3

In addition to the entire sample period 1947:1–87:3, I also examine its three sub-periods, 1947:1–71:2, 1971:3–87:3, and 1980:1–87:3.

The 1947:1–87:3 sample period was chosen to match the sample periods used by Miller (1988), Otto and Wirjanto (1989), and Gulley (1992).[8] The first two sub-periods, 1947:1–71:2 and 1971:3–87:3, correspond to the fixed and flexible exchange rate regimes, respectively.[9] The last sub-period, 1980:1–87:3, is examined to see whether the large capital inflow into the U.S. during the Reagan administration altered the *I*-*S* relationship.

The annual series measured in levels (log) and as a fraction of output (that is, the investment and saving rates) are displayed in Figures 1 and 2, respectively. Similarly, the quarterly series measured in levels (log) and as a fraction of output are shown in Figures 3 and 4, respectively.

I present the integration test results in Tables 1 and 2. The ADF test statistics indicate that the *S*, *I*, and *Y* series are $I(1)$ when measured in levels. When differenced, all three series appear to be $I(0)$. This is true for both the annual (Table 1) as well as the quarterly data (Table 2). When measured in rates, saving and investment appear to be $I(1)$ during the 1971:3–87:3 and 1980:1–87:3 periods.[10] In what follows, therefore, I treat them as $I(1)$.

Table 1. Unit-Root ADF Test of Investment, Saving, and Output: Annual Data

Period	Series	Level	First Difference (Δ)
1947–87	I	–1.47	–3.57**
(n = 41)	S	–1.59	–3.71
	Y	–1.22	–4.01**
	I/Y	–3.53**	
	S/Y	–3.38**	

Notes: Superscripts *, **, and *** in all tables indicate statistical significance at 1%, 5%, and 10%, respectively. The corresponding MacKinnon (1991) critical values for the ADF test statistics are –4.19, –3.52, and –3.19, respectively. Miller (1988), Otto and Wirjanto (1989), and Gulley (1992) do not use annual data.

Table 2. Unit-Root ADF Tests of Investment, Saving, and Output: Quarterly Data

			Otto and		Levy	
Period	Series	Miller	Wirjanto	Gulley	Level	Difference
1947:1–87:3	I		–3.98**	–0.86	–3.33	–6.87*
(n = 163)	S		–3.83**	–1.28	–3.40	–6.90*
	Y				–2.03	–5.51*
	I/Y	–0.14		–4.88**	–3.77**	
	S/Y	–0.77		–3.09**	–3.75**	
1947:1–71:2	I		–3.54**	–0.46	–3.22	–5.48*
(n = 98)	S		–2.54	–0.37	–3.41	–5.19*
	Y				–1.35	–4.48*
	I/Y	–0.04		–3.91**	–4.25*	
	S/Y	–0.40		–3.30**	–4.11*	
1971:3–87:3	I		–3.11	–1.94	–2.66	–4.39*
(n = 65)	S		–3.25	–2.78	–2.76	–4.49*
	Y				–2.43	–3.32***
	I/Y	–0.37		–3.00**	–2.43	–4.43*
	S/Y	–0.74		–1.22	–2.58	–4.44*
1980:1–87:3	I				–2.99	–3.57**
(n = 31)	S				–2.67	–3.63**
	Y				–1.75	–2.73
	I/Y				–3.53***	–3.70**
	S/Y				–3.16	–3.70**

Notes: The corresponding critical values of MacKinnon (1991) for Levy's ADF test statistics are –4.01, –3.43, and –3.14 for 1947:1–87:3, –4.05, –3.45, and –3.15 for 1947:1–71:2, –4.10, –3.47, and –3.16 for 1971:3–87:3, and–4.28, –3.56, and –3.21 for 1980:1–87:3, respectively. Otto and Wirjanto's (1989) sample begins with 1956:1. The ADF statistic values for Miller (1988), Otto and Wirjanto (1989), and Gulley (1992) are taken from the respective studies.

5. COINTEGRATION TEST RESULTS

I use Johansen's (1988) maximum likelihood (ML) method, which is superior to the Engle-Granger (1987) two-step method used by the above authors. In addition to the inferior statistical properties of its estimators, the Engle-Granger method has the disadvantage that for estimating a cointegration relationship, some kind of normalization is necessary. Practical applications have shown that the results can be very sensitive to the normalization chosen. Johansen's method treats all variables as endogenous, thereby avoiding the problem of choosing a normalization altogether.

Johansen (1988) offers two tests for estimating the number of cointegrating vectors. The first is called *maximal eigenvalue test*, and is given by the test statistic $\lambda_{\max} = -n\log(1-\hat{\lambda}_r)$, where n is the number of observations, and $\hat{\lambda}_r$ is the r^{th} eigenvalue to be determined by solving the determinantal equation associated with the residual product moment matrix constructed using the residuals' matrices.

The maximal eigenvalue test is designed to test $H(r-1)$ against $H(r)$. That is, the null hypothesis is that there are $(r-1)$ cointegrating vectors against the alternative r.

The second test, called the *trace test*, is designed to test the null $H(r)$ against the alternative $H(m)$, where $r < m$. The trace test statistic is given by $J_T = -n\sum_{i=r+1}^{m}\log(1-\hat{\lambda}_i)$.

The cointegration test results are presented in Tables 3–7. In estimating the cointegration vectors, I used VAR(4). It is not known a priori whether the true data-generating process contains a deterministic trend or not. I, therefore, conduct the cointegration tests under both options. The test statistics are identical under both assumptions; only the critical values differ.

In Johansen's framework the number of cointegrating vectors is determined sequentially. We start with the hypothesis that there are no cointegrating relations, that is, $r = 0$, where r denotes the number of cointegrating relationships. We continue only if this hypothesis is rejected. In this case, we test the hypothesis that there is at most one cointegrating vector, $r \leq 1$, and so on. The test results can be interpreted in favor of cointegration only if $0 < r < m$, where m is the number of variables in $\mathbf{x}_t$. Full rank, that is $r = m$, only indicates that the data vector process $\mathbf{x}_t$ is stationary. If $r = 0$, then the matrix Π, which is the matrix of the coefficients on the variables $\mathbf{x}_{t-p}$ in the first-differenced VAR model, is the null matrix. In that case, the model becomes a traditional differenced VAR system.

Table 3. Cointegration Test: Annual Data, 1947–87 ($n = 41$)

Variables	Test	H_0	H_1	Test Statistic	Critical Value			
					Trend in DGP		No Trend in DGP	
					95%	90%	95%	90%
I, S	λ_{max}	$r = 0$	$r = 1$	6.56	14.06	12.07	14.90	12.91
		$r \leq 1$	$r = 2$	1.69	3.76	2.68	8.17	6.50
	J_T	$r = 0$	$r \geq 1$	8.26	15.41	13.32	17.95	15.66
		$r \leq 1$	$r = 2$	1.69	3.76	2.68	8.17	6.50
I, S, Y	λ_{max}	$r = 0$	$r = 1$	20.18***	20.96	18.59	21.07	18.90
		$r \leq 1$	$r = 2$	6.23	14.06	12.07	14.90	12.91
		$r \leq 2$	$r = 3$	2.97	3.76	2.68	8.17	6.50
	J_T	$r = 0$	$r \geq 1$	29.39***	29.68	26.78	31.52	28.70
		$r \leq 1$	$r \geq 2$	9.20	15.41	13.32	17.95	15.66
		$r \leq 2$	$r = 3$	2.97	3.76	2.68	8.17	6.50

Note: The critical values reported in all cointegration test tables are taken from Osterwald-Lenum (1992).

Table 4. Cointegration Test: Quarterly Data, 1947:1–87:3 ($n = 163$)

Variables	Test	H_0	H_1	Test Statistic	Critical Value			
					Trend in DGP		No Trend in DGP	
					95%	90%	95%	90%
I, S	λ_{max}	$r = 0$	$r = 1$	18.58**	14.06	12.07	14.90	12.91
		$r \leq 1$	$r = 2$	2.39	3.76	2.68	8.17	6.50
	J_T	$r = 0$	$r \geq 1$	20.97**	15.41	13.32	17.95	15.66
		$r \leq 1$	$r = 2$	2.39	3.76	2.68	8.17	6.50
I, S, Y	λ_{max}	$r = 0$	$r = 1$	27.05	20.96	18.59	21.07	18.90
		$r \leq 1$	$r = 2$	8.66	14.06	12.07	14.90	12.91
		$r \leq 2$	$r = 3$	5.79	3.76	2.68	8.17	6.50
	J_T	$r = 0$	$r \geq 1$	41.51**	29.68	26.78	31.52	28.70
		$r \leq 1$	$r \geq 2$	14.46	15.41	13.32	17.95	15.66
		$r \leq 2$	$r = 3$	5.79	3.76	2.68	8.17	6.50

Table 5. Cointegration Test: Quarterly Data, 1947:1–71:2 ($n = 98$)

Variables	Test	H_0	H_1	Test Statistic	Critical Value			
					Trend in DGP		No Trend in DGP	
					95%	90%	95%	90%
I, S	λ_{max}	$r = 0$	$r = 1$	9.45	14.06	12.07	14.90	12.91
		$r \leq 1$	$r = 2$	0.82	3.76	2.68	8.17	6.50
	J_T	$r = 0$	$r \geq 1$	10.28	15.41	13.32	17.95	15.66
		$r \leq 1$	$r = 2$	0.82	3.76	2.68	8.17	6.50
I, S, Y	λ_{max}	$r = 0$	$r = 1$	32.08	20.96	18.59	21.07	18.90
		$r \leq 1$	$r = 2$	10.49	14.06	12.07	14.90	12.91
		$r \leq 2$	$r = 3$	0.02	3.76	2.68	8.17	6.50
	J_T	$r = 0$	$r \geq 1$	42.60**	29.68	26.78	31.52	28.70
		$r \leq 1$	$r \geq 2$	10.52	15.41	13.32	17.95	15.66
		$r \leq 2$	$r = 3$	0.02	3.76	2.68	8.17	6.50

Table 6. Cointegration Test: Quarterly Data, 1971:3–87:3 ($n = 65$)

Variables	Test	H_0	H_1	Test Statistic	Critical Value			
					Trend in DGP		No Trend in DGP	
					95%	90%	95%	90%
I, S	λ_{max}	$r = 0$	$r = 1$	19.44**	14.06	12.07	14.90	12.91
		$r \leq 1$	$r = 2$	4.91	3.76	2.68	8.17	6.50
	J_T	$r = 0$	$r \geq 1$	24.35**	15.41	13.32	17.95	15.66
		$r \leq 1$	$r = 2$	4.91	3.76	2.68	8.17	6.50
I, S, Y	λ_{max}	$r = 0$	$r = 1$	22.39	20.96	18.59	21.07	18.90
		$r \leq 1$	$r = 2$	7.24	14.06	12.07	14.90	12.91
		$r \leq 2$	$r = 3$	4.21	3.76	2.68	8.17	6.50
	J_T	$r = 0$	$r \geq 1$	33.85**	29.68	26.78	31.52	28.70
		$r \leq 1$	$r \geq 2$	11.45	15.41	13.32	17.95	15.66
		$r \leq 2$	$r = 3$	4.21	3.76	2.68	8.17	6.50
I/Y, S/Y	λ_{max}	$r = 0$	$r = 1$	15.09	14.06	12.07	14.90	12.91
		$r \leq 1$	$r = 2$	1.84	3.76	2.68	8.17	6.50
	J_T	$r = 0$	$r \geq 1$	16.93**	15.41	13.32	17.95	15.66
		$r \leq 1$	$r \geq 2$	1.84	3.76	2.68	8.17	6.50

In the bivariate setting, I find that for the annual data (see Table 3), the null of no cointegration cannot be rejected.

For the quarterly data, *I-S* levels are cointegrated during the 1947:1–87:3 period (see Table 4) as well as during the 1947:1–71:2 period (see Table 5). For the 1971:3–87:3 period, the results are inconclusive because with-trend specification of the test indicates one cointegrating vector but no-trend specification indicates stationarity. When measured in rates (see Table 6), both test statistics indicate *I-S* cointegration with one cointegrating vector.[11]

For the 1980:1–87:3 period, the results support *I-S* cointegration: with no-trend specification, the null of one cointegration vector cannot be rejected. The with-trend cointegration test indicates that the null can be rejected only at 10% significance, but not at 5% significance.

When the variables are measured in rates, I find that during 1971:3–87:3 (see Table 6) and 1980:1–87:3 (see Table 7), both test statistics uniformly reject the null of zero cointegrating vectors in favor of one cointegrating vector. Thus, investment and saving during these periods are cointegrated.

In sum, the bivariate *I-S* cointegration tests are somewhat mixed, although in general they indicate a cointegration if quarterly data are used.

In the trivariate system with *I*, *S*, and *Y*, the results indicate that the three series are cointegrated with one cointegrating vector. This finding holds for all sample periods considered and for both test statistics used (see Tables 4–7). Here we find a cointegration using the annual data also (see Table 3).

Table 7. Cointegration Test: Quarterly Data, 1980:1–87:3 ($n = 31$)

Variables	Test	H_0	H_1	Test Statistic	Critical Value			
					Trend in DGP		No Trend in DGP	
					95%	90%	95%	90%
I, S	λ_{max}	$r = 0$	$r = 1$	17.48**	14.06	12.07	14.90	12.91
		$r \leq 1$	$r = 2$	3.08	3.76	2.68	8.17	6.50
	J_T	$r = 0$	$r \geq 1$	20.57**	15.41	13.32	17.95	15.66
		$r \leq 1$	$r = 2$	3.08	3.76	2.68	8.17	6.50
I, S, Y	λ_{max}	$r = 0$	$r = 1$	27.23	20.96	18.59	21.07	18.90
		$r \leq 1$	$r = 2$	11.84	14.06	12.07	14.90	12.91
		$r \leq 2$	$r = 3$	1.80	3.76	2.68	8.17	6.50
	J_T	$r = 0$	$r \geq 1$	40.88**	29.68	26.78	31.52	28.70
		$r \leq 1$	$r \geq 2$	13.65	15.41	13.32	17.95	15.66
		$r \leq 2$	$r = 3$	1.80	3.76	2.68	8.17	6.50
I/Y, S/Y	λ_{max}	$r = 0$	$r = 1$	20.34	14.06	12.07	14.90	12.91
		$r \leq 1$	$r = 2$	1.29	3.76	2.68	8.17	6.50
	J_T	$r = 0$	$r \geq 1$	21.64**	15.41	13.32	17.95	15.66
		$r \leq 1$	$r \geq 2$	1.29	3.76	2.68	8.17	6.50

This means that the time series of investment and saving are indeed cointegrated, as predicted by the theoretical arguments made in section 2.

The estimated cointegrating vectors and the corresponding adjustment matrices of the cointegration relationships found are reported in Table 8. The long-run coefficient on saving shows remarkable stability with the exception of the annual data, where the estimated coefficient is a little bit higher.[12]

Further, according to the figures reported in Table 8, the homogeneity restrictions seem to be satisfied by the data. For example, in the bivariate

regressions, the coefficient on saving is close to 1 whether the regression is run in levels or rates.

Table 8. Cointegrating Vectors and Corresponding Adjustment Matrices

	Cointegrating Vectors					Adjustment Matrixes				
Sample	*I*	*S*	*Y*	*I/Y*	*S/Y*	*I*	*S*	*Y*	*I/Y*	*S/Y*
1947–87	−1.00	1.19	−0.09			−0.18	−0.33	−0.63		
1947:1–87:3	−1.00	1.00				−0.11	−0.46			
1947:1–87:3	−1.00	1.14	−0.03			−0.27	−0.48	−0.45		
1947:1–71:2	−1.00	1.06	0.14			0.46	0.42	0.21		
1971:3–87:3	−1.00	1.11				−0.80	−1.08			
1971:3–87:3	−1.00	1.14	−0.01			−0.41	−0.70	−0.89		
1971:3–87:3				−1.00	1.06				−0.36	−0.77
1980:1–87:3	−1.00	1.10				−2.87	−3.22			
1980:1–87:3	−1.00	1.05	−0.01			−2.25	−3.39	−2.88		
1980:1–87:3				−1.00	1.05				−2.47	−3.40

Notes: Normalization was carried out by setting the coefficient on investment equal to −1.00. The cointegrating vectors and the adjustment matrices presented here correspond to the cointegration relationships established in Tables 3–7 and are presented in the same order.

Similarly, in trivariate regressions, the sum of the coefficients on *Y* and *S* is close to 1. The speed of adjustment figures reported in the right hand side columns of Table 8, seem rather high. This holds particularly true for the last decade. This suggests that in the US economy, the time series of investment and saving adjust rapidly to their long-run equilibrium levels.

In sum, using the post-war US quarterly and annual data, I find that the time series of investment and saving are cointegrated, which indicates that the U.S. economy is solvent in the sense that it does not violate its dynamic budget constraint. To conclude, therefore, that it is unlikely that *I-S* correlations would provide accurate information on the true degree of international capital mobility.[13]

6. CONCLUSION

Feldstein and Horioka's (1980) finding that saving and investment tend to be correlated in the long run has received significant attention in the literature. This is because Feldstein and Horioka express the view that the long-run *I-S* comovement is an indicator of international capital immobility. If this were true, then the findings reported in this chapter would suggest that capital was not mobile during the 1947–87 period.

As Baxter and Crucini (1993) note, however, most economists disagree with this interpretation. It is difficult to defend this argument for numerous reasons.

First, the restrictions imposed on international capital mobility have been declining over time in the world economy. This is particularly true since early 70s, when many developed, and to a lesser degree developing, countries abolished most capital restrictions.

Second, the increased deregulation and integration of the world financial markets is not compatible with the idea of declining capital mobility. For example, the extreme volatility of exchange rates since the abandonment of the Bretton Woods' system provides persuasive evidence of capital mobility—a large pool of liquid assets are switched in response to anticipation of exchange rate movements.

Third, studies that measure capital mobility directly using various PPP and interest parity conditions, conclude that capital is very mobile and that capital mobility has been increasing over time. For example, Hutchison and Singh (1993) examine real interest rate differential between the U.S. and Japan and find that capital mobility is very high. Popper (1990) uses interest and currency arbitrage conditions along with financial asset returns and finds that capital is as mobile in the long- as in the short-run.

This chapter claims that there is nothing mysterious in the *I-S* comovement. Since the neoclassical growth theory predicts that in the steady state investment and saving should be proportional to output and therefore would grow at the same rate, it would be surprising if we did not find a high long-run *I-S* correlation. The modern optimization-based dynamic model of open economy also predicts that investment and saving would be correlated in the long run regardless of the extent of capital mobility, unless the economy violates its dynamic budget constraint. Therefore, a test of *I-S* cointegration is merely a test of country's economic solvency. To conclude, therefore, the observed long-run *I-S* correlation cannot be useful for measuring the extent of international capital mobility.

As additional evidence, it should be noted that if Feldstein and Horioka line of argument were valid, then the huge capital inflow to the U.S. during the first term of the Reagan administration should have diminished the long-run *I-S* correlation in the early 80s. The findings reported here, however, do not support this view.

NOTES

1. See, for example, Sinn (1992), Ghosh (1995), Coakley, Kulasi, and Smith (1996), Sachsida and Caetano (2000) and the references cited therein. More recent studies include Tsoukis and Alyousha (2001), Alyousha and Tsoukis (in this volume), and Fountas and Tsoukis (2000), who study a sample of seven industrialized economies.
2. See, for example, Bayoumi (1990), Sachs (1981), Obstfeld (1986), Frankel (1991), Levy (1995), Frankel and MacArthur (1988), Popper (1990), and Baxter and Crucini (1993).
3. I shall mention that the focus of this chapter is the long-run capital mobility. Short-run capital mobility is less controversial. See, for example, Feldstein (1983) and Levy (2000, 2001).
4. Virtually all other macro models, with or without open capital markets, make similar predictions on the long-run investment-saving comovement.
5. For example, Barro, Mankiw, and Sala-I-Martin (1995) construct an open economy version of the neoclassical growth model with this conclusion.
6. A similar problem arises in the estimation of cointegrating regressions using Engle-Granger two-step method, where the residuals' ADF unit root test statistic distribution depends on the true value of the intercept term. As MacKinnon (1991) notes, all tables assume that $\alpha_1 = 0$, and, therefore, may be quite misleading if this is not the case.
7. The reason for the common use of investment and saving rates is to avoid the difficulties the presence of integrated variables create in traditional regression analysis. It turns out, however, that modeling the time series of investment and saving as rates may not be sufficient to make them stationary. See footnote 10 below.
8. Miller (1988) considers only investment and saving rates, Otto and Wirjanto (1989) only consider levels, and Gulley (1992) considers both levels and rates.
9. To conserve degrees of freedom, I do not divide the annual data into sub-periods because the cointegration test I use employs a maximum likelihood procedure based on error correction representation of the VAR formed by the variables considered.
10. It may seem puzzling that investment and saving are $I(1)$ in levels as well as rates. See Levy (2000, p. 115, footnote 13) for a possible explanation.
11. Because of the possibility that investment and saving rates may contain no deterministic trend, the data were also tested for cointegration with the restriction $\boldsymbol{\mu} = \mathbf{0}$, where $\boldsymbol{\mu}$ is the vector of constants in the VAR. The result is identical. That is, the time series of investment and saving were found to be cointegrated with one cointegration vector.
12. Sinn (1992) also finds that the coefficient is higher for lower frequency data.
13. I have also tested for *I-S* cointegration in rates under the assumption that the series don't contain a deterministic trend. The results are the same. It should also be noted that the investment-saving relationships studied here were also estimated recursively and the results indicate significant parameter constancy.

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Chapter 5

TWIN DEFICITS, REAL INTEREST RATES, AND INTERNATIONAL CAPITAL MOBILITY

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Abstract: We argue that the causal interactions among the current account and budget balances and the real interest rate can provide more information about the effective degree of financial openness of an economy than simple saving-investment correlations. Cointegration tests reveal a variety of linkages between the variables across countries. A number of economies (Canada, Germany, Netherlands, and increasingly the UK) appear to be small and open, while Japan and the USA are effectively closed. The "twin deficits" and "current account targeting" hypotheses receive some support in the short run.

Keywords: International capital mobility, twin deficits, real interest rates.

1. INTRODUCTION

Much of the literature attempting to assess the extent of international capital mobility has followed the saving-investment correlation approach initiated by Feldstein and Horioka (1980). Despite institutional developments

(financial market liberalisation, lifting of capital controls) which have made capital more internationally mobile across the industrialised world in the last 20 years (see e.g. Grilli and Milesi-Ferretti, 1995; Mathieson and Rojas-Suarez, 1994), the Feldstein-Horioka findings of a high correlation suggest limited financial integration, giving rise to the "Feldstein-Horioka" puzzle.[i] The interpretation of such findings, however, has been widely questioned on the grounds that, in theoretical intertemporally-optimising models, saving and investment are likely to be correlated even in open economy models for a variety of reasons, including large country bias (Baxter and Crucini, 1993); endogeneity of both saving and investment (Razin, 1995); external solvency (Coakley *et al.*, 1996); and endogenous fiscal policy (Summers, 1988; Levy, 1995). It is also argued that the absence of any natural threshold magnitude of the correlation mars the interpretation of the results with inherent ambiguity (Taylor, 1997)[ii].

To overcome such criticism, Argimon and Roldan (1994) and Levy (1995) focus on the causal relation between national and sectoral (public - private) saving and investment rates. The underlying rationale is very much in the spirit of the original Feldstein-Horioka argument but bypasses the ambiguities mentioned above: In closed economies, developments in saving determine investment, while in open economies the reverse causal ordering should hold. Argimon and Roldan (1994) find that in most countries in their sample, saving causes investment and the current account does not elicit any response by the government budget deficit; they interpret those results as signs of closed economies and of employment of policies other than fiscal (e.g., monetary policy and capital controls) in dealing with the external (im)balance.[iii]

An obvious problem with the causality approach is the lack of cointegration.[iv] Although saving and investment should cointegrate in the very long run to ensure external solvency (Trehan and Walsh, 1991; Coakley, Kulasi and Smith, 1996), this may be difficult to uncover in available samples. In the medium term, missing variables like the budget deficit and the real interest rate may plausibly drive the current account. Those can therefore be used to shed additional light on the issue of financial openness. The role of the former has been highlighted in the literature on the "twin deficits" (see e.g. Abell, 1990; Kearney and Monadjemi, 1990; and Kasa, 1994, as well as the Argimon-Roldan approach) which suggests that the budget deficit may be a major influence on the external deficit. Against that, Ricardian equivalence implies the absence of any relationship between the two while the "current account targeting" hypothesis (Summers, 1988) would argue for reverse causality. The role of the interest rate is emphasised in Abell (1990) as a mediating mechanism between the two deficits. The real

interest rate may also be particularly important as an indicator of the actual (as opposed to institutional) degree of openness. In a small open economy, the real interest rate is exogenous and therefore long-run causality is expected to run from it to the current account; whilst, in a large economy the loanable funds market clears and the real interest rate is determined by the deficit. A third important variable may be the real exchange rate; that is expected to be endogenous in the long run, however, at least because of full price flexibility.

In this paper, we investigate cointegration and the causal ordering between the current account, the budget surplus (both as ratios over GDP) and the real interest rate in a sample of industrialised economies for the post-war era. Our objective is to offer quantitative information on the extent of international capital mobility. Following the lead of Argimon and Roldan (1994), we employ causality tests that bypass the ambiguities associated with simple saving-investment correlations. The choice of variables is dictated by the foregoing discussion: The interactions between the current account (as the mirror image of the capital account, or excess supply of loanable funds) and the real interest rate offers additional information on openness.

The structure of the paper is as follows: Section 2 provides a theoretical basis for our empirical analysis and section 3 presents our empirical findings and interpretation. Finally, section 4 concludes.

2. THEORETICAL CONSIDERATIONS

The relationship between the twin deficits, i.e., the fiscal deficit and the current account deficit, can be analyzed using the following national accounts identity:

$$CA = GNP\text{-}C\text{-}G\text{-}I \equiv S\text{-}I = (S^P\text{-}I^P) + (T\text{-}G) \qquad (1)$$

CA stands for the current account balance given by the difference between GNP and domestic absorption, the sum of consumers' expenditure C, total investment I and government expenditure G, or else the difference between total domestic saving S and investment. We follow the usual practice of utilising the CA as an indicator of capital mobility, since it is the "mirror image" of the capital account of the balance of payments (see e.g. Ghosh, 1995; Obstfeld and Rogoff, 1996). The S-I difference can then be broken down into the two sectoral balances, the private one (indicated by the superscripts P) and the government budget surplus (tax revenue T minus government spending G). With its elements expressed as ratios over GDP

(Y), and pointing out the dependence of S and I on the real interest rate R, the last equality of (1) becomes:

$$CAY = SPY(R) - IPY(R) + SURY, \qquad (2)$$

$$CAY \equiv CA/Y, \quad SPY \equiv S^P/Y, \quad IPY \equiv I^P/Y, \quad SURY \equiv (T-G)/Y.$$

With the saving and investment ratios representing behavioural relationships, (2) implies a long-run equilibrium relationship between the current account-to-income ratio, the fiscal surplus-to-income ratio and the real interest rate.

The Feldstein-Horioka approach is to investigate openness based on the simple correlation between SPY and IPY in (2), disregarding the effects of SURY or indeed R on either: In closed economies, where the availability of saving determines investment, the correlation should be close to unity. On the other hand, in open economies, investment is financed by the world pool of loanable funds, so that the correlation should tend to zero. Argimon and Roldan (1994) and Levy (1995) focus on causality tests between the same variables. While following the same method of cointegration/causality, our analysis above suggests that full investigation of causality among CAY, R and SURY may more richly characterise financial openness. Despite its simplicity, (2) allows us to formulate a number of hypotheses.

The "twin deficits" hypothesis recognises the role of the budget deficit in the context of (2) and implies a cause-and-effect relationship from SURY to CAY, given net private savings. The theoretical predictions regarding this hypothesis vary widely. In the Mundell-Fleming model under flexible exchange rates and perfect capital mobility, a fiscal expansion leads to a domestic-currency appreciation and a deterioration of the current account balance, hence the term "twin deficits". Imperfect asset substitutability is however a complicating factor and its recognition by the portfolio balance model leads to predictions of short-run and long-run effects of fiscal policy on the current account that may differ from those of Mundell-Fleming. Furthermore, wealth effects and wage and price inertia represent additional factors that will contribute to a deviation from the twin-deficit hypothesis (Marston, 1985). In contrast to vintage *ad hoc* models of the open economy, the optimizing models of the open economy explicitly take account of the nature of the fiscal expansion (i.e. temporary vs. permanent) in considering its effects on the current account and their consistency or not with the "twin-deficit" hypothesis; see e.g. Razin (1995); Obstfeld and Rogoff (1996).

A simple but powerful argument against "twin deficits" is, of course, provided by Ricardian equivalence which suggests that developments in

SURY crowd out SPY one-for-one, so that CAY=SPY+SURY-IPY is unaffected. [v] Reasoning in the Feldstein-Horioka vein on the other hand suggests that the shocks to SURY+SPY are matched by IPY in closed economies, so again the current account is unaffected. One may conclude that necessary conditions for "twin deficits" to emerge is the absence of Ricardian equivalence *and* financial openness. Any finding of twin deficits, therefore, must be interpreted as an indirect sign of financial openness.

Ultimately, the hypothesis needs to be resolved empirically. Evidence in its favour is offered by Abell (1990) and Kasa (1994), among others, while Friedman (2000) and Ahmed and Rogers (1995), for instance, are more sceptical. At the same time, as the work of Kearney and Monadjemi (1990) and Argimon and Roldan (1994) emphatically points out, there may be reverse causality between the two. This will, for instance, be the case if governments utilise their fiscal stance to target the current account via (2) (Summers, 1988). Though implying the opposite causal order to "twin deficits", current account targeting may also be interpreted as a sign of an open economy, since it also implies that the external balance is ultimately affected by the budget. Thus, the degree of causal link between the two balances, of whatever direction, is a measure of financial openness.[vi]

Our discussion of openness may be supplemented by the relation of the current account to the real interest rate, given an exogenous surplus. We can use the simple framework of Coakley *et al.* (1996) to illustrate its implications for causality. Accordingly, let the current account ratio of country j be a linear function of R:

$$CAY_{j,t} = \alpha_j + \beta R_{j,t} + \sum_i \phi^i \varepsilon_{j,t-i} \qquad (3)$$

where $\alpha_j<0$, β and $0<\phi<1$ are parameters (the former subsuming the exogenous budget surplus). The geometric sum at the RHS captures all the primitive shocks (productivity and spending) affecting the current account. (In the diagrammatic representation of the "scissors" of IPY(R) and SPY(R), the ε_{t-i}'s would be exogenous shifts of the schedules.) In a closed economy, $CAY_{j,t}=0$ for all j and t, implying:

$$R_{j,t} = \frac{-\alpha_j - \sum_i \phi^i \varepsilon_{j,t-i}}{\beta} \qquad (4a)$$

In this case, the exogenous process generating the current account also determines the real interest rate and causality runs from the former to the

latter. In contrast, in open economies, there is a common real interest rate that clears the global market for (flow) loanable funds, implying:

$$R_{j,t} = R_t, \quad \forall j, \qquad R_t = \frac{-\sum_j \alpha_j - \sum_i \phi^i \sum_j \varepsilon_{j,t-i}}{\beta} \qquad (4b)$$

Hence, the real interest rate is determined by processes generated largely elsewhere, and therefore causes individual-country current accounts via (3).

Consequently, the real interest rate will be exogenous for small open economies, but will be caused by current account developments in large, nearly closed economies. The real interest rate can provide additional information when the budget surplus is present: For example, cointegration and causality from the budget deficit to the interest rate would imply that the domestic saving market clears and that the budget deficit crowds out private saving via the interest rate as befits a closed economy. [vii] Causality from the real interest rate to the surplus may be interpreted as evidence of fiscal stabilisation policy at work with the real interest rate as the target variable[viii].

3. EMPIRICAL EVIDENCE

Based on the above analysis, we proceed to examine empirically the interrelationship between the external and budget balances and the real interest rate for 7 industrialised economies with post-war quarterly data.[ix] Our dual aim is to characterise the interaction between the two balances and to find evidence on the degree of effective openness of the economies during the sample period. The sample of countries is representative in the sense that they range from small open economies to larger ones like the USA or Japan. The series used in the construction of our variables were obtained from the IMF *International Financial Statistics*.[x] After examination of the order of integration of the series (current account ratio CAY, budget surplus ratio SURY and real interest rate R), we examine both the long-run (cointegrating) relationships and associated causal ordering and the short-run interactions among the variables in question.

The empirical results are reported in Tables 1-5; instead of presenting them by Table, we comment on the full picture by country later on. Orders of integration are given in Table 1. In a number of cases, the current account ratio is an I(1) variable, possibly suggesting that external solvency is violated

(see above). However, this result may alternatively be due to the finiteness of our sample.

Table 1: ADF tests

Country	Variable	Trend?	Lag	t-stat	result
Australia	CAY	N	0	-2.87	I(1)
	SURY	N	4	-2.35	I(1)
	R	N	4	-1.30	I(1)
Canada	CAY	N	0	-3.17	I(0)
	SURY	N	4	-2.30	I(1)
	R	N	4	-2.12	I(1)
Germany	CAY	N	0	-3.40	I(0)
	SURY	N	4	-3.13	I(0)
	R	N	3	-4.05	I(0)
Japan	CAY	N	1	-3.51	I(0)
	SURY	Y	3	-3.28	I(1)
	R	Y	4	-2.84	I(1)
Netherlands	CAY	Y	4	-3.02	I(1)
	SURY	Y	3	-2.41	I(1)
	R	N	0	-9.06	I(0)
UK	CAY	N	1	-2.64	I(1)
	SURY	N	4	-3.11	I(0)
	R	N	4	-1.26	I(1)
USA	CAY	N	0	-2.40	I(1)
	SURY	N	4	-2.19	I(1)
	R	N	4	-2.64	I(1)

Notes: Critical value with a deterministic trend: -3.46; without a trend: -2.88. The lag length was determined by the significance of the longest lag, testing down from a maximum of 4.

Table 2: Cointegration results

Country	VAR length	Max Eigen. stat	Trace stat	No. of vectors
Australia	4	17.60	25.71	0
Canada	2	13.85*	21.23**	1
Germany	4	-	-	0
Japan	4	21.97**	24.79**	1
Netherlands	4	17.87*	23.17*	1
UK	6	15.77*	18.46*	1
USA	6	23.01**	33.26**	1

Notes: The VAR length was determined by the Adjusted LR test. ** indicates significance at the 5% level and * significance at the 10% level.

In all cases except Germany, two variables are I(1), allowing us to search for cointegration based on Johansen's (1988, 1991) test. Note however, that the relevant pairs vary from case to case. Table 2 above gives the cointegration results, established for all cases except Australia. Table 3 lists the cointegrating vectors.

Table 3: Cointegrating vectors

	AU	CA	GE	JA	NL	UK	USA
CONST		0.01				0.03	
TREND					-0.001		
CAY					1.00	1.00	1.00
SURY	NA	1.00	NA	1.00	0.003		-36.59
R		0.28		-1.06		-0.63	-18.11
Sample	1960Q3	1977Q3	1966Q1	1958Q4	1978Q1	1972Q4	1969Q3
	1997Q2	1995Q3	1989Q4	1997Q3	1998Q1	1998Q1	1998Q1

Toda and Phillips (1994) discuss the equivalence between long run causality and weak exogeneity. This is examined by testing whether the loading coefficients in the Error Correction Model (ECM) for each equation is 0 (Urbain, 1992).[xi] The results are reported in Table 4. Finally, short-run (Granger) causality is tested by looking at the block significance of the off-diagonal elements of the lag polynomials in the Vector ECM form of the VAR (Table 5).

A variety of cointegrating pairs and long/short run causal ordering emerges from these Tables, as was expected in view of the diversified nature of our sample. The results for Australia indicate no long-run cointegrating relationship. In addition, the Granger-causality tests show no short-run relationship among the three variables. Therefore, our model does not allow us to derive any conclusions regarding the openness of the economy. Moreover, it seems that there is no evidence supporting the twin-deficit hypothesis.

Canada shows cointegration of the budget surplus with the real interest rate: Their relationship is negative, being in principle consistent with either the budget deficit exerting a positive effect on the real interest rate through the demand for loanable funds, or the interest rate increasing interest payments and the deficit. The exogeneity test shows long-run causality going from the real interest rate to the surplus, supporting the latter hypothesis. This fact, together with the current account ratio exclusion from the vector (since

it is I(0)), is (indirect) evidence mainly of a small open economy, since the domestic variables primarily are influenced by the real interest rate, rather than the opposite. In the short run, there is some evidence of reverse causality and current account targeting, insofar as the differenced current account emerges as significant in the ECM for the budget surplus.

Table 4: Weak exogeneity

Country	CAY	SURY	R
AU	NA	NA	NA
CA	NA	-0.39** (3.65)	-0.20 (1.49)
GE	NA	NA	NA
JA	NA	-0.35** (2.90)	0.18** (2.09)
NL	-0.60** (3.92)	-66.74 (1.27)	NA
UK	-0.10** (2.20)	NA	0.07** (3.21)
USA	-0.001 (0.35)	0.007** (3.02)	0.005** (2.44)

Notes: Shown are the coefficients and the absolute t-statistics (in parentheses) of the Error Correction Term in the relevant equation. ** indicates significance at the 5% level; * significance at the 10% level.

Since no cointegration is evident in Germany, only short-run Granger causality could be examined. The single notable fact is that the budget surplus (mildly) and the real interest rate (quite strongly) influence the current account. However, in the case of budget surplus or real interest rate equations, none of the other variables makes any significant contribution. There is thus consistent short-run evidence of an open economy, whose current account is determined by the exogenous world interest rate developments, and with a twin deficit which adds further weight to the evidence of openness, as suggested above.

The results for Japan imply a positive long-run association between the fiscal surplus and the real interest rate; the positive sign of the relation may be interpreted as fiscal stabilisation whereby the budget deficit is reduced (surplus increased) in order to bring the real interest rate down. The weak exogeneity tests show that there is bidirectional long-run causality between the two variables. A somewhat different type of causality applies in the short run, as shown by the Granger-causality tests of Table 5 below.

Table 5: Granger causality tests

	Variable	CAY		SURY		R	
		LR	F(p, n-k)	LR	F(p, n-k)	LR	F(p, n-k)
AU	CAY I(1)			0.50	0.15	2.51	0.77
	SURY I(1)	0.69	0.21			4.45	1.36
	R I(1)	1.84	0.56	1.44	0.44		
CA	CAY I(0)			0.00	0.00	1.29	1.23
	SURY I(1)	5.54**	5.49**			2.01	1.93
	R I(1)	0.87	0.83	0.21	0.20		
GE	CAY I(0)			9.12*	2.04*	14.31**	3.31**
	SURY I(0)	4.67	1.02			1.35	0.29
	R I(0)	5.14	1.13	2.10	0.45		
JA	CAY I(0)			0.62	0.18	0.31	0.09
	SURY I(1)	1.88	0.55			8.56**	2.61*
	R I(1)	19.65**	4.60**	8.05*	1.75		
NL	CAY I(1)			13.06**	4.20**	0.99	0.88
	SURY I(1)	2.40	0.73			0.07	0.07
	R I(0)	3.45	1.02	3.46	1.03		
UK	CAY I(1)			5.34**	4.82**	4.96	0.89
	SURY I(0)	13.65**	2.45**			7.69*	1.34
	R I(1)	23.34**	4.62**	10.76**	9.98**		
USA	CAY I(1)			8.34	1.47	1.79	0.31
	SURY I(1)	2.74	0.46			21.87**	4.01**
	R I(1)	0.95	0.16	8.13	1.44		

Notes: This Table reports the results of variable exclusion tests. Rows indicate regressions. The variables in the 3rd column are the LHS variables; whilst the regressors are shown at the top of columns 4-9. The order of integration of variables is indicated in column 3. In the case of I(1) LHS variables, the results are based on the relevant ECM equations; in the case of I(0) LHS variables, the results are based on the VAR in differences of the order given for the levels-VAR in Table 2 minus 1 (except for Canada where one more lag was added). The statistics shown are the Likelihood Ratio (LR) and F-test statistics of exclusion of the relevant regressor from the equation. ** indicates significance at the 5% level; * significance at the 10% level.

It is evident that the real interest rate is caused mainly by the current account and it causes the fiscal surplus ratio. Hence, these results offer

mixed evidence on the degree of financial openness of the Japanese economy. The signs of fiscal stabilisation and short-run current account influences on the real interest rate may be interpreted as signs of a large, rather financially insular economy. According to Granger-causality tests, there is no evidence supporting the twin-deficit hypothesis or the current account targeting hypothesis.

In the case of the Netherlands, it is the two balances that are related in the long term. As argued above, this relation is *prima facie* evidence of openness. While long-run causality goes from the budget surplus to the current account, the cointegrating vector implies a negative long-run relationship, which is consistent with current account targeting. The differenced SURY enters very strongly and positively the ECM for CAY, lending support to the twin deficit hypothesis in the short run. The real interest rate does not significantly enter either ECM, but the opposite is equally true: Neither CAY nor SURY influence R which then appears exogenous both on these grounds and on the fact that its nature (I(0)) is very different to the other two variables. Hence, Netherlands shows signs of capital market openness; more cautiously, one may also suggest that the budget balance affects the external balance, so much so that the budget surplus is used as an instrument for current account targeting.

The UK experience is rather different: The sign of the cointegrating vector over CAY and R suggests that the influence runs from the latter to the former – one may think of the textbook "scissors" diagram of saving and investment against the real interest rate. The exogeneity test, however, suggests there is bi-directional long-run causality. A wealth of short-run interactions is also evident from Table 5, with both balances affecting each other and collectively the interest rate. Thus, over the whole sample, the UK gives mixed evidence as to financial market integration, showing less openness than may be justified by its size and lead in financial market liberalisation (see below). One may interpret this finding as showing that because London is a strong financial hub internationally, domestic saving market development unusually affected real interest rates in the UK.

However, further scrutiny of the UK case is desirable: The UK has been among the pioneers of lifting international capital controls and of financial market liberalisation, starting from the late 1970s. A Chow test of the same ECM for R run over 1972Q4-1984Q4 indicated structural instability; the same ECM for the remainder of the sample (1985Q1-1998Q1) when liberalisation was well under way, reduced the t-statistic of the EC term in the equation of R to 1.89, down from 3.21 and significant only at 10%. Hence, there are signs that towards the end of the sample period, the UK developed more into a small open economy in integrated international financial markets.

The cointegration tests for the US show a long-run association between the two ratios and the real interest rate. The signs in the cointegration vector are consistent with a number of hypotheses, namely twin-deficits, interest rates affecting the budget surplus, and a direct positive relation between real interest rates and the current account. However, the twin deficits hypothesis is not supported by the insignificant negative coefficient in the current account equation of the ECM; it is not supported in the short run either, as shown by the insignificance of the lagged SURY terms in the CAY equation in Table 5. Based on the significance of the ECT in the interest rate equation and budget surplus equations, we conclude with the classification of the US as a closed economy and one where either of current account and real interest rate targeting is pursued by the fiscal balance. The last conclusion is also evident in the short run.

4. CONCLUSIONS

The aim of this paper is to quantitatively examine international capital mobility in a group of 7 industrialised countries in the post-war era. We argue that interactions among the triplet of variables, current account ratio, budget surplus ratio and the real interest rate, may offer richer information on the degree of international capital mobility than simply examining the relation between saving and investment, as has mainly happened so far. Our method of work is to examine causal relationships, as suggested by Argimon and Roldan (1994) and Levy (1995) as a way of avoiding the weaknesses of Feldstein-Horioka-type correlations. Thus, our contribution is to offer evidence on financial openness and evaluate it based on a unified discussion of hitherto rather disparate theoretical arguments.

These arguments are formalised via a number of well-known hypotheses which are also interesting in themselves. The "twin deficits" hypothesis would imply a causal ordering from the budget deficit to the external deficit, while the "current account targeting hypothesis" (Summers, 1988) argues that external adjustments may be sought via fiscal policy, in which case reverse causality prevails. We argued that each of the above gives indications of financial openness. The link between the two balances would be entirely denied by Ricardian equivalence and, perhaps more plausibly, in an effectively closed economy. Furthermore, the interactions between the two balances, primarily the external one, and the real interest rate may reveal the extent to which the country in question is effectively integrated in world financial markets. In a closed economy, the real interest rate is domestically determined by the need to clear the (flow) market for loanable funds, while in

an open one, it is given exogenously. This insight is essentially an extension of the original one by Feldstein and Horioka (1980). Accordingly, causality runs from the current account and secondarily the budget surplus to the real interest rate in a closed economy, while the opposite holds true in an open economy.

We examined these hypotheses by establishing cointegration among the I(1) variables and examining the causal ordering among them in the short and long runs. As expected by the nature of our industrialised country sample, a variety of experiences shows up in our results. A number of economies emerge as fairly open, notable Canada, Germany and the Netherlands, while the UK showed signs of progressively becoming more integrated in financial markets later on. Signs of being large and more financially closed economies were present for Japan and the USA; both are able to affect their real interest rates by domestic fiscal policies and have actually pursued such policies during the sample period; the US also shows signs of current account targeting. The "twin deficits" hypothesis is upheld only in the cases of Germany and the UK and only in the short run. Note, however, that the "opposite" hypothesis of current account targeting carries some weight in the case of Canada in the short run. Finally, regarding the relation between the two balances, the Netherlands presents a puzzle: There is some evidence consistent with current account targeting according to the sign of the cointegrating vector, a result not supported by the long-run exogeneity tests.

NOTES

[i] Those findings have been corroborated by a large subsequent amount of literature; as a recent example, see e.g. Levy (2000) which uses long US time series. Obstfeld (1986, 1995) and Coakley, Kulasi and Smith (1998) provide good surveys.

[ii] There is also the ambiguity of how much importance to attribute to the slope vs. intercept estimates in the original Feldstein-Horioka regression of investment on saving; see Sachsida and Caetano (2000).

[iii] Testing for causality as a means of characterising economic openness has also been followed by Tsoukis and Alyousha (2001) with mixed results.

[iv] For instance, in Argimon and Roldan (1994), 4/9 countries show no saving-investment cointegration; a similar finding is reported in Alyousha and Tsoukis (2000).

[v] Deficits induced from the tax side leave the consumption behaviour of the private sector unaltered and, by (2), should not show up in the current account. On the other hand, private agents realize that deficits generated by bigger spending show up as increased lifetime tax

burden and reduced private resources, in which case they cut consumption commensurately. The result again is that the LHS of (2) is unaltered.

[vi] Note that Levy (1995) shows that endogenous fiscal policy predicts a lack of Granger causality from private saving to private investment, which (along Argimon-Roldan lines) is more indicative a of a closed economy. Investigation of this point, however, is beyond the scope of this paper.

[vii] Note that Dwyer's (1985) "capital inflow" hypothesis, advanced to explain the US experience of the 1980s, suggests openness, in that a budget deficit is paired with capital inflow and an external imbalance; and, at the same time, it indicates a large economy which can affect the world real interest rate. Both elements can in principle be picked up in our framework, which can characterise experiences in a richer way than the "open-closed" continuum of the Feldstein-Horioka-type correlations.

[viii] Theoretical work along the lines of the intertemporal approach to the current account (see Obstfeld and Rogoff, 1996) has suggested that the current account may potentially anticipate and therefore cause other variables, including the budget deficit and the interest rate. If so, our results would be biased towards showing causality running from the current account to the other variables. However, the empirical relevance of this argument is unclear; see Obstfeld and Rogoff (1996) for a review.

[ix] The countries are Australia (AU), Canada (CA), Germany (GE), Japan (JA), the Netherlands (NL), the United Kingdom (UK) and the United States (USA). The sample periods are indicated in Table 3. For Germany, the sample was restricted only to end of 1989 since there is evidence of a structural break in the saving ratio during 1990 following the reunification; the graph is available on request.

[x] The series were nominal interest rate 60, budget deficit 80, private consumption c (line 96f), government consumption g (91f), investment i (gross fixed capital formation 93e+change in stocks 93i), nominal and constant-price GDP (99b & 99b.c) and GNP (99a). Then DEFL≡99b/99b.c, CAY≡(GNP-c-g-i)/GDP, SURY≡80/GDP and R≡60(series)/400-(DEFL-DEFL(-4))/(4*DEFL(-4)). The US data are given slightly differently as government consumption+fixed capital formation (91ff) and private fixed capital formation (93ee). The data is seasonally adjusted at source.

[xi] The full ECMs will not be shown for economy of space. The results are available on request and will be commented upon in the text.

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Chapter 6

THE DETERMINANTS OF FOREIGN DIRECT INVESTMENT:

A Panel Data Study for the OECD Countries

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Abstract: This study examines panel data evidence concerning empirical relevance between Foreign Direct Investment (FDI) attraction and its determinative effects. The main bulk of FDI is among the developed countries. Indeed, OECD countries has probably been the most potential group in undertaking FDI by caring out about 95% of the total outward FDI while, on average, 75% of the world FDI was directed into OECD countries. In this paper, we first present and analyse the theoretical/empirical findings on FDI, then we focus on assessing the relative significance of the factors that may attract FDI via a panel data regression analysis for a sample consisting of 20 OECD countries for 23 years (1975-1997). Our findings suggest that certain variables such as human capital and trade regime, as well as, the density of infrastructure appear to be robust under different specifications. Positive significance of the agglomeration factor is also observed, confirming the relevant theoretical propositions. However certain deferential variables, such as the governmental policy effect, could not be fully captured due to the statistical homogeneity of the sample.

Key words: Foreign Direct Investment, Panel Data Analysis

1. INTRODUCTION

Cross-border investment is considered to be one of the most striking features of the global economy. The determinants, the growth enhancing effects, the motivations towards the formation of FDI (Foreign Direct Investment), as well as, the undertaking and attraction policies, have been topics of intensive research in the last two decades. Foreign direct investment

is broadly defined as capital flows resulting from the behavior of multinational companies (MNCs). Thus, factors that may affect the behavior of MNCs could also affect the magnitude and the direction of FDI. MNCs expand their activities abroad for a variety of reasons including, among others, the exploitation of economies of scale/scope; the use of specific advantages (Hymer, 1976); often due to a life-cycle pattern of their products or simply because their competitors are engaged in similar activities. On the other hand, governments are also engaged in a policy competition by altering key factors of their economic policies, such as domestic labour market conditions; corporate taxes; tariff barriers; subsides; privatization and regulatory regime polices, in order to enhance FDI activity in their countries.

Although the interest on the FDI effects was originated in the mid-fifties, when the first growth models appeared (Solow, 1956), the extent of multinational activities has significantly augmented over the past two decades, implying FDI as a desirable element for economic development, mostly because it is characterized by a combination of capital, technology, marketing[i], entrepreneurship and human resources management. Romer, (1993) also underlines the influential role of FDI in transferring such factors across countries and economic regions, and more specifically, he considers FDI as one of the contributory factors in the diffusion, dissemination of knowledge and assimilation of technologies and ideas. FDI often takes the form of capital flows from a parent company to its foreign affiliate, an activity that is considered to be (i) transferring technical factors from a region to another; (ii) substituting capital movement with labor mobility in host regions and (iii) capitalizing domestic markets and thus reducing or eliminating their imperfections. FDI can be either inward when foreigners purchase assets into the home economy or outward when home citizens purchase assets abroad. Among many analysts who tried to analyse the causality effects of FDI, Ethier (1986) suggests that uncertainty together with information may act as a stimulus for FDI.

Barrell and Pain (1997), tried to examine the relative rise over time in the world trade share accounted by multinational enterprises (MNEs), and found that the aggregate stock of FDI as a percentage of the total estimated output in the OECD countries increased dramatically from 4.75% in 1975 to 10% in 1995.

In recent years, many nations lunched an open door policy towards FDI, in order to capture the growth enhancing effects of FDI on investment, employment, productivity and economic development in general. The approaches towards the formation of FDI activity differ between the US and the European countries and they are subsequently different even within the borders of the EU[ii]. The European integration process and especially the

Single Market Programme (SMP) has affected positively the intra-EU FDI, either directly with the removal of capital controls, or indirectly by increasing the level and growth of the overall economic activity. It is estimated that the European Internal Market has increased intra EU FDI stocks for the UK and Germany 8%-14% or around 0,5% of EU GDP at constant 1990 prices (EAG, 1996 and Barrel et al., 1997). The USA and Japanese inflows into the EU have also been higher, mostly with the form of opening subsidiaries in EU countries, in their attempt to overcome the external barriers of the European integration Progress. OECD countries has probably been the most potential group in undertaking FDI between 1980 and 1995, by caring out, on average, about 95% of the total outward FDI, while EU-15 had a share of about 44% in this period (Barrell and Pain, 1997). On the other hand, about 75% on average, of the world FDI was directed into OECD countries and about 15% in EU-15. Clearly, not only there is a rapid increase in FDI worldwide but also the main bulk of FDI is among the developed countries (Barrell et al., 1997).

Given this major extend of FDI activity across OECD countries; we focus our paper into assessing the relative significance of the factors that may attract FDI into OECD countries. Indeed, this paper aims to explore the empirical evidence for FDI attraction and its determinative effects, by assessing and quantifying empirically these determinants for a data set that covers 20 OECD countries and runs from 1975 to 1997. Section 2, analyses the relevant theoretical background in order to sustain our study. Section 3, briefly reviews the literature on the determinants of FDI. Section 4, describes the data, as well as, the model specifications and outlines the empirical methodology. The analysis utilizes a panel-data study method in order to provide an extended specification of our empirical model and to evaluate more effectively the total average effect of determinative variables on FDI concentration. In Section 5, we discus our results. Finally, Section 6 concludes our paper.

2. THEORETICAL BACKGROUND

The related literature can be broadly divided in two branches: the first one examines the impact of FDI in economic growth; while the second branch focuses on the determinants of FDI.

Let us, first, start with the growth effects of FDI. According to this branch of research, it is important to investigate the precise nature of the relationship between FDI and economic growth; the preconditions for FDI to promote growth and the identification of the mechanisms through which growth can

be achieved. One of the first approaches is the Neoclassical Growth Theory. Solow (1956) attempted to express a growth model into a simple production function and to explore "key" variables that could provide steady growth rates. In his models, he captures variables determining FDI in growth rates. On the other hand, within the Endogenous Growth Theory, FDI flows may contribute either directly or indirectly into the economic growth of an economy. Wang (1990) discerns the effects of FDI activity into direct positive home-country effects, by stepping up production and transferring knowledge to local suppliers and indirect effects by upgrading the quality of their workforce. FDI is considered to be the major source of economic growth for the less developed countries (Balasubramanyam et al., 1996) while relative similarities are also observed in EU. Indeed, FDI inflows have contributed to the EU economic growth since foreign affiliates exhibit relative greater propensity to undertake R&D expenditures and the relative higher productivity while undertaking investment in EU than in their domestic market (Barrel et al., 1997). Moreover, Barrel et al. (1997), using a model of labour-augmenting technical progress, estimates for the period 1972-1995, that around 30% of the growth of the British FDI manufacturing productivity is attributed to the FDI inflows. Blomstrom and Kokko (1996) argue that there are evidence suggesting the enhancing effects of FDI on host country's employment and output rates and a significant potential spillover-effect towards local firms in host regions. Girma and Wakelin (2002) examining whether productivity spillovers from FDI activity occur in the UK economy, found that positive spillovers from MNCs occur to domestic firms in the same sector and region as the foreign affiliates. Moreover, their findings suggest that domestic firms may gain more from these spillovers if the technology gap they have from foreign firms is low. Other studies have also found that FDI affects recipient country's economic growth through new inputs (Feenstra & Markusen, 1994), through new technologies and the subsequent spillovers to domestic firms (Krugman, 1979) and through knowledge transfers (de Mello and Sinclair, 1995). The advent of endogenous growth theory (Romer, 1990, Barro & Sala-i-Martin, 1995) has enabled research into channels through which FDI can be expected to promote growth in the long run.

The second branch of literature on FDI, attempts to illustrate the basic set of determinants controlling the motivations for cross-border investment. Early evidence expressed by Mundell (1957) attempt to explain FDI in terms of relative factor endowments and relative factor costs. Mundell (1957) concludes that in the presence of barriers to trade and migration, as well as, with the existence of large differences between capital-rich and capital-poor countries, the incentive for capital flows is greater. The geographical

distribution of new investments, however, suggests that FDI does not target only low GDP-level and low-wage countries. According to IMF, the intra-EU FDI flows account for 4.5% of EU GDP in 1995, evidence suggesting that more additional explanatory variables affecting FDI should be incorporated in a general equilibrium model. Within this framework many researchers incorporated additional variables that are assumed to affect cross-boarder investment decisions, such as, the market size; domestic labour market conditions; cultural and language differences, exchange rate stability; as well as, governmental and geographical indicators. Recent empirical studies stress the role of corporate restructuring and macroeconomic evaluation of FDI cash-flows and analyze factors such as, financial incentives, and political instability. Ex- Posterior theories consider more complicated aspects of the matter and have pointed out the importance of product differentiation; the existence of imperfect competition or trade costs and economies of scale in investment choice; the capacity of the domestic market share from indigenous firms, educational variables and the role of human capital accumulation (Krugman, (1991), Krugman and Venables (1995), Benhabib and Speigel (1994)). Cheng & Kwan (2000) argue that none of the educational variables expressed as percentage of population with primary high education, has positive significant effect on FDI. Other studies attempt to analyze the role of governmental policies, trade regimes and financial market capacity in taking FDI decisions. Also, empirical studies suggest several measures that a government should take in order to attract FDI including tariffs (Barnes and Davidson, 1994), taxes, subsidiaries (Rains and Brown, 1999), regulatory regime and revitalization policy (Curwen, 1997). Others, suggest that unit labour cost may be a significant factor (see e.g. Barrell and Pain, 1999a) suggesting that 1% increase in the relative unit labor cost in USA could result in 0.89% increase in FDI inflow in EU.

3. THE DETERMINANTS OF FDI

The purpose of this section is to provide a brief survey of the possible locational variables, identified, here, as potential factors in influencing foreign investment decision, assuming a priori homogenous economic consideration. The most intrinsic characteristics in order to define FDI is to analyze its determinants, such as the market size; market growth; economic development; agglomeration; urbanization; human capital; labor costs; governmental and integration policies etc. Each of the above factors determines the applicability of investing abroad.

At this point we find it necessary to mention that the well-documented relationship between FDI and growth is an interactive process. Not only FDI promotes output levels in the host economy but also the level of economic development, as a determinant, plays a significant role in attracting FDI. Theoretical and empirical evidence consider two mechanisms playing an important role in attracting FDI: (a) the market size and (b) the level of economic development.

The former permits economies of scale exploitation and standard production factor specialization, resulting in cost minimisation and market growth, consequently, improving the total supply side (services and inputs) in the host economy. Bhasin et al (1994) followed by Morrissey and Rai (1995), claims that the size of the domestic market, as well as, growth prospects of recipient economy are highly taken into consideration when foreign investors relocate production in the host country. The later argue that international agreements on trade and investment also affect the volume and direction of FDI flows. Jeon (1992) and Wang & Swain (1995) use profitability rates as a sensor for growth level and consequently, as an explanatory variable for FDI, concluding that there exist statistical segnificance and positive linkage between the two measures. Agarwal (1980) points out that FDI is considered to be a function of output or sales of foreign firms in the host country. This is usually approximated by the size of market –either the absolute, captured by the level of GDP (Bandera and White, 1968), or the relative, expressed by the growth rate of GDP[iii]- of the host country. In the meanwhile other researchers used both measures to show that level of development and market capacity play a decisive role in attracting and positioning FDI (Wang and Swain, 1995.

The second mechanism in attracting FDI inflows concerns the stage of economic development and the so-called Investment Development Path (IDP) of the recipient country (Barrell & Pain, 1998). A well-developed existing market infrastructure is expected to support FDI decisions (De Menil, 1999). Major studies encounter and measure IDP rates using GDP per capita proxies. For instance Agarwal (1990) and Mainardi (1992) emphasise the level importance and growth prospectus of the real per capita GNP per se and the role of real GDP growth in taking investment decisions in a region. Head & Ries (1996), Cheng & Kwan (1999), use infrastructure factors, proxied by road constructions (km/km^2 of land mass), and additionally the regional income as potential variables for FDI attraction.

Another important supply condition, that is considered to be promoting labour-intensive and export-oriented FDI, is the human capital both in terms of quality and availability. In this the capital stock created by investing over and above the depreciated capital, expands the productivity potentials of a

firm or a country and enables FDI growth enhancing effects (De Mello, 1997). This, however, presupposes a minimum human-capital efficiency level and assumes that further training is attainable. However, empirical literature concerning the impact of educational level on inbound FDI appears to be counter-intuitive. Cheng & Kwan (2000), for example, argue that none of the education variables (expressed as percentage of population with primarily and high education) has a positive and significant effect on FDI, while Cheng & Zhao (1995) report similar results. Guntlach, (1995) argues that the poor explanatory power of human capital accumulation is attributed to the fact that education creates externalities and spillover effects in production, which are hard to capture using standard set of variables. More explanatory power can be achieved by identifying the role of human capital augmentation, rather than human capital accumulation, which may be poor explanatory variable in growth models because the crucial role of educational variables is difficult to be captured in using standard growth accounting.

Recent literature puts forward agglomeration effects as a significant factor of attracting FDI. Venables, (1996a) argues that agglomeration economies arise from the presence of other firms, other industries, as well as from the availability of skilled labour force. Empirical evidence evaluating agglomeration effects is limited though, partly because of data limitations and difficulties in obtaining definite statistical specifications. Wheeler & Mody (1992) found that the US FDI is attracted by the size of the total inward investment. Head et al (1995) using plant-level data argue that the locational FDI attraction in a sector is mostly determined by the location of existing firms in that industry. Barrell and Pain (1999a) point out that the FDI in Europe is attracted by agglomerations proxied by market size and a 5-year moving average of stock manufacturing patterns, among other determinants such as relative costs, technology and integration. Finally, Braunerhjelm and Svensson (1998) show that FDI is highly sensitive in agglomeration patterns.

Governmental policies could also be important determinants of FDI flows since governments consider FDI flows as means to fight unemployment and to enhance national growth rates. Governmental policies can take a variety of forms such as tariffs, taxes, subsidies, regulatory regime and privatisation policy. For instance a relative increase in tariffs or taxes rates in the host country is expected to raise the cost of investment, resulting in eliminated profitability rates. Cheng & Kwan (2000) having examined empirical evidence on governmental capabilities and recourses found that governments are major catalysts for economic restructuring and location attraction of inward FDI. Indeed, when the Chinese government launched an open door policy, China has emerged as the second largest recipient in the world (after US) since 1993. Morrisey and Rai (1995) point out the institutional features

of the recipient economy and the degree of political intervention as a catalyst for economic restructuring and hence as a potential determinant of FDI.

Table 1: Determinants of FDI - Summary

Determinant	Possible Proxy Variable	Effect
Market Size, Market Growth,	GDP, GDP Growth Rate	+ + +
Level of development	GDP per Capita, GDP per Capita Growth Rate	+ +
Urbanisation	%age of Urban Population	+
Human Capital	Secondary School Enrolment Ratio	+/-
Agglomerations	FDI Lagged One Period	+
	Number of Firms in the Region	+
	GDP	+
Economic Integration	Member of Economic-Political Union	+
Governments, Trade Regime	(Exports + Imports) / GDP	+
	FDI as a fraction of GDP	+
	Infrastructure (Roads)	+
Labour Costs	Wages and Salaries	-
Exchange Rate Variability	Absolute / Relative Change in Real Exchange Rate	+/ -
Political Instability	Foreign Debt as a Fraction of GDP	
Interaction Between The Foreign Investor and the Domestic Firms	R&D	+/ -
	Marketing process	+/-

Notes: The sign shows the net influence of these variables as discussed in the text.

Another possible determinant in attracting FDI inflows is the liberal degree of trade regime. Although there exist obvious difficulties in measuring the above factor, a general positive relationship between a liberal trade regime and FDI, is anticipated. In EU, UK's success in attracting FDI inflows, was founded in three key factors: a) the liberalization of foreign owner regulation, b) the privatisation programme in traditionally state activities (telecommunication, railways, electricity, water), c) the financial deregulation, the "Big Bang" in 1986, (Raines et al., 1999). Bhagwati, (1978) argues that FDI is captivated by countries that implement export promotion than those promoting import substitution policy. Milner and Pentecost (1996) proxy the trade regime as the ratio of exports to sales and sales concentration ratio and report that both variables are found to contribute

positively to FDI. Wang & Swain (1995) examine the case of export-oriented FDI and find positive influence on inbound FDI. Recently, the inherent disadvantage of closed economies is outweighed by the launch of special Export Processing Zones. Cheng & Kwan (2000), for example, found that the Chinese Economic Zones exert a positive and significant influence on attracting FDI.

New political factors have been clearly emerged due to global economic trends such as economic integration among conjuncted nations and trade liberalization all around the world. Recent studies[iv] report evidence that the Single Market Programme (SMP) among the EU countries promoted the level of investment rates within member states. De Menil (1998) states that the EU involves increases in the flow of information and capital, which in turn increase FDI flows.

Pain & Lansbury (1997) report ambiguous results concerning the labour market reforms in UK, which although having reduced the total labour costs, they did not succeed on promoting the anticipated FDI attraction. More specifically UK performed poorly in attracting FDI from those sectors where innovations were growing most rapidly. Cheng & Kwan (2000) report that wage costs have negative effects on FDI, contrary to Chen (1996), who found that labour compensations do not have any influence on FDI and to Head and Ries (1996), who outcome a completely neutral impact of wages.

4. DATA AND METHODOLOGY

In this section we will try to empirically assess the determinants of FDI for the OECD countries. The panel data set used for this analysis covers 20 OECD countries[v] and runs from 1975-1997. The database has been built using a number of different sources. The main source was the World Bank CD-Rom: World Development Indicators (1999), while data from the IFS-IMF (various issues) were used for the construction of the FDI over GDP ratio and data from other national sources (in companion with the World Bank CD-Rom) were used for the construction of the physical infrastructure proxies. All values used in the analysis are expressed in US dollars in real terms. The scope of the model, although being formulated at a relatively aggregated level, is to consider the diverse range of influences on decision making in investing abroad.

Since both cross-section and time-series data are available, we estimate equations, which take the following form:

$$y_{it} = \mu_i + \gamma x_{it} + \varepsilon_{it} \qquad (1)$$

where the pair of terms (i, t) expresses the transversal and temporal aspects of the per country panel data, y and x are respectively the dependent variable and the matrix of explanatory variables, and μ_i is a parameter specific to each country[vi]. The latter parameter (which varies only across countries and not over time) is introduced to take account of unmeasured features specific to the countries concerned. The set of independent variables is measured prior to the investment decision. This approach allows overcoming the problem of endogeneity when examining macroeconomic flows (Baltagi, 1995).

In the light of the previous analysis in Section 2 above, and in order to assess the influence of the variables described, a foreign investment equation may be built up in the following linear form:

$$(FDI/Y)_{i,t} = \mu_i + \beta_1 GY_{i,t-1} + \beta_2 y_{i,t-1} + \beta_3 (FDI/Y)_{i,t-1} + \beta_4 Gexp_{i,t-1} + \beta_5 h_{i,t-1} + \beta_6 Open_{i,t-1} + \beta_7 Road_{i,t-1} + \beta_8 Rail_{i,t-1} + \varepsilon_{it} \quad (2)$$

where $(FDI/Y)_{i,t}$ denotes the share of FDI to GDP for each country; so obviously Y is real GDP, GY denotes real GDP growth and y is GDP per capita (both introduced as indicators showing the level of development, the size of the market, and the growth potential of each country), lagged share of FDI is introduced to take into consideration the existence of agglomeration effects. Moreover, the implications of this variable are not only confined to agglomerations but also signal the absorbing capability of a host country. We expect a positive influence of this variable. The role of policy measures is captured by *Gexp*, which denotes government expenditures.[vii] The Openness of the economy (trade regime) is captured by the variable named *Open*, which is defined as the ratio of trade flows (exports plus imports) over GDP (macroeconomic variables that are expected to have effect on the location of FDI). Next, we consider the set of skills possessed by the workers in the economy, i.e. we include human capital proxies in our equations. Hence, h denotes the level of human capital measured as the ratio of pupils enrolled on secondary education over the total active population (aged between 15-65). Finally, *road* (percentage of roads paved) and *rail* (railway network proxy) are variables measuring the physical infrastructure of each country. To our knowledge these variables have not been used before when studying the determinants of FDI using longitudinal data. The scope of these variables is to assess the role played by the quality and the concentration of infrastructure. These variables can also signal the level of development and the population distribution of the host country. In principle, an extensive network promotes trade within the country and helps a foreign investor to gain access to separate or different markets at the lowest cost.

5. EMPIRICAL RESULTS

We consider equation (2) by using three different methods (namely common constant, fixed and random effects), in order to test our data sample under different specific-country characteristics estimations. The panel consists of 20 countries, and runs for a time span of 22 years (we miss one observation due to the lags introduced in the equation). The total number of observations is 440, which is sufficient to produce robust estimates. Note also that T and N are sufficiently large and of the same magnitude. The estimated results are summarised in Table 2.

Table 2: The Determinants of FDI – Empirical Evidence from a Panel of OECD Countries

Dependent Variable: $(FDI/Y)_{i,t}$

Sample: 1976 – 1997; T=22; N=20; Total panel observations: 440

Variable	**Common Constant**	**Fixed Effects**	**Random Effects**
Constant	-0.151	-	-0.027
	(-0.180)	-	(-0.046)
$GY_{i,t-1}$	3.126	4.132	1.938
	(2.261)*	(2.810)*	(1.500)
$y_{i,t-1}$	0.254	0.244	0.164
	(3.387)*	(1.586)	(2.886)*
$(FDI/Y)_{i,t-1}$	0.673	0.528	0.831
	(17.16)*	(11.50)*	(27.75)*
$Gexp_{i,t-1}$	0.004	0.005	0.002
	(0.793)	(0.893)	(0.465)
$h_{i,t-1}$	16.63	8.896	12.66
	(3.554)*	(1.109)	(4.111)*
$Open_{i,t-1}$	0.579	0.972	0.334
	(3.760)*	(1.538)	(3.927)*
$Road_{i,t-1}$	0.002	0.004	0.002
	(1.486)	(0.426)	(2.314)*
$Rail_{i,t-1}$	0.146	0.126	0.092
	(3.138)*	(0.712)	(3.323)*
R-squared	0.618	0.653	0.575
Adj. R-squared	0.609	0.629	0.566
D-W Stat	2.176	2.172	1.906

Notes: Values of t-statistics in parenthesis. * denotes statistical significance at the 95% level.

Column 2 presents the results under the assumption that there are no differences between the economies, which is not implausible since our sample consists of a homogeneous group of countries. An important finding is the positive and significant effect of human capital. This is consistent with the findings reported by Cheng & Wang (2000) and Cheng & Zhao (1995)

who adopted the same approach for human capital. Despite the inconclusiveness of previous empirical studies concerning the role played by human capital as described above, and summarized in Table 1, our results suggest that an economy with high fraction of skilled workers is likely to be much more productive and more desirable on behalf of foreign investors.

The catalytic role played by the growth prospects of the recipient economy clearly emerges lending support to the theory and empirical evidence outlined above (see for example Agarwal, 1980 and Mainardi, 1992). Indeed our estimates reveal that investors are influenced by the degree of development and the market size, in terms of GDP per capita and GDP growth. Looking at the Table 2, both coefficients are found to be positively related to the inbound FDI flows and statistically significant at conventional levels. Foreign investors will invest in a country where the perceived profitability of their projects is secured and the signals transmitted by the GDP are good indicators for doing so.

The potential role played by the agglomeration effects turn out be positive and highly significant showing that past experience is very important for the increase of the share of FDI among countries. This implies that the impact of the previous stock of investment creates positive externalities, which is indicative of the present condition and the future prospects of the host country. The US FDI, for example, is attracted by the size of the total inward investment (Wheeler and Mody, 1992) or the location of the firms is influenced by the location of other firms, which invested previously (Head et al, 1995). Our results are also in line with Barrell and Pain (1997,1999b) who using panel data but different proxies (the fraction of national GDP and the ratio of host country R&D stock) report that agglomerations exhibit positive and significant impact on attracting more investment.

A liberal trade regime is positively and significantly associated with the FDI inflows, suggesting that, all things being equal, investors are more likely to invest in the countries which have been opened up to the outside world (Milner and Pentecost 1996). The role of trade is frequently taken into consideration, but it commonly agreed that there are other channels for the diffusion of knowledge and the associated gains in output realised through FDI. It should be noticed here that previous evidence viewing trade as a growth determinant, claims that the role of openness to trade per se is inadequate and does not fully account for the post-war growth in East Asia for example. The experience of Greece is equally illustrative as it shows that trade liberalisation, while necessary is not a sufficient condition for large-scale FDI inflows[viii]. In our study, however, viewing the trade regime from a different perspective, it clearly appears to be a major determinant of the pattern of stocks of FDI. Summarising, in the case of OECD countries and

after controlling for macroeconomic effects the impact of trade is consistent with the evidence discussed in Section 2.

The role of governmental expenditures although has a positive effect on attracting FDI it is not significant. One possible explanation is that the expenditures per se are not a major determinant within OECD countries framework. These countries have attained a certain level of development and the share of governmental expenditures does not significantly fluctuate. Therefore, the incremental governmental expenditure will have a little effect on the probability of inducing a foreign investor to undertake an investment. In our case, it seems that public expenditure does not significantly affect the international cost competitiveness of each country.

One of the two infrastructure indicators, rail is significant while the insignificance of road can be explained by the fact that most of the OECD countries are highly developed and the percentage of roads paved are not that much different among them. This is along the lines suggested by Head et. al (1996) and Cheng & Kwan (1999, 2000) using panel data from Chinese regions, point out the positive role played by good infrastructure (roads). The latter study, however, reports that the coefficient estimates were insignificant, and even with the wrong sign in the case of railways (km/km^2 of landmass).

The above results, however, do not take into account the specific unmeasured features of each country. Thus, we proceed by estimating equation (2) introducing the methods of fixed and random effects. Firstly, we estimate a fixed-effects model that will capture all temporally constant country-level effects. Secondly, we estimate a random-effects model. These estimates are then compared to the previously estimated coefficients using the Hausman test (for a comprehensive analysis of those methods see Baltagi, 1995).

The fixed effects method suggests that only the level of development and the agglomeration effect are significant on the determination of the location of FDI, while the random effects is consistent with the results of the common constant method analysed before. In order to choose among the fixed effects and random effects estimator, econometric theory suggests performing a Hausman (1978) type test of no correlation between the ui and the regressors. The tests gave an χ^2 value of 3.78 which is distributed with $\chi^2(8)$ under the null and it is not significant suggesting that the GLS estimators of the random effects method are the preferred ones.

The random-effects method reports the same results of the common constant method analysed before, with the exception of real GDP growth, as our first method revealed sustaining the robustness of our initial estimates. The results do not dramatically change both in terms of the quantitative impact of the coefficients and the size of their corresponding significance. In

the light of this specification, there is evidence that the rise in GDP per capital increases the absorbing capabilities of the recipient economy. The dominant effect of this factor has been extensively investigated in the literature and our findings confirm that it is of great magnitude in the case of determinants of FDI. The coefficient on the trade regime still remains positive and significant reinforcing its robustness. Similarly, several studies have pointed out to the importance of a liberal trade regime compared to a closed economy regime. Sianesi (1995) using Southeast Asian data examines the role of protectionism as a proxy for trade regime and report that it is negatively correlated with FDI inflows. Pfaffermayr (1994) argues that there is a positive association between FDI inflows and volume of trade among countries and finds that a foreign investor would invest in a country that has strong trade connections. Others using manufacturing data argue that the openness to trade plays a positive and significant role as a destination for companies. To our knowledge the openness to trade is not explicitly taken into account as determinant of FDI and, hence, the associated empirical evidence is limited. Based on the discussion regarding the trade regime and the patterns of FDI our approach shed some light on the previously neglected aspects of FDI.

Both variables regarding the infrastructure are rendered positive and highly significant suggesting that improving stocks of infrastructural capital increase the attractiveness of a country as a platform for multinational investment. An extensive network, apart from the blatant consequences in market growth, also signals the quality level of the host country. It is likely that a large-scale improvement of the physical infrastructure would have been facilitated by the Economic Union's regional and financial aid. Since the vast majority of our sample countries are linked to EU, the positive effect of these variables indirectly reflects the crucial effect of Single European Market or other similar programmes of other Integrated Unions on the pattern of FDI. The robustness of the education variables serving as proxies for labour quality is still evident. Neither the sign nor the significance of the as proxies or labour quality is abolished revealing the strong effect of a skilled labour force. This effect suggests that a highly educated and trained labour force is likely not only to attract labour-intensive investments but also to instigate better performance of the foreign firm and larger labour productivity. Furthermore, since much of the foreign industry is located in high-technology manufacturing sectors the fraction of skilled labour force becomes crucial for the patterns of FDI inflows. The governmental expenditures retain their positive sign yet seem not to exert a significantly positive influence on the FDI inflows. Budget constraints and the fact the global economy fluctuated during the period involved in our sample coupled with the mature stage at

which our sample countries have arrived may account for the insignificance of this specific variable. Barrell and Pain (1997) argue that tighter domestic financial conditions are linked to lower level of foreign investment. Wang and Swain (1995) argue that domestic expenditures exert positive influence but their total impact does not appear robust such as the foreign demand variables such as level of development and size. Finally, the impact of agglomerations and its subsequent implications on the attractiveness of a country coupled with the recent shifts to maturing products (information technology, emerging technologies) and a potential for bringing in more R&D activity in the area of new products, remains relatively large and significant. By boosting agglomerations, the previously undertaken FDI is likely to instigate new techniques, process and products stimulating larger inbound foreign investment.

6. CONCLUSIONS

Despite data limitations, the findings regarding the patterns of inbound FDI in OECD countries offer a potential empirical framework. The significant explanatory factors consist of: a more highly educated and trained workforce, large-scale investment in the physical infrastructure, partly facilitated by the authorities of the corresponding Economic Union in most cases; the level of development and market size as well as the openness to trade and the spillover effects. All these factors are expected to enhance the attractiveness of host countries, representing an additional growth dynamic. Our findings are broadly consistent with the results obtained in the literature on the location of FDI in the US, China and Europe. Adopting a different econometric approach, as far, as the determinants of FDI are concerned and utilising panel data techniques, our main result is that variables such as human capital and trade regime, as well as, the density of infrastructure appear to be robust under the different specifications. In addition, our study confirms the significant role played by the newly emerged factor concerning the agglomerations and contributes to the limited empirical evidence on this area. Given this framework an extension towards including variables dealing with labour costs and political factors will shed more insights into the dynamics of FDI. New technologies and trends may arrive through the dissemination of knowledge transmitted by international trade and foreign investment.

NOTES

i Balasubramanyan et al.(1996)

[ii] Indeed, there are major differences in the Institutional Framework for foreign investment promotion, in nominal and real macroeconomic measures, as well as, in the population distribution and in labour and capital mobility (see e.g. Pain & Young, 1996 and Raines et al. 1999).

[iii] Goldberg (1972) and Petrochilos (1989).

[iv] Arrowsmith et al. (1997) and Pain (1997)

[v] Austria, Denmark, Finland, France, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, Great Britain, Australia, Japan, South Korea, New Zealand, Canada, Unites States

[vi] In fact, we estimate (1) under different assumptions about the structure of our panel data model. The constant is specific to each country only under the fixed and random effects methods.

[vii] Unfortunately due to data unavailability, we cannot include more variables measuring the effects of government policies such as financial incentives or wage effects.

[viii] In Greece, the share of manufacturing FDI relative to GNP remained low and stagnant over the whole period (see, e.g. U.N., 2002).

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Chapter 7

EUROPEAN INTEGRATION AND FOREIGN DIRECT INVESTMENT

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Abstract: This paper uses a gravity model to analyze the separate effects of exchange rate volatility and economic integration, such as membership in the European Union (EU) and participation in the European Monetary System (EMS), on foreign direct investment (FDI). The panel data includes bilateral observations from 23 OECD countries from 1982 to1999. There are two conclusions. First, European integration, such as EMS or EU membership, is found to have a positive effect on intra-EU FDI, even after controlling for the endogenous nature of the exchange rate regime. Second, the total effects of the European Union on FDI can be divided into a customs union effect and an additional EMS, or "pseudo monetary union," effect.

Keywords: Currency Union, European Integration, Exchange Rates, Foreign Direct Investment, Gravity Model, Panel Data.

1. INTRODUCTION

The effects of the European Monetary System (EMS) and the European Economic and Monetary Union (EMU) on foreign direct investment (FDI) continue to attract economists' attention. Did the EMS really boost FDI? Will the EMU boost FDI? These are among the important and unresolved questions regarding the EMS and the EMU.

A closely related theme is the effect of the European Union (EU) on FDI. Since its creation in 1957, many barriers to trade and investment within the European Union have been eliminated. However, exchange rate uncertainty remained a major factor reducing trade and investment within European

countries. A fixed or at least pegged exchange rate system is essential for a unified European market.

The EMS was the first step toward monetary integration. In order to avoid large misalignments among European currencies, the Exchange Rate Mechanism (ERM) of the EMS was established in 1979. One of the stated goals of the EMS was to reduce exchange rate uncertainty in order to encourage intra-EU trade and investment. The EMU represents the most recent stage in this process and national currencies were replaced by the euro.

Although the ERM did not eliminate all currency fluctuations, it attempted to contain them within certain ranges. As such, it could be expected to boost FDI. The total effect on FDI, however, is potentially even larger than only that brought about by the corresponding reduction in short-run exchange rate volatility, given the credibility effects of participation in the EMS or ERM. In this paper, I test this additional ERM effect by estimating separately the effect of reduced exchange rate volatility and that of participation in ERM on FDI. Arguably, membership in the ERM represents a much more serious and stronger commitment to macroeconomic stability than participation in a regime aimed at achieving only a stable exchange rate and nothing more.

This issue has important policy implications. Recently, some Central and Eastern European countries (CEECs) have been preparing to enter the EU. Following the European Union's summit in Nice on December 11, 2000, the EU began preparing to admit 12 new members. One question that arises is how much more FDI the CEECs or Greece—which joined the EMU at the beginning of 2001—can expect to receive as a result of their memberships in the EU or EMU.

Recently, some studies have been done about how membership in a currency union can increase trade and income per capita. Rose (2000) finds that two countries trade three times as much when sharing the same currency as they would if using different currencies. Frankel and Rose (2000) find that joining a currency union has a positive effect on a country's trade and income per capita. Parsley and Wei (2001) find that it also has a positive impact by institutionally stabilizing the exchange rate on goods market integration. So far, however, no empirical study has considered the effect of a currency union on FDI.

I use a gravity model to explain intra-EU FDI flows among the current 15 EU member countries. The results suggest two conclusions. First, European integration, as represented by membership in the EMU or EU, is found to have a positive effect on FDI, even after controlling for the endogenous nature of the exchange-rate regime. These effects are statistically significant and imply that joining the EU causes intra-EU FDI to increase by about 31

percent. Likewise, joining the EMS causes intra-EU FDI to increase about 25 percent. Second, the total effects of the European Union on FDI can be divided into a customs union effect and an additional EMS, or "pseudo monetary union," effect.

This paper is organized as follows. Section 2 reviews recent studies about European integration and examines trends in FDI, with a view to assessing whether membership in the EU and EMS boosted FDI. Section 3 applies a gravity model and gives the econometric results. Section 4 examines a possible simultaneity problem and checks the robustness of the results. Section 5 concludes.

2. EUROPEAN INTERGRATION AND FDI

In this section, I review recent studies about European integration and FDI and examine the historical record as to whether countries only newly joined the EU or EMS saw an increase in FDI.

2.1 Exchange Rate Volatility and FDI

Both theory and empirical studies have generated an ambiguous link between exchange rate movements and FDI. Froot and Stein (1991) find that when capital markets are imperfect, the relationship between exchange rates and FDI is ambiguous. By examining bilateral FDI flows between the United States, Canada, Japan, and the United Kingdom, Goldberg and Kolstad (1995) find that investment activities are increasingly switched to foreign soil as exchange rates become more volatile.

Empirical evidence and initial modeling work, such as in Molle and Morsink (1991), Brenton (1996), and Blomstrom and Kokko (1997), suggest that European economic integration can attract not only trade, but foreign direct investment as well. Brenton, Di Mauro, and Lucke (1999) find that the stocks of FDI in CEECs—specifically, Poland and Hungary—have increased significantly since integration began in the early 1990s.

2.2 Some Stylized Facts on FDI Inflows

Figures 1 and 2 show the FDI inflows/GDP ratios for several EU countries, which joined or exited the EU and/or EMS from 1982 to 1999.[i]

Figure 1 . FDI Inflows and EU

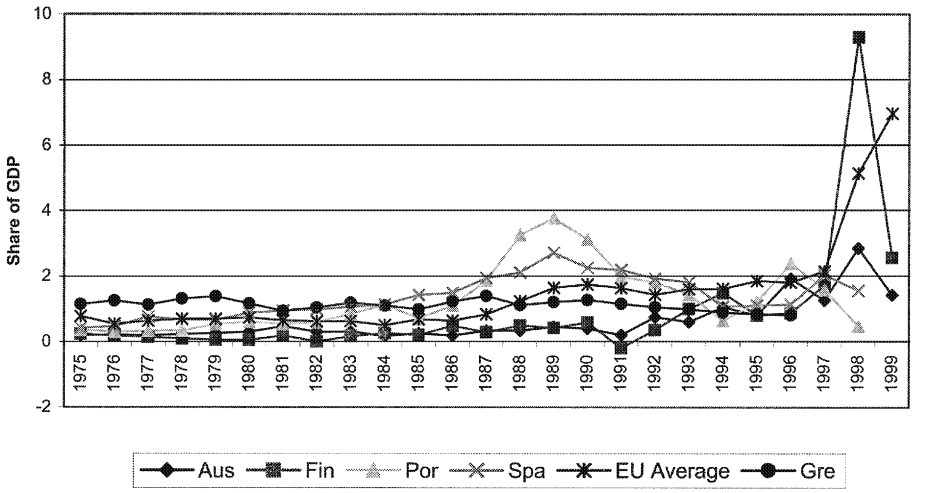
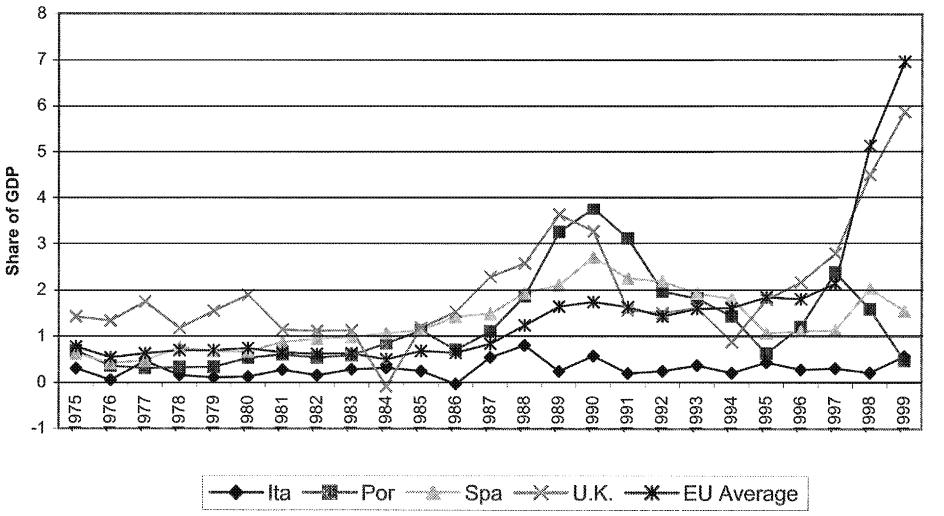


Figure 2. FDI Inflows and EMS



Data Source: IMF, *Balance of Payments Statistics Yearbook 2000* and *World Economic Outlook 2000*

Table 1 provides basic statistics on FDI for these countries, taken from the IMF *Balance of Payments Statistics Yearbook 2000.*[ii] The economic integration effects of EU and EMS membership on FDI appear to be significant. Table 9-1A attempts to isolate the EU effect. From 1967 to 1999, eight countries joined the EU: the United Kingdom in 1973; Greece in 1981; Portugal and Spain in 1986; and Austria, Finland, and Sweden in 1995.

After becoming members of the EU, seven of the eight (Greece being the exception) increased their average FDI inflows, as a percentage of GDP, both in the short term (an average of two years after joining the EU) and over the long term (an average of five years after joining the EU). Take for example, Portugal and Spain, which joined the EU in 1986. From 1975 to 1986, their average FDI inflows/GDP were 0.57 percent and 0.79 percent, respectively. After joining the EU, from 1986 to 1999 their respective ratios increased to 1.82 percent and 1.79 percent. In the short term (i.e., two years after joining the EU), their respective FDI inflows/GDP ratios increased to 0.91 percent and 1.46 percent. Over the long term (i.e., five years after joining the EU), their respective ratios increased to 2.15 percent and 1.94 percent.

Table 1-A: Statistics on the European Union Effect

FDI inflows in percentage of GDP, 1970—1999*								
Host Country	Year of accesion EU	Country average	Before EU	After EU	2 years before EU	2 years after EU	5 years before EU	5 years after EU
Austria	1995	0.61	0.42	1.66	0.83	1.37	0.61	1.66
Finland	1995	0.88	0.33	3.06	1.25	0.84	0.65	3.06
Greece	1981	1.12	1.25	1.08	1.35	1.05	1.25	1.09
Portugal	1986	1.27	0.57	1.82	0.99	0.91	0.74	2.15
Spain	1986	1.34	0.79	10.78	1.10	1.46	1.00	1.94
Sweden	1995	2.00	0.58	9.14	2.48	4.16	1.67	9.14
U. K.	1973	1.89	1.08	1.98	1.01	1.88	---	1.65
Period	before / after 73		before / after 81		before / after 86		before / after 95	
EU Ave.	0.89/1.46		0.80/1.82		0.75/2.17		0.95/3.59	

Notes: In tables 1A and 9-1B, only countries, which joined or exited the EU and/or EMS from 1982 to 1999, are selected. Italy, the United Kingdom, and Sweden starts in 1970; Ireland starts in 1974; Germany and Greece starts at 1976; the rest starts at 1975; Greece ends in 1997; Data missing for Denmark for 1979 and 1980.

Table 1-B. Statistics on the European Monetary System Effect

FDI inflows in percentage of GDP, 1970—1999								
ost ountry	ear in MS	Country average	Before EMS	fter MS	years efore MS	2 years after EMS	years efore MS	5 years after EMS
Italy*	79-91	0.33	0.30	0.34	0.39	0.31	0.48	0.31
Portugal	92-98	1.27	1.18	1.45	3.45	1.91	2.63	1.42
Spain	89-98	1.34	0.97	1.79	1.72	2.42	1.41	2.25
U.K.	90-91	1.89	1.53	2.43**	3.11	2.43	2.25	.60***
Period	before / after 79			efore / after 89		before / after 92		
EU Ave.	0.81/1.66			0.77/2.52		0.88/2.83		

Notes: See Table 1-A. *Italy exited in 1991. For Italy, 2 years before EMS means 2 years before exiting EMS. 2 years after EMS means 2 years after exiting EMS. ** From 1990 to 1991 only. *** 5 years after EMS means 5 years after exiting EMS.

Table 1B analyzes the EMS effect. From 1982 to 1998, three countries joined the EMS and two exited it: Spain joined in 1989, and Portugal in 1992; the United Kingdom joined in 1990 and exited in 1992; and Italy exited in 1992. As can be seen from Table 9-1B, the EMS effect is significant, though not as significant as the EU effect. After joining the EMS, all three countries' FDI inflow/GDP ratios increased. Of interest to our study is whether FDI inflows in Italy and the United Kingdom declined after they exited the EMS in 1992. Comparing five-year average FDI inflows/GDP ratios for before and after 1992, we find that they decline, from 0.48 and 2.25, to 0.31 and 1.60 respectively.[iii] For Italy, the two-year average for the FDI inflows/GDP ratio also declined after it exited the EMS in 1992.

One possible reason for this apparent "EU" or "EMS" might be the increasing trend in FDI in general. There are two ways to check this: (1) by comparing for two or five years before and after entry into the EU or EMS;[iv] and (2) by deflating the FDI inflows/GDP ratios by the EU average or over a time trend. Roughly speaking, the effects of membership in the EU and EMS still hold.[v] A more rigorous examination of the effects of EU and EMS membership is provided in the next section.

2.3 The Credibility Theory of the EMS

As can be seen from the stylized effects, the "monetary union" effect of EMS membership seems to encourage FDI, but how can this be explained? Arguably, the EMS amounted to more than just a mechanism for reducing exchange rate volatility to within certain bands. The question, however, is in what way? Two possible explanations exist. The first revolves around what might be called the "credibility theory" of EMS. Alesina and Barro (2000) argue that currency union is efficient since it uses an institutional arrangement to handle credibility problems. The second explanation is that monetary union induces financial integration, which induces more FDI.

First, the EMS can be seen as a type of "pseudo monetary union," as it increased the transparency of central bank monetary policy. Eichengreen (2000) argues that EMS countries outside of Germany fixed their exchange rates against the DM, and therefore, effectively imported the German Bundesbank's credibility to fight inflation and discourage the development of inflationary pressures at home.

Second, a monetary union represents a serious and strong government commitment to long-term integration. This commitment, so the argument goes, decreases expected future exchange rate volatility and induces the private sector to engage in greater FDI. Some studies, such as Clegg (1998) and Molle and Morsink (1991), argue that expected future exchange rate uncertainty plays an important role in intra-EU FDI.

It might be further argued that the "pseudo monetary union" of the EMS should also induce financial integration, which in turn should induce more FDI. After a country joins the European Union, there is less capital control, and financial capital can move about quite freely, not only within the European Union, but also between the European Union and countries outside of it. Other related factors, such as lower transaction costs and increased competition, should also affect FDI inflows. In general then, it is clear that the monetary union effects of EMS should encourage FDI.

3. THE MODEL AND EMPIRICAL RESULTS

3.1 The Success of the Gravity Model

Many empirical studies in international trade use the gravity model, which overall has proven very successful. Many recent studies on FDI, such as Molle and Morsink (1991), Martin and Velazquez (1997), Brainard (1997),

Brenton, Di Mauro and Lucke (1999), and Wei (2000) also employ a gravity model.

In this paper, I concentrate on EU member countries in identifying the principal features of FDI and determining how these have evolved in an environment of increasing economic integration. There are two main reasons why the 15 current EU members are the only countries included in the empirical sample. First, as Dell'Ariccia (1999) points out, the gravity model assumes that preferences across countries is identical and homothetic. Within the European Union, many factors, such as technology level and per capita income, are relatively similar. Thus, the model seems appropriate for the EU. Second, 11 of the current EU members adopted a common currency, the euro, in 1999. Europe's natural experiment in economic and monetary integration provides an excellent example for this kind of study.

In a standard gravity model, there are three key variables: GDP, GDP per capita (or population), and distance. The effects of GDP and per capita GDP on FDI from a source country to a host country is expected to be positive and negative respectively. The GDP level in a host country represents its market size. The evidence for intra-European FDI, such as in Culem (1988) and Martin and Velazquez (1997), confirms this argument. In general, both home and host per capita GDP is associated with the country's technology level. The higher it is, the more it will tend to encourage FDI.[vi] The effect of geographical distance on FDI is negative, since greater distance translates into higher transaction costs; it should therefore lower bilateral FDI and trade.

3.2 The Model

The following modified gravity model is specified to estimate the effects of the ERM and exchange rate volatility on FDI. Following Martin and Velazquez (1997), I separate source country and host country characteristics with respect to effects on FDI flows. To put it another way, there are good reasons to believe that the determinants of FDI flows from Germany to Greece are not the same as those for of FDI flows from Greece to Germany. The basic equation is as follows:

$$FDI_{ijt} = \alpha_t + \lambda Y_{ijt} + \gamma A_{ij} + \beta EU_{ijt} + \delta V_{ijt} + \kappa ERM_{ijt} + \theta PERM_{ijt} + \varepsilon_{ijt} \quad (1)$$

The description of the variables is as follows:

Membership dummies:

EU_{ijt}, a binary variable from 1982 to 1999, equal to unity when both i and j are in the EU at time t, otherwise 0;

ERM_{ijt}, a binary variable from 1982 to 1992,[vii] equal to unity when both i and j are in the EMS at time t, otherwise 0; and

$PERM_{ijt}$, a binary variable from 1993 to 1999 (post 1992/93 ERM crisis), equal to unity when both i and j were still in the EMS after the bands were expanded, otherwise 0.

Y_{ijt}, *or time-varying variables (in logs).*

FDI_{ijt}, the bilateral FDI outflows from i to j at time t;

$GDPO_{ijt}$, jth source country's real GDP at time t;

$GDPH_{ijt}$, ith host country's real GDP at time t;

$POPO_{ijt}$, jth source country's population at time t; and

$POPH_{ijt}$, ith host country's population at time t.

A_{ij}, *or country-specific effects.*

$Border_{ij}$, a binary variable equal to unity if i and j share a land border;

$Lang_{ij}$, a binary variable equal to unity if i and j have a common official language; and

$Dist_{ij}$, the distance between country i and j.

V_{ijt} is the volatility of the bilateral nominal or real exchange rate at period t. ε_{ijt} is an error term, which represents other influences on bilateral FDI. The model also includes other factors that may affect FDI, such as growth, economic regulation, and corruption. Note that the intercept must be allowed to change over time. I use year dummies to capture common cyclical effects. For example, most EU countries were in a recession in 1992; the year dummy for 1992 captures this effect with a negative number. Dell'Ariccia (1999) argues that any change in world aggregate GDP should be captured by the intercept. My main interest is the coefficient of the ERM dummy, κ, which captures the effect of monetary union (as represented by the EMS) on FDI. It is expected to be positive.

In this paper, panel data is used. There are two main advantages in using fixed-effect estimates in this context. One is that it controls for country-specific effects. The fixed-effect model is appropriate as long as these effects are constant over time. The other advantage is that a fixed-effect model

answers the policy question, "What is the effect on FDI of a country joining (or leaving) the EU or EMS?" It is an important question for CEECs.

3.3 Data

The equation is estimated using a data set from the *OECD International Direct Investment Database 1999* consisting of 1,131 bilateral FDI observations made from 1982 to 1999. The host countries include 15 countries currently in the EU. Usually, Belgium and Luxembourg are regarded as one country. The FDI variable is defined as bilateral stocks of FDI in 15 EU host countries. Of the source countries, eight are from the EU and eight are non-EU OECD countries. The eight EU source countries are Germany, the United Kingdom, France, Italy, Sweden, Austria, the Netherlands, and Finland. The eight non-EU OECD source countries are Australia, Canada, Iceland, Japan, New Zealand, Norway, Switzerland, and the United States. Many EU member countries report inward and outward FDI. In this paper, only outward FDI is considered.[viii] Similar to Frankel and Wei (1993) and Rose (2000), the exchange rate volatility between two countries is measured by the standard deviation of the first difference of the logarithmic nominal exchange rate.[ix]

I include the EU or EMS dummy to control for the enlargement of the EU or EMS. The border and language dummy represents country-pairs sharing a common border and language. The simple correlation between EU membership and FDI is 0.46, and the correlation between nominal exchange rate volatility and FDI is 0.02.

4. REGRESSION RESULTS AND THE EU EFFECT

Table 2 shows the three basic panel regression results; these being for the pooled, fixed, and random effects models.[x] For the pooled-effects model, the results are mixed. The effect of distance on FDI is significant and negative. The effect of a shared language on FDI is positive and significant. The signs for the population and GDP coefficients are switched, partly because GDP and population are highly correlated in the EU sample. For example, for source countries, the correlation coefficient is 0.99, and for host countries, it is 0.98.[xi] The effect of exchange rate volatility on FDI is positive and significant, which is consistent with Goldberg and Kolstad (1995).

In the pooled regression, there may be other country-specific effects that are missed. For this reason, the fixed-effects model is preferred. For the fixed- and random-effects models, the coefficients for three basic variables—

income, population, and distance—have the expected signs and are significant; positive for income, and negative for population and distance. The effect of exchange rate volatility on FDI is positive, but not significant, which is consistent with Froot and Stein (1991).

The coefficients for EU membership in the pooled, fixed, and random effects models are 0.89, 0.27, and 0.30, respectively, and are always significant. Since $e^{0.27} \approx 1.31$, the fixed-effects estimate implies that joining the EU causes FDI to increase by about 31 percent. Thus, after controlling for exchange rate volatility, membership in the EU still has a positive effect on FDI. Put another way, becoming a member of the EU could cause FDI to increase. A country's accession to the EU may well inspire international investors with sufficient confidence to shift production to it from their respective host countries.

4.1 ERM and the Post-ERM Effect

The goal of the EMS was to control exchange rate fluctuation among member countries, so as to encourage trade and investment and promote economic convergence. In fact, the volatility of both the nominal exchange rate and the real exchange rate was decreased by the EMS and the ERM should have had a positive effect on bilateral FDI inflows.

As can also be seen from Table 2, the coefficients for EMS membership in the pooled, fixed, and random effects models are 0.72, 0.22, and 0.23 respectively, and are always significant. Since $e^{0.22} \approx 1.25$, the fixed-effects estimate implies that joining the EMS causes FDI to increase by about 25 percent. Thus, a positive sign could mean that the ERM's role goes beyond that of reducing exchange rate volatility. Moreover, after controlling for the effect of EU membership, there is an extra ERM effect. All participants in the EMS are also in the EU. Moreover, most EU countries joined the EMS. Thus, the EU dummy and the EMS dummy are positively correlated, with EMS constituting a subset of EU. After controlling for exchange rate volatility and EU effects, the positive effect of ERM means that there is an extra "pseudo monetary union" effect in addition to the "customs union" effect.

In August 1993, economic shocks caused by the reunification of Germany three years prior forced the EMS to adopt wider ($\pm$ 15 percent) bands, until the introduction of the euro in 1999. Thus, after 1993, the ERM was not the same as before. I therefore designate the 1993-1998 period as a "Post-ERM" period, and define a new dummy, PERM, to capture the Post-ERM effect. It is widely believed that the 1992-1993 "EMS crisis" was a step backward in the economic integration of the European countries. If the EMS has had a positive effect on FDI between EU countries, then the end of EMS

should have had a negative effect on FDI. With the introduction of the PERM dummy, the effect of Post-ERM on FDI can be estimated.

Table 2. Intra-EU FDI Flows and European Integration, Panel Regressions, 1982—1999

Independent Variables	Pooled Effect			Fixed Effect			Random Effect		
ERM	0.72		0.47	0.22		0.13	0.23		0.14
	(0.13)***		(0.15)***	0.05)***		(0.07)*	(0.06)***		(0.07)**
PERM			0.63			-0.08			-0.05
			(0.16)***			(0.08)			(0.10)
EU		0.89	0.67		0.27	0.21		0.3	0.24
		(0.12)***	(0.14)***		(0.06)***	(0.07)***		(0.06)***	(0.07)***
SD. Exch. Rate	0.33	0.3	0.36	0.02	0.01	0.02	0.03	0.02	0.03
	(0.05)***	(0.04)***	(0.05)***	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)	(0.02)
GDPO	-0.28	0.22	-0.27	2.23	1.93	2.13	1.85	1.73	1.77
	(0.64)	(0.65)	(0.64)	(0.59)***	(0.59)***	(0.59)***	(0.42)***	(0.41)***	(0.42)***
GDPH	-0.63	0.16	0.09	2.32	2.17	2.34	2.04	2	2.05
	(0.25)**	(0.28)	(0.26)	(0.34)***	(0.34)***	(0.35)***	(0.29)***	(0.29)***	(0.30)***
POPO	0.97	0.36	0.84	-1.35	-1.23	-1.22	-1.13	-1.07	-1.08
	(0.63)	(0.63)	(0.64)	0.40)***	0.40)***	0.40)***	0.40)***	0.40)***	0.41)***
POPH	1.33	0.51	0.6	-1.9	-1.95	-1.93	-1.28	-1.27	-1.3
	0.25)***	(0.27)*	(0.28)**	0.48)***	0.48)***	0.48)***	0.30)***	0.30)***	0.30)***
Border	-0.17	-0.05	-0.13	---	---	---	-0.23	-0.19	-0.2
	(0.13)	(0.14)	(0.13)	---	---	---	(0.42)	(0.42)	(0.41)
Distance	-1.74	-1.54	-1.46	---	---	---	-1.3	-1.3	-1.27
	0.10)***	0.11)***	0.11)***	---	---	---	0.27)***	0.27)***	0.26)***
Language	0.78	0.8	0.94	---	---	---	0.68	0.66	0.69
	0.20)***	0.20)***	0.20)***	---	---	---	(0.67)	(0.66)	(0.64)
Constant	13.67	11.48	11.44	-0.62	1.6	-0.78	7.41	7.68	7.29
	1.15)***	1.21)***	1.20)***	(4.43)	(4.32)	(4.33)	2.45)***	2.43)***	2.36)***
Adjusted R^2	0.63	0.63	0.64	0.65	0.65	0.65	0.57	0.58	0.58

Notes: Dependent Variable is LOG of FDI; # of Observations: 1,131; # of Groups: 103; Standard errors are in parentheses. *, **, *** denotes significance at 10 percent, 5 percent, and 1 percent, respectively; time and country dummies, are not reported.

The extra "pseudo monetary union" effect can clearly be seen from the fixed-effects model by combining the three coefficients ERM, PERM, and

EU. If only the EU coefficient is included, it is 0.27; if the coefficients for EU, EMS, and PERM are all included, then they are 0.21, 0,13, and –0.08, respectively. Since $0.21 + 0.13 - 0.08 = 0.26$, and is therefore close to the total effect (0.27), we may, roughly speaking, surmise that the total effect of integration (whereby FDI increases by about 31 percent, since $e^{0.27} \approx 1.31$) consists of three components: a large, positive "customs union" effect (whereby FDI increases by about 23 percent as $e^{0.21} \approx 1.23$), a positive "monetary union" effect (whereby FDI increases by about 14 percent as $e^{0.13} \approx 1.14$), and a small, negative effect related to the ERM crisis (whereby FDI decreases by about 8 percent as $e^{0.08} \approx 1.08$). The monetary union effect can be also regarded as a "macroeconomic convergence" effect, since the policies fostered with respect to the ERM needed to be maintained. These results suggest an important implication for the CEECs joining the EU: the total effect will consist not only of a customs union effect, but also an extra effect due to monetary union, together with the small possibility of an ERM crisis effect as described above.

All the empirical evidence supports the hypothesis that the EMS and the EU did boost FDI. It is not surprising then that the results for FDI are similar to those assessing trade and currency unions, such as Glick and Rose (2001), Rose and van Wincoop (2001), Rose (2000), Frankel and Rose (2000), and Dell'Ariccia (1999). There are two reasons for this. First, almost all empirical studies on the trade effects of FDI find that source country exports tend to increase along with FDI.[xii] Second, as Molle and Morsink (1991) conclude, intra-EU trade and investment are complementary to each other.

5. SIMULTANEITY PROBLEM AND ROBUSTNESS

5.1 Is There a Simultaneity Problem?

There may be a simultaneity problem in the analysis, specifically with respect to the European Monetary System. In particular, countries with extensive trade and FDI may seek to join the monetary union and reduce exchange rate volatility in order to increase trade and FDI.

One way to solve the simultaneity problem is to use instrumental variables (IVs). Frankel and Wei (1993) use the standard deviation of relative money supplies as an instrument for exchange rate volatility. Dell'Ariccia (1999) uses the forward error as an instrument for exchange rate volatility. Rose (2000) chooses three terms involving inflation rates as IVs for exchange rate volatility and currency union. Following Rose (2000), I use the following three terms as instrumental variables: a) the product of the two relevant

inflation rates; b) the sum of the two relevant inflation rates; c) the absolute value of the difference between the two inflation rates. All have a one-year lag. Table 3 presents the results.

Table 3. Intra-EU FDI and European Integration, Instrumental Variable Estimates

Independent Variables	Instruments for both ERM and S.D. Exch. Rate								Instruments for S.D. Exch. Rate only		
	Regression (1)				Regression (2)				Regression (3)		
	First Stage		Fixed Effect		First Stage		Fixed Effect		Fixed Effect		
ERM	ERM	V(e)	4.04	3.32.	ERM	V(e)	1.72	1.22	0.21		0.11
			(1.54)***	(1.54)**			(1.04)*	(1.04)	(0.05)***		(0.07)*
PERM				-0.15				-0.14			-0.1
				(0.08)*				(0.08)*			(0.08)
EU				0.21				0.21		0.27	0.21
				(0.07)***				(0.07)***		(0.06)***	(0.07)***
SD. Exch. Rate			2.21	1.97			0.57	0.39	0.06	0.17	0.21
			(1.06)**	(1.06)*			(0.58)	(0.58)	(0.27)	(0.26)	(0.28)
GDPO	0.44	-2.88	6.08	5.85	0.44	-2.94	2.63	2.41	2.22	2.25	2.5
	(0.10)***	(0.29)***	(2.59)**	(2.57)**	(0.10)***	(0.29)***	(1.87)	(1.85)	(0.78)***	(0.78)***	(0.79)***
GDPH	-0.08	-0.41	3.28	3.31	-0.08	-0.4	2.42	2.47	2.3	2.19	2.38
	(0.05)*	(0.13)***	(0.67)***	(0.67)***	(0.05)*	(0.13)***	(0.47)***	(0.47)***	(0.34)***	(0.34)***	(0.35)***
POPO	-0.37	2.9	-6.23	-5.72	-0.37	2.95	-2.45	-2	-1.46	-1.74	-1.81
	(0.10)***	(0.28)***	(2.67)**	(2.65)**	(0.10)***	(0.29)***	(1.75)	(1.75)	(0.87)*	(0.87)**	(0.89)**
POPH	0.07	0.48	-3.29	-3.15	0.07	0.47	-2.25	-2.15	-1.91	-1.96	-1.96
	(0.04)*	(0.13)***	(0.81)***	(0.81)***	(0.02)***	(0.13)***	(0.57)***	(0.57)***	(0.48)***	(0.48)***	(0.48)***
Border	0.04	-0.36	---	---	0.04	-0.35	---	---	---	---	---
	(0.03)	(0.07)***	---	---	(0.03)	(0.07)***	---	---	---	---	---
Distance	-0.21	0.001	---	---	-0.21	0.13	---	---	---	---	---
	(0.02)***	(0.0004)**	---	---	(0.02)***	(0.05)***	---	---	---	---	---
Language	-0.16	-0.003	---	---	-0.16	-0.22	---	---	---	---	---
	(0.04)***	(0.001)**	---	---	(0.04)***	(0.11)**	---	---	---	---	---
Inflation Product	-0.001				-0.001						
	(0.00***				(0.00***						

Table 3: Continued

Inflation Sum		0.01									
		(0.005)*									
Inflation Diff						0.01					
						(2.08)**					
Constant	0.001	10.	-22.65	-23.25	0.001	-10.4	-9.14	-9.75	0.22	1.97	-0.34
	(0.25)	(1.1432***	(10.63)**	(10.62)**	(0.25)	(1.15)***	(7.95)	(7.93)	(4.40)	(4.38)	(4.25)
Adjusted R^2	0.32	0.37	0.64	0.64	0.32	0.37	0.64	0.64	0.65	0.65	0.65

Notes: No. of observations for regression (1) and (2) are 1,014 and 1,131 for regression (3). F-tests for all parameters are significant at 1 percent level. t statistics in parentheses; *, **, *** denotes significance at 10 percent, 5 percent, and 1 percent, respectively; time and country dummies are not reported.

First, I use inflation as an instrumental variable for exchange rate volatility and confirm the previous results (see the last four columns in Table 3): the coefficients for EU, ERM, and ERM II (i.e., PERM) are still significant with the expected signs. By adding these three coefficients—EU, ERM, and PERM, my third conclusion also holds.

Second, following Rose (2000), I regress the ERM and exchange rate volatility on the instrumental variables, and then do a second stage regression (both the first and second stage regressions are reported in Table 3). The coefficients for ERM are bigger, but remain positive. The coefficients for both ERM and EU are still positive and significant in most cases.

In sum, I don't think increasing FDI plays a crucial role in a country's decision to join the EMS, compared with other factors such as inflation. The decision to join the ERM is based on a combination of political and economic considerations. Thus, the coefficients estimated in this paper still hold.

6. CONCLUSIONS

The primary objective of this paper was to test the ERM effect by estimating the separate effect of exchange rate volatility and EMS on FDI. Having a stable exchange rate may not be the same thing as being part of a monetary union. The latter represents a more serious and stronger

commitment to reduce exchange rate volatility. I use a gravity model to analyze the separate effects of exchange rate volatility and economic integration—as represented by membership in the EU and EMS—on FDI. Two conclusions are drawn. First, European integration, such as per the EMS or EU, has a positive effect on FDI, even after controlling for the endogenous nature of the exchange rate regime. Second, the total effect of the European integration on FDI can be divided into a customs union effect and an additional EMS, or "pseudo monetary union," effect.

These results have important policy implications. Recently, some CEECs have been preparing to apply for EU membership. One question this raises is how much more FDI the CEECs might expect to receive after joining the EU, or even the EMU. This issue is important for CEECs countries, as the economic effects of FDI are regarded unambiguously as beneficial: it helps to finance domestic investment and to import technological and management-related knowledge.

DATA APPENDIX

1.Bilateral Foreign Direct Investment: *OECD International Direct Investment Statistics Yearbook 1999*, diskettes. Data are current U.S. dollars, converted into constant U.S. dollars, using annual exchange rates and U.S. GDP deflator from the IMF, *International Financial Statistics 2000.*

2. Distance: air distances between capital cities, except Frankfurt for Germany and Milan for Italy.

3. Border and Linguistic Tie: from Dell'Ariccia (1999), Except that the United Kingdom and Sweden don't share a language in my sample. Dummy for Border (or Linguistic Tie) is equal to one if two countries share a common border (or language).

4.Monthly Exchange Rate (end of period): IMF, *International Financial Statistics 2000.*

5. Real GDP and Growth: OECD, at 1991 constant U.S. dollars.

6. Population: IMF, *International Financial Statistics 2000.*

NOTES

[i] Sweden is not in Figure 9-1 since its FDI inflows/GDP ratio was over 25% in 1999, an outlier.

[ii] In the following regressions, the bilateral FDI data are used.

[iii] The average FDI/GDP ratio went up slightly after Italy exited the EMS in 1992. From 1992 to 1998, the average ratio is 0.34 percent. While Italy was in the EMS, it was 0.30 percent. This contrasts with 2.2 percent for 1998 and 5.8 percent for 1999.

[iv] There may be an "announcement effect" too.

[v] I don't report the results because of space limit. Moreover, the basic results from the OECD database are similar to the results from the IMF *Balance of Payments Statistics 2000.*

[vi] Dell'Ariccia (1999) argues that the per capita income for the source country can also represent specialization; richer countries tend to have a larger FDI outflow because of more specializations. Per capita income of the host country may also represent purchasing power.

[vii] The ERM crisis happened in 1992 and 1993. As can be seen from regression robustness, it does not matter whether the ERM dummy ends at 1992 or 1993.

[viii] Many empirical studies in FDI choose FDI stock, instead of FDI flows; for instance, Wei (2000a and b), Waldkirch (2001), Brenton, Di Mauro, and Lucke (1999), and Culem (1988). There are two reasons for this. One is that FDI stock has a better theoretical justification than FDI flows. See Wei (2000) and Waldkirch (2001) for details. The other is that FDI flows are much more volatile than stocks. I also tried using FDI flows, and the differences in the results were not significant.

[ix] Some studies use the lag exchange rate volatility, such as Rose (2000); others use current exchange rate volatility, such as Dell'Ariccia (1999) and Frankel and Wei (1993). Using the one or the other does not change the main three conclusions of this paper.

[x] As can be seen from the Hausman tests, the fixed effects are appropriate for most cases, although in some cases, random effects are more efficient. The results for both fixed effects and random effects are presented in Table 9-2. The results for fixed effects are also presented in the following tables.

[xi] If GDP and GDP per capita are used, I can obtain the expected signs.

[xii] See Graham (1996) for a review.

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Chapter 8

TRANSPARENCY AND THE STRATEGIC USE OF PRIVATE INFORMATION IN MONETARY POLICY

A Particular European Problem?

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Abstract: Most economists argue that transparency in monetary policy is desirable because it helps the private sector make better informed decisions. They also argue that a lack of transparency has been the key problem in Europe's monetary policy. Using standard models - where there are also opportunities for fiscal policy - we show that a lack of transparency will have very different effects depending on whether it represents a lack of political transparency or a lack of economic (or information) transparency. The former allows the Central Bank to create and exploit a "strategic" reputation to its own advantage. The latter does not. Thus, political transparency helps us understand how monetary policy decisions are made. But economic transparency reveals what information went into those decisions.

Keywords: Policy Transparency, Credibility, Central Bank Institutions

1. INTRODUCTION

Most economists agree that greater transparency in monetary policy decisions is desirable because it allows the private sector to make better - that is, welfare improving - decisions, as well as better informed decision: [Blinder (1998)]. But not all agree with this point of view.

Some argue that incomplete transparency is optimal, as the effect on the Central Bank's reputation and its consequent ability to control inflation effectively, has to be balanced against the private sector's wish to see output, employment and prices stabilised. Statements of this kind can be found in Svenson and Faust (2000) or Jensen (2000). Others argue that certain restrictions on transparency are also important for operational reasons. Once again the idea is to reinforce the Bank's credibility, and to separate out "the need to know" from "the need to understand" (Issing, 1999; Padoa-Schioppa, 2000).

In practice, most Central Banks have actually increased their transparency in recent years - using inflation forecasts, extensive explanations of the reasoning behind their decisions, and sometimes voting records on policy decisions or a discussion of the policy "bias", to do so. Prominent examples are found in the Federal Reserve System in the US; but also in the Bank of England and the Central Banks of Canada, New Zealand and Sweden. The most distinguished counter example lies in the European Central Bank, which has moved to limit the degree of transparency in its policies. It is significant that the ECB is the most independent of the major Central Banks; and also the one most concerned with the importance of policy credibility and with the need to separate the issue of control ("the need to know") from oversight of the policy rules themselves ("the need to understand").

The problem here is that transparency has many dimensions and therefore means different things to different people (Eijffinger and Geraats, 2002). Kuttner and Posen (2000) list the different characteristics which are necessary for institutional transparency:

- a numerical goal for monetary policy
- an inflation report, explaining the expected effects of changes in monetary policy
- an inflation forecast (plus assumptions) explaining why those changes were necessary, and
- a post-mortem evaluation of past policies and their achievements.

These attributes cover both the information content and the way in which that information has been used. That distinction is important, but is seldom made[i]. The distinction itself relates directly to the conflict between the ability to control and the need for transparency. As a result, many commentators

reach opposite conclusions about the need for transparency. Kuttner and Posen (1999) argue that it will enhance the Central Bank's ability to use discretionary policies, while Svenson and Faust (2000) conclude the opposite. Both sets of authors argue that transparency will reduce the noise and the imprecision in the private sector's decision making. But they differ as to whether greater transparency would increase the ability of the Central Bank and private sector to make consistent decisions, or reduce the Central Bank's ability to control the private sector's natural tendency to avoid monetary discipline.

The purpose of this paper is to review the issues which imperfect transparency in monetary policy, raises. A lack of transparency is said to arise when the Central Bank has private information about the nature of the shocks and the way in which policy affects the economy (Cuckierman 1992, 2000); or when the Central Bank has not stated its objectives clearly (Cukierman and Meltzer 1986); or when the public is uncertain about the preferences of the Central Bank (Nolan and Schaling 1998, Muscatelli 1998, Eijffinger et al, 2000). In each of these cases, a lack of transparency introduces a disturbance which distorts the private sectors expectations for inflation. That provides an automatic link both to the strategic use of that information, and to the desire to ensure accountability.[ii] Our conclusions turn on the difference between knowing what information is being used, compared to knowing how that information will be used.

Stylised facts point to the same distinction. Critics of the ECB's policies, both in the markets and in the academic debate, have called for the publication of inflation forecasts, transcripts of the process by which decisions are reached, voting records (or "bias" statements), and clearer priorities for future policies - i.e. all the things that fall under the "need to understand" heading. The importance that the private sector attaches to these factors is clear. Asked to rank their understanding of their own Central Bank's monetary decisions on a scale of 1 to 5, Goldman Sach's clients gave the Federal Reserve a score of 4.3, the Bundesbank and the Bank of England 3.5 and 3.3 respectively, but the ECB only 2.2.[iii] Our contribution to this debate is to stress the difference between political transparency (where policy preferences, or relative priorities, are clearly articulated for all to see) and economic transparency (where the external information, control errors or target values are made clear). That is to distinguish between understanding how the policy rule works, and knowing what conditioning information has been used in that rule.

2. FISCAL AND MONETARY POLICIES WITH FULL TRANSPARENCY

2.1 The Model

We start with the standard analysis of Barro and Gordon (1983), Rogoff (1985), and Debelle and Fischer (1994). We suppose that the Government delegates the conduct of monetary policy to an independent Central Bank, which optimises period-by-period with preferences at least as conservative as the rest of society. Suppose also that the Government is able to keep control of its fiscal instrument. The Central Bank's problem is then to minimise the loss function:

$$L_{CB} = \frac{1}{2}\left[\pi^2 + \tau^2 + \gamma(y-k)^2\right] \tag{2.1}$$

subject to

$$y = \pi - \pi^e - \tau + \varepsilon \tag{2.2}$$

where y = output (with target level k = 0),[iv] π = inflation (with expected value π^e, but target level of zero), τ = tax revenues net of expenditures[v], and ε is a random shock with zero mean. The Bank's policy instrument is its choice of π. Finally γ is the relative priority placed on the output target. It is therefore an index of conservatism (smaller γ values) or liberalism (larger γ values).

Our aggregate supply function, (2), takes the same form as the supply functions already popularised in this literature [Barro and Gordon (1983), Debelle and Fischer (1994), Alesina and Gatti (1995)]. Implicit in its structure is a sequence of events which gives our problem a two period dynamic structure. Wages will actually be set ahead of the determination of y. That means π^e is the inflation rate which wage setters and the private sector expect, at the beginning of the period, to hold at the end of that period (Roberts, 1995). As such it incorporates the microfoundations of monopolistic competition, staggered wage-price setting as in Calvo contracts, and quadratic adjustment costs. Optimal wage contracts would then produce a relationship like (2.1): Rotemberg and Woodford (1998).

The Central Bank's optimal reaction function is now obtained by inserting (2.2) into (2.1) and optimising with respect to π. We get

$$\pi = \frac{\gamma}{1+\gamma}\left[\pi^e + \tau + k - \varepsilon\right] \tag{2.3}$$

The fiscal authorities, meanwhile, aim to minimise the private sector's loss function

$$L_{FA} = \frac{1}{2}\left[\pi^2 + \tau^2 + \beta(y-k)^2\right] \tag{2.4}$$

subject to (2.2).[vi] The government's instrument is τ, with optimal reaction function

$$\tau = \frac{\beta}{1+\beta}\left[\pi - \pi^e + \varepsilon - k\right] \tag{2.5}$$[vii]

Substituting (2.5) into (2.3) for a Nash equilibrium, reveals expected inflation to be

$$\pi^e = \frac{\gamma}{1+\beta}k \tag{2.6}$$

Consequently the equilibrium choices for inflation (monetary policy) and net tax revenues are:

$$\pi^* = \frac{\gamma}{1+\beta}k - \frac{\gamma\varepsilon}{1+\beta+\gamma}, \text{ and } \tau^* = \frac{-\beta}{1+\beta}k + \frac{\beta\varepsilon}{1+\beta+\gamma}. \tag{2.7a, b}$$

Thus $E\pi^*>0$, reflecting the inflation bias in (2.7a), and $E\tau^*<0$. Finally one might question the presence of $k\neq 0$ among the Central Bank's objectives. It is a fact that all models in this literature include such an objective, and always for the same reason.[viii] Taxes and supply side restrictions are distortionary in the sense that they depress output and employment by more than surprise inflation can improve them. Similarly labour market imperfections, imperfect competition, and job protection schemes will also keep real wages above their market clearing levels, and output below its first best optimum (Persson and Tabellini, 1990). We therefore need to set $k = 0$ to correct for any of those distortions.

Finally solutions where the Bank is fully precommitted to a certain inflation control rule (see McCallum, 1997) or where fiscal policy has only temporary effects on y, may also be fitted into this framework as a special case - see Demertzis et al (1999) for details. We do not report separate results for these cases.

2.1.1 Definitions of Transparency

2.2.1 Political Transparency

To define full transparency, we need to start from a general specification in which the Central Bank attaches explicit weights to both its objectives. It is important to define transparency in its most general form, and only then impose normalisation restrictions, in order to account for all relevant information. Consider a Central Bank which assigns positive numbers, a and b, as the relative priorities on reaching its policy targets:

$$E(L) = \frac{1}{2}E\left[a\pi^2 + b(y-k)^2\right] \tag{2.8}$$

This is just a simplified version of (2.1) to illustrate a particular point. Nevertheless, in identifying this loss function, what we are actually interested in is not the value of each of the parameters a and b *per se*, but the relative weight attached to the two objectives $\frac{b}{a}$, and therefore the Marginal Rate of Substitution between them: $\frac{b}{a}\frac{\Delta\pi}{\Delta y}$. The issue of transparency arises whenever the public's perception of the bank's preferences, for example on output (β), differs from the values that the bank itself actually considers (b). We define this discrepancy as $\beta = b + \eta$, where η is a random error (made by the private sector) with $E(\eta) = 0$ and $V(\eta) = \sigma_n^2$. This formulation implies that the public is correct on average, but may be mistaken when making guesses about preferences in individual cases or at specific points of time. But uncertainty about b implies that the public perception about the relative importance that the Central Bank attaches to controlling inflation is also open to error. To show this, we rescale the sum of two parameters to equal a constant, say a + b = 1.[ix] This helps define the public's uncertainty

about the true value of a in terms of η: i.e. $\alpha = a - \eta$ and therefore $E(\alpha) = a$. However, $E(\eta) = 0$ is not sufficient to define transparency itself. Full transparency would also require that the ratio of the two parameters, as perceived by the public, should equal the ratio of the true values on average. This is not achieved by the assumptions made so far since the expectation of a ratio is not the ratio of the expectations. In fact the perceived relative weights are:

$$\frac{\beta}{\alpha} = \frac{b+\eta}{a-\eta} \tag{2.9}$$

where full transparency requires $E\left(\frac{\beta}{\alpha}\right) = \frac{b}{a}$. But

$$\frac{\beta}{\alpha} = \frac{b+\eta}{a-\eta} = \frac{b}{a} + \xi \tag{2.10}$$

where $\xi = \frac{(a+b)\eta}{a(a-\eta)}$, and

$$E(\xi) = E\left[\frac{(a+b)\eta}{a(a-\eta)}\right] = \frac{(a+b)\bar{\eta}}{a(a-\bar{\eta})} - \frac{(-a)(a+b)\sigma_n^2}{a^2(a-\bar{\eta})^2} + \frac{a^2(a+b)\bar{\eta}}{a^3(a-\bar{\eta})^3}\sigma_n^2 \tag{2.11}$$

We can now see that the assumption $E(\eta) = 0$ is not sufficient since full transparency also requires $E(\xi) = 0$. If we impose $E(\eta) = 0$ alone, it implies that

$$E(\xi) = \frac{(a+b)\sigma_n^2}{a^3} \tag{2.12}$$

and hence that $E(\beta/\alpha) \neq b/a$. In that case, the Central Bank could not deliver full transparency even if it wanted to – unless it also provides the private sector with full information $(\sigma_n^2 = 0)$ at the same time. Hence:

Definition 1: Full political transparency occurs if $E(\eta) = 0$ and $\sigma_\eta^2 = 0$ both hold.

Note that the objective function we will be using below assumes a = 1[x]. This is a convenient simplifying assumption. It does not change any of the qualitative results we present since the conditions for transparency do not change. Following this definition, public perceptions and Central Bank preferences are related through $\beta = b + \eta$ where η has the properties defined above. This implies that the public will on average anticipate the correct preference parameter, i.e. $E(\beta) = b$ but for full transparency to hold, we need $\sigma_n^2 = 0$ as well.

2.2.2 Economic (Goal) Transparency

We also consider a different form of transparency, this time relating to the public being uncertain about the value of k that the Central Bank targets (the control errors approach of Cukierman (2000), Geraats (2002), Jensen (2000), Faust-Svensson (2000)). We identify this with economic transparency. Suppose the Central Bank actually targets k, but the public anticipates c = k + v where v is an error with E(v) = 0 and V(v) = σ_v^2. As a consequence, E(c) = k. Then,

Definition 2: Full economic transparency occurs when conditions E (v) = 0 and $\sigma_v^2 = 0$ both hold.

This time transparency is indexed by the variance of v, and full economic transparency is identified with $\sigma_v^2 = 0$. Note that k would typically contain all the conditioning information that goes into an inflation forecast – exogenous factors, decisions by other players, forecasts of random events[xi], and target values set by the domestic policy makers.

3. IMPERFECT TRANSPARENCY OVER PRIORITIES

Suppose now that the private sector is uncertain about the Bank's true priority for inflation control relative to its priority for stable output and

employment. That implies a lack of transparency about how the Bank will make its decisions, but not about the Bank's target values for inflation or output, or the conditioning information more generally. For the moment we take those target values to be known.

3.1 The Intended Decisions under Private Information

Suppose private sector agents believe the Central Bank will use $\bar{\gamma}$ in (2.1), whereas the Bank actually decides to use γ_1. Suppose too the private sector has a distribution of beliefs about the values of γ_1 that might be used:

$$\gamma_1 = \bar{\gamma} + \eta \tag{3.1}$$

where η is a random variable distributed between $-\bar{\gamma}$ and ∞, with mean zero and variance σ_n^2. The Bank, by contrast, knows the value of γ_1 it will use. It also knows the mean of the private sector's distribution: $\bar{\gamma}$. In that sense the Central Bank has private information.[xii]

Since (2.2) refers to the economy's supply responses, π^e must represent the private sector's expectation for inflation - conditional on the private sector's information set. That means the private sector will need to solve $\min_{\pi} E(L_{CB/PS})$ subject to (2.2)[xiii] in order to evaluate π^e and the decision rules it expects to determine π and τ. We get

$$\pi^e_{PS} = \frac{\bar{\gamma}k}{1+\beta}, \tag{3.2}$$

with

$$\pi^*_{PS} = \frac{\bar{\gamma}k}{1+\beta} - \frac{\bar{\gamma}\varepsilon}{1+\beta+\bar{\gamma}} \tag{3.3a}$$

and

$$\tau^*_{PS} = \frac{-\beta k}{1+\beta} + \frac{\beta\varepsilon}{1+\beta+\bar{\gamma}} \tag{3.3b}$$

By contrast, the Bank's preferred outcomes appear to be

$$\pi^{e}_{CB} = \frac{\gamma_1}{1+\beta}k$$

with
$$\pi^{*}_{CB} = \frac{\gamma_1 k}{1+\beta} - \frac{\gamma_1 \varepsilon}{1+\beta+\gamma_1} \qquad (3.4a)$$

and
$$\tau^{*}_{CB} = \frac{-\beta k}{1+\beta} + \frac{\beta \varepsilon}{1+\beta+\gamma_1} \qquad (3.4b)$$

from which we get the expected outcome of the Bank's preferred policies as π^{e}_{CB}. Hence the private sectors expectations differ from the Central Bank's preferred value by a stochastic term:

$$\pi^{e}_{PS} - \pi^{e}_{CB} = \frac{-k\eta}{1+\beta} \qquad (3.5)$$

But there can be no systematic difference if the private sector has rational expectations - at least, not in the long run. On the other hand short run "errors" are possible, and could be exploited as long as γ_1 remains unknown. And long run errors are also possible, but only if the private sector is subject to bounded rationality or persistent information "biases". That is, only if the conditions for an unconditional rational expectations equilibrium obtain: Fagin et al (1995). Nevertheless, the private sector will eventually realise that the final outcomes will emerge from a solution which combines the Bank's optimal reaction function (2.3), the optimal fiscal reaction function (2.5), and the expected inflation rate π^{e} which those two imply. Substituting (2.5) into (2.3) and taking expectations, shows that both π^{*} and π^{e} are nonlinear in the unknown (to the private sector) random value γ_1 which the Bank will use for γ. That is to say, (2.5) in (2.3) implies

$$\pi^{e} = E\left(\frac{\gamma_1 k}{1+\beta+\gamma_1}\right) \Big/ \left[1 - E\left(\frac{\gamma_1}{1+\beta+\gamma_1}\right)\right] < \frac{\bar{\gamma}k}{1+\beta} \qquad (3.6)$$

where we have used Jensen's inequality when $\bar{\gamma} = E\gamma_1$ is substituted for γ_1. Hence there is no exact, closed form solution to the private sector's problem because it is not possible to determine an exact solution for

$E[\gamma_1/(1+\beta+\gamma_1)]$ in terms of the parameters of the underlying probability distribution. However that does not mean that no solution exists; only that it cannot be written down explicitly. If nothing else, agents could compute π^e numerically. But because that will be costly (Balke and Haslag, 1992), and may be fragile if conditions change, agents are, likely to use an approximate value. And the fiscal authorities could do the same. If the private sector uses $\bar{\gamma}$ in (3.6) as part of the first order certainty equivalent approximation[xiv] to the solution for π^e, - then there will be a systematic error as indicated by the inequality in (3.6). And, since the private sector may never obtain an exact solution for π^e unless the value of γ_1 is revealed, this error could persist even if the private sector refines its estimate of $\bar{\gamma}$ as the mean of the γ_1 distribution. In that case, we will be condemned to remain in a boundedly rational equilibrium whether we like it or not.[xv].

Thus, if there is any reason to maintain this lack of transparency for strategic purposes, the one thing the Central Bank cannot do is publish its inflation forecasts. If it did so, γ_1 would immediately be revealed and any advantages that might flow from maintaining confidentiality about the Bank's policy intentions – such as those presented in Issing (1999), or those discussed in Sections 3.2 and 3.3 below - would be lost.

3.2 From Intentions to Actual Outcomes

The actual outcomes will be different from (3.3) or (3.4) however, since the private sector's information will go into the determination of π^e and the choice of τ^*; but the Central Bank's information in the determination of π^*. Inserting (3.2) as the private sector's first order certainty equivalent approximation for π^e, into the Nash equilibrium defined by (2.3) with γ_1 and (2.5) to provide the Central Bank's decisions, and by (3.3b) as the fiscal authorities' chosen policy rule, we get

$$\pi^* = \frac{\gamma_1}{1+\beta}\left[\frac{1+\beta+\bar{\gamma}}{1+\beta+\gamma_1}\right]k - \frac{\gamma_1\varepsilon}{1+\beta+\gamma_1} \qquad (3.7)$$

and

$$\tau^* = \frac{-\beta k}{1+\beta} + \frac{\beta\varepsilon}{1+\beta+\bar{\gamma}} \qquad (3.8)$$

as the actual outcomes. They differ from the Bank's intended position only in the term in square brackets in (3.7). That term is positive but less than unity

if $\gamma_1 > \bar{\gamma}$. Hence, by choosing $\gamma_1 > \bar{\gamma}$, the Bank can reduce inflation on average – but at a cost to the variability of inflation (the variance of π^* is rising in γ_1). That provides a possible incentive for the Bank to strategically misrepresent its own preferences.

However, there is no change in the average deficit τ^* - either from what the Bank might have chosen for itself, (3.4b), or from what the private sector had expected (3.3b). The only change is that the deficit shows a higher variability in (3.8) than in (3.4b).[xvi] That is the trade-off inherent in misrepresenting ones preferences: lower inflation, but more active fiscal policies. Since the Central Bank will realise that it can achieve better results with less than full transparency, but at the cost of less fiscal stability than it might wish, these results help explain the usual Central Bank rhetoric and frustration over the fiscal authorities' apparent lack of fiscal discipline.

3.3 Will the Bank Use its Lack of Transparency Strategically?

The upshot of these results is that inflation may be lower on average, but more volatile than the private sector had expected. However the fiscal deficit will be no smaller, and it will be used more aggressively. As a result, it is not clear that the Central Bank would actually want to use this lack of transparency strategically. The opportunity is there. But whether this tactic actually produces more stable output, and an unambiguous incentive for the Bank to misrepresent its preferences, remains to be seen. If it does, then we have a plausible model of the ECB during its first three years: conservative monetary policies and strong rhetoric, but little attempt explain to those policies.

Inserting (3.2) and (3.3), or (3.2), (3.7) and (3.8), into (2.2) yields

$$y^*_{PS} = \frac{\beta k}{1+\beta} + \frac{\varepsilon}{1+\beta+\bar{\gamma}} \qquad \text{and} \qquad y^* = \left[\frac{\beta}{1+\beta} + \frac{\eta}{1+\beta+\gamma_1}\right]k + \left[1 - \frac{\eta(1+\beta)}{1+\beta+\gamma_1}\right]\frac{\varepsilon}{1+\beta+\bar{\gamma}}$$

which means that the Central Bank and the private sector both expect the same level of output if ε and η are uncorrelated. But it would expect a higher level of output volatility even so. And any counter-cyclical policies, if η and ε were negatively correlated, would destabilise output. Thus, if anything, an imperfectly transparent Central Bank would use its monetary policy procyclically. There have been moments during 2000 and 2001 when the ECB has appeared to do just that.

However, for simplicity, let us now assume that ε and η are distributed independently. In that case, the Central Bank will expect:[xvii]

$$EL^{*}_{CB} \cong \frac{1}{2}\left[\frac{\left(\bar{\gamma}^2+\sigma_n^2\right)\left(1+\beta+\bar{\gamma}\right)^2+\left(\gamma_1+\beta^2\right)\left[\left(1+\beta+\bar{\gamma}\right)^2+\sigma_n^2\right]+\gamma_1\left(1+\beta\right)^2\sigma_n^2}{\left(1+\beta\right)^2\left(\left(1+\beta+\bar{\gamma}\right)^2+\sigma_n^2\right)}\right]k^2$$

$$+\frac{1}{2}\left[\frac{\left(\bar{\gamma}^2+\sigma_n^2\right)\left(1+\beta+\bar{\gamma}\right)^2+\left(\gamma_1+\beta^2\right)\left[\left(1+\beta+\bar{\gamma}\right)^2+\sigma_n^2\right]+\gamma_1\left(1+\beta\right)^2\sigma_n^2}{\left(1+\beta+\bar{\gamma}\right)^2\left(\left(1+\beta+\bar{\gamma}\right)^2+\sigma_n^2\right)}\right]\sigma_\varepsilon^2 \tag{3.9}$$

Notice that, in (3.9), $\bar{\gamma}$ and σ_n appear in matched pairs of the same order in each term. This makes conservatism in monetary policy (credibility) and a lack of transparency into strategic substitutes, as far as the Bank is concerned. That would explain Issing's (1999) comments about Central Bank policy, in that the Bank will only have an interest in creating a lack of transparency, and misrepresenting its preferences as being more conservative than they really are, if:

$$E\left(L^{*}_{CB}\right)-E\left(L^{*}_{CB}(\gamma_1)\right)=\frac{1}{2}\left[\frac{\left(\bar{\gamma}^2+\sigma_n^2\right)\left(1+\beta+\bar{\gamma}\right)^2+\gamma_1\left(1+\beta\right)^2\sigma_n^2-\gamma_1^2\left(\left(1+\beta+\bar{\gamma}\right)^2+\sigma_n^2\right)}{\left(1+\beta\right)^2\left(\left(1+\beta+\bar{\gamma}\right)^2+\sigma_n^2\right)}\right]k^2$$

$$+\frac{1}{2}\left[\frac{\left(\bar{\gamma}^2+\sigma_n^2\right)\left(1+\beta+\bar{\gamma}\right)^2+\gamma_1\left(1+\beta\right)^2\sigma_n^2-\gamma_1^2\left(\left(1+\beta+\bar{\gamma}\right)^2+\sigma_n^2\right)}{\left(1+\beta+\bar{\gamma}\right)^2\left(\left(1+\beta+\bar{\gamma}\right)^2+\sigma_n^2\right)}\right]\sigma_\varepsilon^2<0 \tag{3.10}$$

where $L^{*}_{CB}(\gamma_1)$ denotes the Central Bank's welfare had it announced its chosen preferences exante. This expression is negative, if

$$\left(\bar{\gamma}^2+\sigma_n^2\right)\left(1+\beta+\bar{\gamma}\right)^2+\gamma_1\left(1+\beta\right)^2\sigma_n^2<\gamma_1^2\left(\left(1+\beta+\bar{\gamma}\right)^2+\sigma_n^2\right) \tag{3.11}$$

Hence the desire to use or maintain a lack of transparency, vanishes as $\sigma_n^2 \to 0$ since then $\gamma_1 \to \bar{\gamma}$. But an incentive to manipulate the private sector through a lack of transparency would still remain if σ_n^2 is not too large: (3.11) is satisfied by

$$\sigma_n^2 < \frac{(2\bar{\gamma}+\eta)\eta(1+\beta+\bar{\gamma})^2}{(1+\beta+\bar{\gamma})^2+\gamma_1\left((1+\beta)^2-\gamma_1\right)} \qquad (3.12)^{xviii}$$

That means the Bank will always want to engineer a reputation of being more conservative, *if* that doesn't create too much extra uncertainty at the same time. But (3.12) implies it is only possible to do that if η is strictly positive. In other words, there is a trade-off between the scope for manipulating information strategically and the extra degree of uncertainty created. But the Bank could always arrange to reveal just enough information to ensure (3.12) was satisfied. Moreover the right hand side of (3.12) is increasing in positive values of η, at least as long as the Bank wishes to remain more conservative than the government (γ_1 ? β), or if the private sector believes the Bank to be relatively conservative ($\bar{\gamma} \leq 1$). Those two conditions imply an increasing upper bound on the permitted values of σ_n^2; as does an increasingly conservative government (lower values of β). Under those circumstances, the incentive to manipulate through imperfect transparency increases.[xix]

3.4 The Bank's conjectures: the no "malice aforethought" solution

Our model of imperfect transparency assumes that the Central Bank pursues the conventional Nash equilibrium set up at the start, despite having access to private information. We do not consider what would happen if the Bank were to go back and reoptimise its decisions, taking into account what it now knows to be the disturbances which would be caused by its own lack of transparency, in (3.6), (3.7) and y^*. That is a perfectly valid alternative; but it produces a form of conjectural variations solution in which the Bank exploits the fact that it can use its access to private information as a form of leadership which forces the private sector/fiscal authority off its optimal reaction function. That would help the Bank, but not the private sector or fiscal authority. It implies a one-sided variation around the Nash solution, the opportunity for which arises only when the Bank actively and consciously pursues the consequences of its lack of transparency. That is the solution discussed in appendix B.

By contrast, we have the Bank passively allowing imperfect transparency to have its effect. Although this may make the Bank worse off than under a more active strategy, society as a whole will be better off. This, we argue, is closer to Issing's (1999) perception that the purpose of a lack of transparency

is to separate "the need to know" from "the need to understand" – without injecting any incentive to confuse, or for the public "not to know" at the same time.

Our solution therefore contains no "malice aforethought". Nevertheless the key point is that, even with this less self-interested solution, the Bank will still find that it has an incentive to create and exploit a strategic reputation for its own ends. If the Bank discovers that it can benefit from a strategic reputation in a restricted class of "optimal" decisions, then it will still want to exploit that reputation in any solution that allows for further re-optimisations – since any new solution must at least reach the performance of the old. Hence our solution is sufficient to identify the incentive for a strategic reputation among more liberal Central Banks who opt for less than full transparency.

4. IMPERFECT TRANSPARENCY OVER POLICY GOALS

4.1 Measurable Information vs. Inferred Information

We now compare our preference transparency results, with the "control errors" approach of Faust and Svenson (2000), Cukierman (2000), Jensen (2000) and Geraats (2002), in which the question of transparency is restricted to the measurable elements in the private sector's information set. That information set includes the exogenous conditioning information, any decisions made by other players outside the game, and the desired values for the target variables of any player modelled within the game. It does not include any endogenous variables from the same period since such variables could not be part of any player's conditioning information. And it does not include any information which is not directly observable, but which has to be inferred from observations on those endogenous variables. Typically that covers the model parameters and the preference parameters which have been used by the associated decision makers. In other words we are making a distinction between what is measurable, publicly or privately, through conventional data gathering techniques; and what can be obtained only by inference or deduction from observed behaviour, i.e. upon additional assumptions about economic behaviour, optimisation, risk aversion or the underlying probability models. The only exception to this classification might be the intended values for the target variables, which might have to be inferred[xx]. But that doesn't matter as we shall see.

4.2 The "Control Errors" Approach

The conventional analysis of this kind of transparency problem has the central bank in office for a notional two period interval, but allows no fiscal policy or wage setting decisions. That forces the Bank to consider its policies over a two period horizon, but implies that the Bank will retain the right to release further information/data about its intentions and conditioning information at the end of the first period. This, according to Padoa-Schioppa (2000), is exactly how the European Central Bank operates and is intended to operate. Thus, the Bank now has a two-period loss function like (2.1):

$$L^{CB} = \frac{1}{2}\left(\pi_t^2 + t_t^2 + \gamma\left(y - k_{CB}\right)^2\right) \qquad (4.1)^{xxi}$$

in which k_{CB} contains the Bank's output target and "preferred" conditioning information. But, as in Section 3, output responses depend on the markets expectations for inflation. And π_t^e is defined to be $E(\pi_{t+1}|I_t)$; the inflation rate which is expected to hold at end of period t and into period t+1 – that is, after the decisions of period t have been taken and implemented. It is therefore conditional on the private sectors information at the start of period t. However, as π will be chosen as a function of k_{CB} and hence depends on the Bank's information set, it is obvious that an outsider will be unable to distinguish between random shocks to output, and mistakes made in the values assumed for k_{CB}. Hence there is a role for transparency here. The Bank could reveal the true value of k_{CB}: for example, by publishing its inflation forecasts (Geraats, 2002), or it could decide not to do so. And given those forecasts and the assumptions which underlie them, the private sector could deduce the value of k_{CB} from (2.6) as long as there is no preference uncertainty at the same time.

4.3 Would the Central Bank find this Lack of Transparency Useful?

If we take the preference parameters to be known we have the following loss functions :

$$L_{CB} = \frac{1}{2}\left[\pi^2 + \tau^2 + \gamma\left(y - k_{CB}\right)^2\right] \qquad \text{where } \gamma < \beta \qquad (4.2)$$

for the Central Bank; and

$$L_{FA} = \frac{1}{2}\left[\pi^2 + \tau^2 + \beta(y - k_{FA})^2\right] \tag{4.3}$$

for the government. We suppose the Bank's conditioning information and implicit target values to be uncertain:

$$k_{CB} = k_{FA} + v \tag{4.4}$$

where k_{FA} is the private sector's estimate (known also to the Bank), and v is a random variable with mean zero and variance σ_v^2. Information on k_{CB} remains the Bank's private property.

The private sector and the fiscal authorities will now have to use k_{FA} as their best estimate of k_{CB} when computing their versions of π^e and π^*. Likewise the Central Bank must assume the fiscal authorities will use k_{FA} when computing its estimate of the fiscal authorities' reaction function for τ, and that π^e refers private sector expectations throughout. Hence we will get inflation from (2.3) with $k = k_{CB}$ and the fiscal balance from (2.5) with $k=k_{FA}$; where it is understood that $\pi^e = \gamma k_{FA} / (1+\beta)$, and that the fiscal authorities have to use their own estimate of $\pi = f(k_{FA})$ to solve out (2.3) and (2.5). That leads to:

$$\pi^* = \frac{\gamma}{1+\beta} k_{FA} - \frac{\gamma(\varepsilon - (1+\beta)v)}{1+\beta+\gamma} \tag{4.5}$$

$$\tau^* = \frac{-\beta}{1+\beta} k_{FA} + \frac{\beta\varepsilon}{1+\beta+\gamma} \tag{4.6}$$

and

$$y^* = \frac{\beta}{1+\beta} k_{FA} + \frac{\varepsilon + (1+\beta)\gamma v}{1+\beta+\gamma} \tag{4.7}$$

Since the Central Bank knows its choice of v, this means

$\pi^e - \pi^e_{FA} = \gamma v / (1+\beta)$, $\pi^* - \pi^*_{FA} = \gamma(1+\beta)v / (1+\beta+\gamma)$, and $\tau^* - \tau^*_{FA} = 0$.

Hence the Central Bank might be tempted to manipulate its choice of

inflation target by choosing $v < 0$ (i.e. by choosing a lower inflation target, $k_{CB} < k_{FA}$). But that won't affect either the decisions of the fiscal authorities (τ^*), or private sector beliefs $\left(\pi^e_{FA}\right)$. In that case, inserting (4.5) - (4.7) into (4.3) yields

$$E L^*_{FA} = \theta_1 k^2_{FA} + \theta_2 \sigma_\varepsilon{}^2 + \theta_3 \sigma_v{}^2 + \theta_4 \rho \sigma_\varepsilon \sigma_v \qquad (4.8)$$

where $\theta_1 = \dfrac{\left(\gamma^2 + \beta^2 + \beta\right)}{2(1+\beta)^2} > 0$ $\qquad$ $\theta_2 = \dfrac{\left(\gamma^2 + \beta^2 + \beta\right)}{2(1+\beta+\gamma)^2} > 0$

and $\theta_3 = \dfrac{\gamma^2 (1+\beta)^2 (1+\gamma)}{2(1+\beta+\gamma)^2} > 0$ $\qquad$ $\theta_4 = \dfrac{\gamma(1+\beta)(\beta-\gamma)}{(1+\beta+\gamma)^2} \geq 0$

where $\mathrm{Cov}(\varepsilon, v) = \rho \sigma_\varepsilon \sigma_v$; ρ = the correlation coefficient; and $\gamma \leq \beta$.

Equation (4.8) shows that a lack of goal transparency does indeed harm social welfare since $\theta_3 > 0$. But the more the Bank's policies turn out to be countercyclical ($\rho < 0$), the less this matters. Moreover $\partial \theta_3 / \partial \gamma > 0$ for all $\gamma \leq 1$. That implies goal transparency and credibility are strategic complements; or, equivalently, that a lack of transparency and credibility are substitutes (as might have been inferred from Issing's (1999) discussion). But once again, the more conservative the Central Bank, the less important is this issue of goal transparency.

Thus a Central Bank which is able to achieve credibility by single-mindedly controlling inflation, has little need to worry about economic transparency or the need to provide it. That reflects the ECB's attitude very well. Moreover, any Central Bank will be less concerned about transparency than the private sector since

$$E L^*_{CB} = \phi_1 k^2_{FA} + \phi_2 \sigma_\varepsilon{}^2 + \phi_3 \sigma_v{}^2 + \phi_4 \rho \sigma_\varepsilon \sigma_v \qquad (4.9)$$

where $\phi_1 = \dfrac{\left(\gamma^2 + \beta^2 + \gamma\right)}{2(1+\beta)^2} > 0$ $\qquad$ $\phi_2 = \dfrac{\gamma^2 + \beta^2 + \gamma}{2(1+\beta+\gamma)^2} > 0$

and $$\phi_3 = \frac{\gamma^2(1+\beta)^2 + (\beta(\gamma-1)-1)^2}{2(1+\beta+\gamma)^2} > 0 \qquad \phi_4 = \frac{\beta\gamma - (\beta+1)(1+\gamma^2)}{(1+\beta+\gamma)^2} < 0$$

where $\phi_3 < \theta_3$. And it will favour procyclical policies, rather than the countercyclical targets preferred by the private sector, since $\phi_4 < 0$ but $\theta_4 \geq 0$.

4.4 Political Economy Implications

Figures 1 and 2 below show some consequences of these results. Figure 1 shows the private sector welfare losses, with and without full economic transparency, for some plausible values of the parameters in our problem. Imperfect transparency clearly causes losses to the private sector if ρ ? 0; that is if monetary policy becomes more procyclical. But it may improve it if $\rho \leq 0$ and σ_ε is not too large.

Figure 2 meanwhile shows the private sectors welfare function for different levels of fiscal activism (β). An increasing lack of transparency clearly makes the private sector want governments to become more cautious about fiscal policy – simply because it cannot be sure how the Central Bank would react with its monetary policy if fiscal policy were to be used more vigorously.

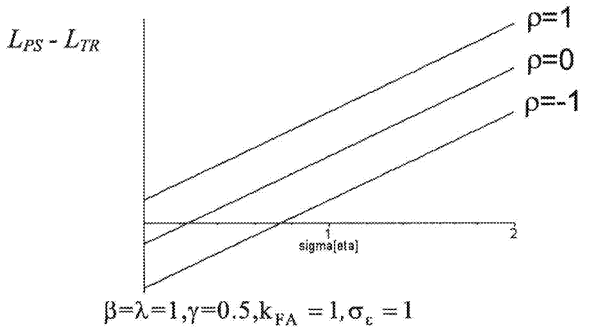

Figure 1. Difference between the private sector objective function without and with transparency for different correlation coefficients

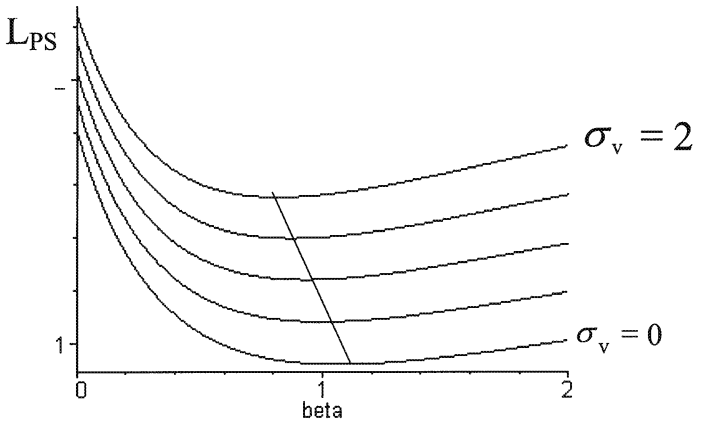

Figure 2. Private sector welfare function for different levels of fiscal activism

The significance of these two diagrams is that the lower the value of σ_v^2 (the more goal transparency), the better the outcomes for the private sector. But (4.9) shows that smaller values of σ_v^2 leads to smaller values of EL_{CB}^*

unless $\rho > \frac{-\phi_3 \sigma_v}{\phi_4 \sigma_\varepsilon} > 0$. Hence, except in the case of very procyclical policies $(\rho > 0)$ in a world of large output shocks $(\sigma_\varepsilon$ large$)$ [xxii], the Central Bank will have no incentive to try to manipulate the outcomes through imperfect (goal) transparency.

5. CONCLUSIONS

As it offers no strategic opportunities to the Central Bank, except as a substitute for credibility which may be difficult to acquire by other means, economic transparency is really an exercise in controlling the use of private information. It does not allow the Bank to make better decisions. Hence the more conservative the Central Bank, the less it will feel the need to provide full transparency in this sense. However, that may be less apparent to a private sector that needs information pooling in order to make better decisions. Hence the suspicion that the Central Bank is being too conservative, or too favourable to procyclical policies, may remain.

Political transparency is quite different. Here the Bank has a clear strategic interest in restricting transparency. But the private sector would clearly benefit from greater transparency in this sense, since it could then make better (as well as better informed) decisions. Political transparency therefore allows us to understand how decisions are made, as well as what information goes into them. It is important to maintain a distinction between these two forms of transparency since creative economic transparency alone would provide no protection against the Bank's incentive to establish a strategic reputation in order to manipulate private sector expectations.

NOTES

[i] See the discussions in Friedman (1997), Bomfin and Reinhart (2000) or Sheffrin (1989).

[ii] See King (1997), Eijffinger et al (2000), de Haan and Eijffinger (2000).

[iii] Financial Times, 7 March 2000.

[iv] Output is measured in deviations from its long run, full capacity level: y_c. It is important to note that the inclusion of τ in (2.1) will have no influence on the Central Bank's first order conditions. We have included τ here only because many Central Banks appear to be very concerned about the fiscal stance of their governments - even though they cannot affect fiscal policy themselves.

[v] Like Debelle and Fischer (1994) and Nordhaus (1994), we do not include an explicit budget constraint in our model. Instead we constrain fiscal policy by placing explicit penalties on the use of fiscal policy by the fiscal authorities, see (2.4) below. Standard theory would then produce a feedback rule which satisfies the sufficient conditions required for long term solvency and the "cash in advance" constraint (Canzoneri et al, 2001), and which endogonises expenditures and the financing costs. Consequently, we do not need to report the components of the budget constraint or debt separately.

[vi] If, following Rogoff's arguments, the Central Bank should be at least as conservative as the government, then $\gamma \leq \beta$. Demertzis et al (1999) show that the electoral mechanism will typically deliver exactly that result.

[vii] Note that (2.5) is invariant to changes in the parameter (of unity) on τ in (2.4).

[viii] See Barro and Gordon (1983) Rogoff (1985), Debelle and Fisher (1994), Alesina and Gatti (1995), McCallum (1997).

[ix] See Beetsma and Jensen (1998), for example.

[x] That is the normalisation adopted in most studies of transparency: see the papers by Cukierman (2000), Sibert (2001) or Muscatelli (1998).

[xi] In other words, any systematic information that the Central Bank may have on ε is assumed to have been incorporated into k (Walsh, 2002). But whether the Bank will choose to reveal that information is the subject of Section 4. Canzoneri (1985) argues that the credibility of the Bank's policies may fall apart if its forecasts are private information because wage setters cannot tell if the Bank is performing as promised – even taking into account the different forms of information uncertainty, the Bank's forecasts will be related to k. The Bank may then have an incentive to misrepresent. Canzoneri suggests certain rules to overcome this difficulty. But as we see in Section 4.2, this is unlikely to be a major issue.

[xii] An alternative formulation would be the "constructive ambiguity" approach of Cuckierman and Meltzer (1986), and Balke and Haslag (1992). This involves constructing time varying, random preference parameters with persistence, to represent changing, and partly uncertain, priorities for output stabilisation vs. monetary control. However, this is done through a linear term in the Central Bank's objective function; and since a linear term is equivalent to a shift in the target value for the corresponding variable in the quadratic term (Hughes Hallett and Rees, 1983), this approach is formally equivalent to marking k time varying and uncertain. We deal with that case in Section 4. Nevertheless, we should note that imperfect transparency may still be left in the problem because of the costs of gathering information on the Bank's true intentions, and because variability in monetary policies will increase the desire to uncover those intentions. On the other hand, the Bank may want to preserve some ambiguity because it allows the Bank to operate "opportunistically": that is, sharpen the timing of its actions (surprise inflation in slumps, tighter policies in booms), just as Blinder (1997) has argued.

[xiii] From now on we write $L_{i/j}$ to denote the objective function of player i evaluated conditional on the information set of player j. And, in order to keep things simple, we will assume that, the private sector and the fiscal authorities share information sets.

[xiv] See Theil (1964). In fact it is rather easy to show that the error in using first order certainty equivalence is almost certainly small: less than 10% of the "true" expected inflation rate on any reasonable assumptions for the underlying parameters (see Appendix A for details). Thus, if the private sector is led to expect an inflation rate of approximately 2%-3%, the true expectation should have been a little above 1.8%-2.7%. That means there is really very little incentive for either the private sector to make their expectations more accurate (especially if it costs a lot to do so); or for the Central Bank to revise and refine their monetary policy decisions on the basis of the true expectations revealed by (3.6) – given that (2.2) shows that output reacts to expectations in the market, not to what the Central Bank may think.

[xv] That means it would be impossible to get a full rational expectations equilibrium when one player is forced, through incomplete information, to make a series of approximation errors – unless the private sector finds it worthwhile to employ a learning algorithm which is able to fit values of γ_1 such that their calculation of π^e converges (eventually) onto the mean of the inflation outcomes actually experienced.

[xvi] Recall that $\tau<0$ represents a deficit. (3.8) shows greater variability than (3.4b) since $\gamma_1 > \bar{\gamma}$ is the condition required for lower inflation on average.

[xvii] Each loss function value quoted here and below depends on substituting the associated policy choices into the appropriate loss function: i.e. (3.7), (3.8) and y* into (2.1) for (3.9); or (3.3a,b) and y^*_{ps} into (2.1) for (3.10). To evaluate $E\pi^{*2}$ and $E(y^*-k)^2$ we have to apply our assumption of the independence of ε and η in order to evaluate terms such as $E\eta^2\varepsilon^2$ or $E\eta^2\varepsilon$; and assume independence, and also first order certainty equivalence, to obtain

$$E\left(\eta^2/\left(1+\beta+\gamma_1\right)^2\right) \cong \sigma_n^2/\left[\left(1+\beta+\bar{\gamma}\right)^2+\sigma_n^2\right]$$

and

$$E\left(\gamma_1/\left(1+\beta+\gamma_1\right)^2\right) \cong \left(\bar{\gamma}^2+\sigma_n^2\right)/\left[\left(1+\beta+\bar{\gamma}\right)^2+\sigma_n^2\right].$$

[xviii] We have assumed that the denominator of (3.12) is positive: $\eta \leq 1+\beta$ would be sufficient, which implies the private sector assumes that, irrespective of the value of γ_1 finally chosen, the Central Bank will remain more conservative than the government.

[xix] Our strategic reputation result also appears in Sibert's (2001) dynamic analysis, which shows that the private sector would expect less inflation if there were no private information problems – and increasingly so, the more inflation averse are the policy makers preferences for future periods. That is the same result, as we have it in this section. But the strategic reputation effect may be exploited less in the first period, when the Bank's reputation is at its most vulnerable. As a result inflation, and the strategic reputation effect, are more affected by the length of time left in office than by current or past performance. Nevertheless these are results from a model without fiscal policy or output stabilisation. We conjecture that they generalise to our model, and can show that to be the case even when the private sector uses the correct expectations for π^e and the Bank reoptimises in the knowledge of what its lack of transparency will do to private sector decisions (the "malice aforethought" solution of appendix B).

[xx] Recall that any decision problem under uncertainty can be split into four components: the objective (preferences and aspirations), the model (the feasible constraints), the measure of risk aversion, and the (external) conditioning information: Hughes Hallett and Rees (1983). All we have done here is put aspirations (target values) into the "observable" information set, leaving the preferences (relative priorities), the model and risk aversion measure in the "inferred" information set.

[xxi] For comparability, Geraats also has a linear term for y_t-k_{CB} which implies an adjustment to k_{CB} in (4.1), and (without loss of generality) we have rescaled the output measure in order to remove the scale parameter in Jensen's inflation equation. Geraats also has the uncertain target value on inflation rather than output, but that is just an alternative normalisation for the purposes of our analysis (Jensen, 2000).

[xxii] Note $\rho > 0$ implies $\sigma_v \neq 0$. And that $\phi_3/\phi_4 < 0$ holds for all $\beta, \gamma > 0$.

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Appendix A: The error in the first order approximation at (3.6)

To evaluate this error, we have to evaluate the expectation terms in (3.6):

$$\mathrm{E}\left(\frac{\gamma_1}{1+\gamma_1+\beta}\right) \approx \frac{\bar{\gamma}}{1+\beta+\bar{\gamma}} - \frac{\mathrm{Cor}\left(\gamma_1, 1+\gamma_1+\beta\right)}{\left(1+\beta+\bar{\gamma}\right)^2} - \frac{\bar{\gamma}\,\mathrm{Var}\left(1+\gamma_1+\beta\right)}{\left(1+\beta+\bar{\gamma}\right)} \qquad \text{(A1)}$$

where $\bar{\gamma} = \mathrm{E}(\gamma_1)$, and β is fixed and known to the government and private sector. But $\mathrm{Var}\left(1+\gamma_1+\beta\right) = \sigma_n^2$ and $\mathrm{Cor}\left(\gamma_1, 1+\gamma_1+\beta\right) = \sigma_n^2$. Hence

$$\pi^e \approx \theta \frac{\bar{\gamma} k}{1+\beta} \text{ where } \theta = \frac{\bar{\gamma}\left(1+\beta+\bar{\gamma}\right)^2 - \sigma_n^2\left(1+\beta\right)}{\bar{\gamma}\left[\left(1+\beta+\bar{\gamma}\right)^2 + \sigma_n^2\right]} \leq 1 \text{ all } \sigma_n^2$$

follows from the left hand side of (3.6). The "true" expectation is therefore proportional to our first order equivalent approximation, with the factor of proportionality being less than unity but approaching unity as $\sigma_n^2 \to 0$. In fact

$$1-\theta = \frac{\sigma_n^2\left(1+\bar{\gamma}+\beta\right)}{\bar{\gamma}\left[\left(1+\beta+\bar{\gamma}\right)^2 + \sigma_n^2\right]} \qquad \text{(A2)}$$

so that: a) $\theta \to 1$ monotonically as $\sigma_n^2 \to 0$; b) θ approaches 1 as $\bar{\gamma}$ increases; and c) $\theta \to 1$ as β increases. Conversely $1-\theta$ increases as $\bar{\gamma} \to 0$, or $\beta \to 0$. Consequently the more conservative the Central Bank and/or the more conservative the fiscal authorities, the larger is the error in the first order approximation and the lower the "true" expectations for

inflation should be. But, as we show next, the policy authorities would really have to be extremely conservative for those errors to be of any significant size. For all reasonable values of β and $\bar{\gamma}$, including some fairly conservative values, the expectations error would be less than 10%.

a) Suppose γ_1 is distributed uniformly on the unit interval, implying that the Central Bank is always conservative with respect to inflation control. Then $\bar{\gamma} = \frac{1}{2}$ and $\sigma_n^2 = \frac{1}{12}$. Equation (A2) now implies the error in π^e would be less than 10% if $\frac{1}{6}(1.5+\beta) \Big/ \left[(1.5+\beta)^2 + \frac{1}{12}\right] < 0.1$; i.e. if $\beta \geq 0.117$.

In other words, we could be 100% sure that the error in π^e would be < 10% if β was at least greater than a value four times smaller than the Central Bank's preference for output stabilisation. That seems inevitable. It would take an outrageously conservative government, relative to the Central Bank, to produce errors larger than this.

b) Suppose γ_1 is distributed uniformly on the interval (0,0.9). Then $\bar{\gamma} = 0.45$, $\sigma_n^2 = 0.061$ and the expectations errors will be < 10% for <u>any</u> value of $\beta \geq 0$.

c) Suppose γ_1 is distributed normally such that 99% of the distribution (±3SD) lies within the unit interval. Then we are 99% certain the error in π^e will be < 10% if

$$\bar{\gamma}(1+\beta+\bar{\gamma})/9 \Big/ \left[(1+\beta+\bar{\gamma}) + \bar{\gamma}^2/9\right] < 0.1$$

i.e. if $\gamma \geq 0.1$, given <u>any</u> value of $\beta > 0.01$. Or if $\beta \geq 0.1$, given any value of $\bar{\gamma} > 0.01$. Again, it seems almost certain that these inequalities would be satisfied.

Appendix B: The Incentive to use Imperfectly Transparent Strategies when the Bank Optimises with Malice Aforethought.

We examine the outcomes, and the incentive for the bank to use its imperfect transparency strategically by strategically misrepresenting its preferences with $\eta > 0$, when the Bank reoptimises its monetary policy conditional on the private sectors response to the Bank's access to private information (imperfect transparency). This is the "malice aforethought" solution which was avoided in section 3.4. We will also assume that the private sector would (eventually) learn to use the corrected inflationary expectations: $\pi^e = \bar{\gamma}\bar{k}/(1+\beta)$ from appendix A, where $\bar{k} = \theta k$.

The Bank's reoptimisation, (2.3) with π^e above and (3.8), yields

$$\pi^* = \frac{\gamma_1}{1+\gamma_1}\left(\frac{1+\bar{\gamma}}{1+\beta}\right)\bar{k} - \frac{\gamma_1(1+\bar{\gamma})\varepsilon}{1+\gamma_1(1+\beta+\bar{\gamma})} \qquad \text{(B1)}$$

and $E\pi^* = \frac{\bar{k}}{1+\beta}\left(\bar{\gamma} - \frac{\sigma_n^2}{(1+\bar{\gamma})^2}\right)$. Hence $E\pi^* < \pi^e$ in this case too, since $\sigma_n^2 \neq 0$ by assumption. Now evaluating L_{CB}, we get

$$L_{CB} = \frac{\bar{k}^2}{(1+\beta)^2}\left\{\frac{(\bar{\gamma}+\eta)^2(1+\bar{\gamma})^2}{(1+\bar{\gamma}+\eta)^2} + \beta^2 + \frac{\gamma_1\left[(1+\beta)-1\right]}{(1+\bar{\gamma}+\eta)^2}\right\} \qquad \text{(B2)}$$

plus other terms not involving η or σ_n^2. Hence, using $\gamma_1 = \bar{\gamma} + \eta$,

$$\frac{\partial L_{CB}}{\partial \eta} = \frac{2\gamma_1\left\{(1+\bar{\gamma})^2 + \left[(1+\beta)\eta - 1\right]\left[(1+\beta)(1+\bar{\gamma})+1\right]\right\}}{(1+\bar{\gamma}+\eta)^3} \qquad \text{(B3)}$$

Since the first term in curly brackets is positive, we need to choose $\eta < 1/(1+\beta)$ to make the second term negative and hence have a chance of reducing/minimising L_{CB} in this reoptimisation exercise. In fact the optimal choice in this case would be

$$\eta^* = \frac{(1+\bar{\gamma})(\beta-\bar{\gamma})+1}{(1+\beta)^2(1+\bar{\gamma})+(1+\beta)} \qquad \text{(B4)}$$

which is positive as long as $\beta \geq \bar{\gamma} - 1/(1+\bar{\gamma})$, and never too negative $(\eta > -\bar{\gamma})$. Consequently, there is always an optimal choice of η, and hence always an incentive to exploit imperfect transparency by creating a strategic reputation even in this case of malice aforethought and corrected inflationary expectations. The manipulation of information on preferences is the way to do that, and in all reasonable cases (i.e. $\beta \geq \bar{\gamma}$) it requires the Bank to represent itself as being more conservative than it really is $(\bar{\gamma} < \gamma_1$, or $\eta > 0)$. The conclusions of section 3 therefore go through unchanged.

Chapter 9

EUROBOND MARKET INTEGRATION

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Abstract: The paper explores the issue of integration in the Eurocurrency market. In particular, by using information from the short end of the Eurodollar, Euromark and the Eurosterling term structures we explore their dynamic links. The empirical analysis employs the Johansen Multivariate Cointegration methodology and the Principal Components Analysis in order to test for the presence of common dynamic factors among the selected Eurocurrency interest rates. The findings provide evidence in favour of an integrated market.

Keywords: Cointegration, Eurocurrency, Market Integration, Principal Components Analysis.

1. INTRODUCTION

The integration of international bond markets, or 'globalisation' has increased dramatically during the 1980's and 1990's (Caramaza et al., 1986; Blundell-Wignall and Browne, 1991; Frankel, 1992; Arshanapalli and Doukas, 1993, 1994; Goldstein and Mussa, 1993; Goodwin and Grennes, 1994; Bremnes et al, 1997; Fase and Vlaar, 1998). Integration of the bond markets is equivalent to interest rate convergence, defined as a tendency of interest rates across countries (different financial centres) to synchronise (Christiansen and Piggot, 1997).

Mundell (1968) provided a very intuitive economic rationale for interest rate convergence based on first principles, where the degree of capital mobility would determine the degree of substitutability of international assets and ultimately would determine the extent of their comovement. In this context, given that there is sufficient capital mobility enabling meaningful substitutability among international assets, spreads will tend to narrow down and interest rates will move together.

Given the increasing deregulation (Gruijters, 1995), international capital mobility has accelerated international capital movements both in terms of speed and volume (Tesar and Warner, 1992). In that respect, Mundell's predictions are now more relevant than ever. However, although intuitive, Mundell's model cannot cope sufficiently with today's globalised markets. Therefore, one needs a different model to account for interest rate comovement. A model would serve for this purpose if it perceived international assets as being traded in a homogeneous market. Homogeneity here is defined as the situation where interest rates are determined not only by individual country's conditions but also by factors operating at the global level.

Two classes of models have this characteristic embedded in their construction. The first includes the Capital Asset Pricing Model (CAPM hereafter) (Sharpe, 1964) in its international form (Solnik, 1976), and the Consumption-based CAPM (Breeden, 1979). The second class includes Arbitrage Pricing Models (APT, hereafter) (Ross, 1976).

Modern theories dealing with the pricing of risk, identify asset risk as the 'additional' risk borne by the 'representative' investor when the particular asset is included in a well-diversified portfolio. Therefore, risk is expressed in terms of covariance (correlation) with a benchmark. For instance, in the international CAPM it is the covariance with the 'world' market portfolio that constitutes the so-called systemic risk, whereas in the Consumption based CAPM it is the covariance with the intertemporal marginal rate of substitution of consumption, and finally in the APT it is the covariance with a vector of fundamental risk factors. Although, the above models propose different ways of measuring risk, that is use different benchmarks, the important thing is their assertion that international assets are determined by a common set of international factors rather than country-specific factors alone. Empirical evidence for the presence of a set of common factors underlying the determination of interest rates has been provided by a number of researchers (Barro and Sala-i-Martin, 1990; Harvey, 1991; and Sutton, 1996).

The goals of the present paper are to explore to what extent international bond's interest rates have moved together, and furthermore, if comovement is present whether one can discern any pattern in it. A subset[1] of Eurobond interest rates spanning different maturities from the short-end of the spectrum (1-month, 3-months, 6-months) denominated in Deutsche Mark, Pound Sterling, and US Dollar will be used.

The choice of the particular interest rates was based on three considerations. Firstly, it was essential that the sample included rates from different geographical and economic regions (financial centres). Secondly, it

was also important to include different maturities in order to avoid maturity-specific inferences and also exploit the information embedded in the respective term structures. Thirdly, the Eurocurrency market is a non-domestic financial intermediary, so Eurocurrency assets are comparable in all aspects except currency of denomination. Furthermore, they are less affected than on-shore rates by capital controls, tax considerations and legal regulations, which could drive observed rates away from equilibrium levels. Finally, these rates do not depend on factors such as default risk, the calculation of yield etc.

The Eurobond market integration hypothesis will be investigated by employing two statistical tools: Firstly, the Johansen Multivariate Cointegration procedure (Johansen, 1988, 1991, 1995) will be used in order to uncover any common stochastic trends underlying the variables' dynamic paths. Secondly, a Principal Components Analysis (Hotelling, 1933) will be applied in order to test for the existence of any common factors affecting the rates' behaviour.

The paper will be organised as follows. Section 2 will describe the data used in the analysis. Section 3 will briefly provide the statistical background for the two methodologies. Section 4 will present the empirical results and finally Section 5 will conclude.

2. DATA ISSUES AND STATIONARITY TESTS

The dataset consisted of end-of-month observations from the short-end of the nominal term structure of the Eurocurrency market for bonds with maturities of 1-month, 3-months, and 6-months. The interest rates used were denominated in Deutsch Mark, Pound Sterling, and US Dollar. Sampling begins at November 1988 and ends November 2000 providing 144 data points available for the analysis. The Bank of International Settlements kindly supplied the data set.

Table 1 reports the unit root tests (Dickey and Fuller, 1979, 1981; Phillips and Perron, 1988) for the series. As expected, the null of non-stationarity was not rejected for the levels of all series implying that standard asymptotic theory cannot be applied. In contrast, the null of non-stationarity was comfortably rejected for the first differences of the series leading one to conclude that all of them were integrated of order one [I(1)].

Table 1: Unit Root Tests

Level	ADF	PP	First Difference	ADF	PP
ED1	-2.16	-1.54	ED1	-4.93*	-14.59*
ED3	-2.05	-1.62	ED3	-5.09*	-10.8*
ED6	-2.13	-1.7	ED6	-5.4*	-9.6*
EM1	-1.19	-0.82	EM1	-4.88*	-11.64*
EM3	-1.28	-0.83	EM3	-5.02*	-10.08*
EM6	-1.23	-0.85	EM6	-4.98*	-9.92*
ES1	-1.59	-0.196	ES1	-4.96*	-10.03*
ES3	-1.64	-1.1	ES3	-5.27*	-9.99*
ES6	-1.72	-1.2	ES6	-5.48*	-10.21*

Notes: ADF stands for the Augmented Dickey and Fuller (1979, 1981) 'pseudo' t-statistic with intercept. PP stands for the Phillips-Perron (1988) statistic with intercept. The asterisk denotes significance at the 5% level. Critical value at the 5% level is -2.89. ED stands for Eurodollar, ES of Eurosterling and EM for Euromark, the number attached stands for the maturity of the interest rate.

3. ECONOMETRIC METHODOLOGY

Since the primary goals of this paper are to explore the degree of interest rate convergence and to account for the variance among interest rates the Cointegration and Principal Components methods will be employed. The following two subsections will briefly review the statistical backgrounds for the two methods. The two statistical tools should not be perceived as competing, they are rather complementary. Both the Cointegration framework and the Principal Components Analysis focus on uncovering the common set of factors that can account for the realised in-sample correlation structure of the variables at hand. In that respect, they are set out to provide an answer to the same empirical question. Their complementarity[ii] arises from the fact that Cointegration focuses on the long run structure (and thus

exploiting their stochastic trends), whereas Principal Components focuses on the short run structure[iii].

3.1 The Johansen Procedure

The Johansen procedure (Johansen, 1988, 1991, 1995) starts with the definition of an *n*-dimensional vector of non-stationary variables *X*, which potentially form a cointegrating set. The Vector Autoregressive (VAR) representation of the unrestricted system with Gaussian error *u* is:

$$X_t = A_1 X_{t-1} + A_2 X_{t-2} + \ldots + A_k X_{t-k} + u_t \qquad (1)$$

Where $u_t \sim N(0, \Sigma)$ and X_t is $(n \times 1)$ and each of the A_i is an $(n \times n)$ matrix of parameters. Model (1) can be reformulated into a Vector Error Correction (VECM) form:

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \Gamma_2 \Delta X_{t-2} + \ldots + \Gamma_{k-1} \Delta X_{t-k-1} - \Pi X_{t-k} + u \qquad (2)$$

Where $\Gamma_i = -(I - A_1 - \ldots - A_i) \qquad i = 1, 2, \ldots, k-1$, and

$\Pi = -(I - A_1 - \ldots - A_k)$.

The rank of matrix Π determines whether there are any significant cointegration vectors between the variables. Clearly if the rank of Π is zero the matrix is null and (2) is just a VAR model in first differences. The other extreme case is when Π has full column rank, which is equivalent to the stationarity of the vector process. The intermediate case of reduced column rank implies that there exist stationary linear combinations of the variables, corresponding to the cointegration vectors. Furthermore, Johansen has developed a sequence of Likelihood Ratio (LR) tests to test for the number of the cointegration vectors (or equivalently the rank of II) the so-called trace test (denoted by $\lambda_{tr)}$ and the maximum eigenvalue test (denoted by λ_{max}). Critical values obtained from Monte Carlo simulations of the limiting distribution are given in Johansen and Juselius (1990) and Osterwald-Lenum (1992). The Johansen procedure is known to be sensitive to deviations from 'whiteness' for the residuals. In particular, autocorrelation has adverse effects on inference, therefore for that reason the lag length was chosen so as to guarantee that autocorrelation is absent.

3.2 The Principal Components Analysis

The Principal Components Analysis (PCA, hereafter) (Hotelling, 1933)[iv]. Let[v] z_{it} denote the standardised ith rate of interest at time t. If all interest rates observed move proportionately, then:

$$z_{it} = \alpha_{i1} f_{1t} \tag{3}$$

for all i and t, with α_{i1} a set of constants to be determined and f_t the non-observable first principal component. In general, (3) will only hold approximately. Therefore, one seeks to determine those α_{i1} and f_{it}, which will minimise the residual sum S_1, with

$$S_1 = \sum_t \sum_i (z_{it} - \alpha_{i1} f_{1t})^2 \tag{4}$$

Because (4) is determined up to a constant factor usually the following normalisation is imposed:

$$\sum_i f_{1t}^2 = 1 \tag{5}$$

It can be shown that (4) attains its minimum when:

$$f_{1t} = \frac{1}{\lambda_1} \sum_i z_{it} \alpha_{i1} \tag{6}$$

Where λ_1 denotes the largest eigenvalue of the (p x p) matrix (m_{ih}) with:

$$m_{ih} = \sum_i z_{it} z_{ih} \tag{7}$$

and i, h = 1,2,...,p while the α_{i1} are derived from the elements of the corresponding eigenvector by multiplying with ?λ_1. It may therefore, be shown that:

$$\lambda_1 = \sum_i \alpha_{i1}^2 \tag{8}$$

Expression (6) implies that f_1 is a linear function of the observed variables with coefficients proportional to the elements from the eigenvector

corresponding to the largest eigenvalue λ_1.The second principal component may be taken in the same way from the resulting residuals. In general, the *k*th principal component is obtained as:

$$f_{kt} = \frac{1}{\lambda_k} \sum_i z_{it} \alpha_{ik} \tag{9}$$

It should also be noted that by construction each principal component is orthogonal to all others. In equation (8) λ_k denotes the *k*th eigenvalue of the matrix (m_{ih}) ranked in descending order of magnitude. The factor loadings α_{ik} are computed from the corresponding eigenvector. Finally, again holds that:

$$\lambda_k = \sum_i \alpha_{ik}^2 \tag{10}$$

In the case of standardised variables the matrix (m_{ih}) turns into a correlation matrix. In such a case, the factor loadings correspond to the correlation coefficient between the *i*th variable z_i and the *k*th principal component f_k. Also it should be noted that the sum of the eigenvalues equals the trace of the matrix (m_{ih}), denoted by tr (m_{ih}), which equals p if standardised variables are used. Each factor f_k therefore accounts for a fraction of the total variation in z_i, given by:

$$\varphi_k = \frac{\lambda_k}{tr(m_{ih})} \tag{11}$$

The quantity ϕ_k is an unweighted average of the R^2 of the interest variables with f_k, and it is used as the coefficient of determination in regression analysis indicating the goodness of fit.

4. EMPIRICAL RESULTS

The cointegration results are presented first followed by the PCA results.

4.1 Cointegration results

The finding that all series were I(1) naturally leads to the use of the Johansen procedure. The Johansen procedure is known to be sensitive to deviations from 'whiteness' for the residuals. In particular, autocorrelation has adverse effects on inference. For that reason the lag length was chosen by

the means of the Schwartz Criterion (Schwartz, 1978) so as to guarantee that autocorrelation is absent. Table 2 summarizes the results for the cointegration rank of the system. The Schwartz criterion led to the selection of a lag order of 3.

Applying a battery of multivariate autocorrelation tests (Panel B, Table 2) and univariate heteroscedasticity tests (Panel C, Table 2), residual 'whiteness' was established. The null hypothesis of 'white' (homoscedastic, non-autocorrelated) residuals was not rejected.

As far as the cointegration rank of the system is concerned, both the maximum eigenvalue and trace statistics (Panel A of Table 2) indicate that at the 5% significance level there exist six (6) cointegration vectors. Furthermore, a Long-Run exclusion test was applied for each of the rates in order to test whether it should be included in the system (Panel C of Table 2). The null was rejected for each case implying that all interest rates were taking part in the cointegration space spanned.

Given the presence of six cointegration vectors between the nine interest rates one may conclude that there exist three common stochastic trends between them. Therefore in conclusion, on the basis of this evidence, one cannot reject the hypothesis that long run dynamic linkages between Eurocurrency rates across the short-end of the nominal term structure do exist. This finding implies that Eurocurrency interest rates exhibit long run interdependence and therefore are integrated to some extent.

Table 2: Cointegration Results[a]

Panel A					
		λ_{max}		λ_{tr}	
Null r	Alt/ve p-r	Test stat.	Critical value	Test Stat	Criticalvalue
0	9	79.3*	57.12	356.58*	192.89
1	8	64.37*	51.42	277.28*	156
2	7	56.05*	45.28	212.91*	124.24
3	6	54.66*	39.37	156.86*	94.15
4	5	38.41*	33.46	102.2*	68.52
5	4	37.72*	27.07	63.8*	47.21
6	3	14.49	18.06	26.07	29.68
7	2	8.01	12.07	11.59	15.41
8	1	3.58	2.69	3.58	3.76

Panel B	
Multivariate Diagnostics	
Test Statistic[b]	P-value
L-B(35)	0.21
LM(1)	0.55
LM(4)	0.61

Panel C					
Univariate Diagnostics			Long Run Exclusion / Weak Exogeneity Tests[c]		
Equation	ARCH(3)	R^2	Equation	Exclusion	Weak Ex/ty
ED1	1.56	0.68	ED1	49.27*	58.10*
ED3	1.57	0.48	ED3	45.91*	38.31*
ED6	8.17	0.4	ED6	38.73*	29.46*
EM1	1.08	0.48	EM1	40.1*	38.1*
EM3	1.76	0.36	EM3	39.52*	26.94*
EM6	6.99	0.31	EM6	34.93*	20.05*
ES1	0.9	0.43	ES1	44.97*	21.08*
ES3	3.46	0.39	ES3	44.63*	20.13*
ES6	6.35	0.33	ES6	42.36*	15.38*

Notes: The asterisk denotes significance at the 5% level. The estimation included an unrestricted intercept. For the maximal eigenvalue test the null is for at most *r* cointegration vectors, against the alternative of $r + 1$ cointegration vectors. For the trace test the null is at most *r* cointegration vectors, with more than *r* vectors under the alternative. L-B stands for the Ljung-Box autocorrelation statistic. LM stands for the Lagrange Multiplier autocorrelation statistic. Both the Long Run exclusion and Weak Exogeneity tests are distributed as chi-square with 6 degrees of freedom. The critical value at the 5% significance level is 12.59.

4.2 Principal Components results

After having observed and discussed the findings of the Cointegration methodology attention now turns to PCA. It should be noted that the PCA requires stationarity of the series, so the first differences were employed to achieve stationarity. Table 3 reports the results of the PCA.

Table 3: Principal Components Results

Panel A

Componen t	Eigenvalues[a]	% of Variance Explained	Cumulative %
1	4.42	49.14	49.14
2	2.2	25.35	75.05
3	1.46	16.3	90.81

Panel B

Factor Loadings

Series	Factor 1	Factor 2	Factor 3
ED1	0.56	0.7	0.12
ED3	0.58	0.77	0.19
ED6	0.54	0.75	0.22
EM1	0.73	Sn[b]	-0.59
EM3	0.8	-0.13	-0.54
EM6	0.83	-0.16	-0.46
ES1	0.69	-0.48	0.38
ES3	0.76	-0.45	0.42
ES6	0.73	-0.39	0.45

Notes: Only the first three largest (significant) eigenvalues are reported. The criterion used to assess the significance of a factor was the Kaiser's test (Kaiser, 1960), qualifying a factor as significant when the associated eigenvalue is greater than unity. Sn stands for small number.

There are only three significant[vi] principal components explaining among themselves 90.81% of the system's total variation. The first principal component explains 49.14% of the total variation, the second 25.35%, and the third 16.3% (Panel A, Table 3).

The loading factors to the three principal components (Panel B, Table 3) show that all interest rates are highly correlated with a uniform sign (positive) to the first principal component. As far as the second component is concerned, the US rates are highly correlated (positively) with it, whereas the European rates are less sensitive to it (also negatively correlated). Finally, the European rates are more sensitive with respect to the third factor, with the US rates exhibiting very low sensitivity.

In such cases, moving from the description of the results to their interpretation is not a straightforward operation. The basic problem is that the PCA does not explicitly identify the factors. Therefore, claiming what they exactly represent is not strictly valid. However, provided that one bears this caution in mind an attempt can be made to provide some intuitive explanation of the results. Our interpretation is that the first principal component may represent the 'world price of risk' (Harvey, 1991). In other words, rates are mainly driven by world market conditions and thus capturing 'world systemic risk'. If one is prepared to believe in the validity of an international asset-pricing model then such an interpretation would not be too extreme.

Regarding the other two components, our interpretation is that they mainly capture the business cycle in the two economic regions identified in the dataset. In particular, the second component is associated with the US business cycle, whereas the third with the European. Such an interpretation would account for the fact that the US (European) rates are more (less) sensitive to the second factor and vice versa for the third factor. Additionally, it would also account for the fact that all rates are correlated (although at a different degree) with both factors. This could be seen via some sort of international transmission of national monetary policies. It is a well-established fact that changes in policy, say by the Federal Open Market Committee (US) typically have repercussions to the decisions of the Bundesbank (Germany) and the Monetary Policy Committee (UK). Additionally, it could be explained in the light of spillovers, which are plausible in 'globalised' markets (Christiansen and Piggot, 1997).

5. CONCLUSION

The goal of the analysis presented was to explore the issue of Eurocurrency market integration. In order to do so, Cointegration and Principal Components Analyses were employed to test the hypothesis that Eurocurrency rates are driven by a common set of factors. In other words, the null hypothesis tested was that the interest rates exhibited sensitivity to a common set of factors that characterizes their multivariate correlation structure.

The empirical findings provide evidence that is consistent with the null of market integration. Thus, the main conclusion reached was that the Eurocurrency market is indeed integrated since interest rates are exhibiting sensitivity to a common set of factors both in the long and in the short run. Therefore, as far as modeling is concerned, the evidence presented in the

paper is that it is appropriate to model Eurocurrency rates in a multivariate framework and also allow for term structure effects (that is, include more that one maturity). Finally, as far as economic policy is concerned, the analysis indicates that interest rates are interrelated across financial centers and as a result policies cannot be designed independently.

The main goal of future research should be to attempt an explicit identification of these factors and directly test a global APT model.

NOTES

[i] Utilizing information from the term structure comes at the expense of focusing on a lower number of countries. This trade-off is due to keeping the parameter space relatively moderate and thus save degrees of freedom.

[ii] Which basically provides the rationale for using both methods.

[iii] The Principal Components analysis can be applied only to a set of stationary variables. Therefore it will be conducted on the interest rates' first differences. In that sense, any long run information will be lost.

[iv] For details see (Harman, 1968; Lawley and Maxwell, 1971).

[v] The paper follows very closely the exposition of (Fase, 1973; Fase, 1976; and Fase and Vlaar, 1998) who have established a comprehensive and easily communicated notation.

[vi] The criterion used to assess the significance of a factor was the Kaiser's test, which basically qualifies a factor as significant when the associated eigenvalue is greater than unity.

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Chapter 10

CONTEXTUALISING BANK FAILURES:
An International Comparison

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Abstract: Using data on bank failures during the years 1991 to 1997, for the US, Canada, the UK and Germany, this study examines the relationship between institutional characteristics of national legal and auditing systems and the incidence and severity of bank failures. The first part of the study notes a significant correlation between the law and order tradition ('rule of law') of a national legal system and the incidence of bank failures. Another variable which appears to impact on bank failure rates is the 'risk of contract repudiation'. The results of the second part of the study show a significant correlation between the amount paid out by national deposit insurers (a proxy for the severity of bank failures) and the macroeconomic variable 'GDP change'. A less pronounced relationship with the severity of bank failures can also be established for the institutional variables 'accounting standards' as well as 'risk of contract repudiation'.

Key words: Bank Failures, Governance, Risks, Legal Systems, Accounting Standards

1. INTRODUCTION

The high incidence of bank failures in advanced capitalist nations during the late 1980s and early 1990s has been remarkable for several reasons. Firstly, bank failures occurred in nations to whose banking systems most

observers would have attributed a high degree of stability and reliability. Secondly, they occurred at a time of moderate, but largely continuous, economic growth and relative economic stability. Thirdly, the cumulation of failures included unusually severe losses, notably those associated with the US saving and loans industry.

While the incidence and magnitude of bank failures has differed across advanced capitalist nations, a number of countries with reputedly conservative banking systems were affected. In the UK, the collapse of *Barings* in 1995, with losses of £200 million, marked the closing episode of a series of financial scandals which included the *Guinness* affair, the *Maxwell* pensions debacle, the *Barlow Clowes* and *Nat West* scandals, and the *Morgan Grenfell UK* branch fraud investigation. Germany too experienced a number of prominent financial failures, such as the *Metallgesellschaft* debacle, which resulted in losses of $1.5 billion as well as the failure of a number of large private bank houses.

These losses, nonetheless, were small by comparison to those experienced in the two North American countries; Canada and the United States. With a GDP of less than half of that of Germany, Canada experienced four major bank failures in 1991, resulting in a total loss of $1.22 billion. The year 1992 brought further losses of $2.05 billion, associated with the collapse of three major financial institutions. It was only in 1993 that the number of bank failures began to drop, although associated losses still amounted to $980 million.[1] These developments must be viewed against the background of Canada's relatively stable banking system, which had experienced only a few bank failures prior to 1970 (Carr, Mathewson and Quigley, 1995).

Whilst relatively high when compared to the UK and Germany, the incidence and severity of Canadian bank failures was nowhere near as serious as that of the US for the same time period. Like Canada, from 1940 through to the 1970s, the US had experienced few bank failures. This changed dramatically in the late 1980s, with more than 200 banks closing their doors each year from 1987 to 1990 (Thomson, 1991). This increase in bank failures was accompanied by a dramatic rise in the cost of their resolution (Bovenzi and Murton, 1988). For instance, when the *Bank of New England* failed in 1990, the Federal Deposit Insurance Company (FDIC) was required to inject $2.3 billion in a rescue effort. In 1991, the restructuring of the *Goldom Bank* required an almost identical FDIC outlay.

In the early 1990s, these failures led to astronomical FDIC expenses, amounting in 1991, to a payment of $12.47 billion in connection with 115 bank failures. In 1992, the corresponding FDIC outlay had dropped to $8.44 billion in connection with 97 bank failures. By 1993, it amounted to 'only'

$1.97 billion being paid out in connection with 36 bank failures. Both in the US and Canada, the reduction in fund injections towards the mid 1990s was associated with a tightening of regulatory oversight, which included the measures contained in the US Federal Deposit Insurance Corporation Improvement Act of 1991 (FDCIA) and similar legislation in Canada.

2. EXPLAINING BANK FAILURES

The cumulation of banking failures in the late 1980s and the early 1990s, and the particular circumstances under which they occurred, notably the absence of a major recession, poses new questions about the nature and origin of bank failures. In the past, a number of macro, meso, and micro-theoretical interpretations of bank failures have been forwarded which apply only very imperfectly to the circumstances under which the bank failures of the late 1980s and early 1990s occurred.

On a macro-theoretical level, bank failures have frequently been linked to macroeconomic disturbances and shocks which are said to lead to abrupt increases and declines (bubbles) in asset values, and ultimately defaults (Kaufman, 1996). Schwartz (1988) and Goodhart (1995), for instance, have argued that identified macroeconomic instability, mostly being attributable to flawed central bank policy, constitutes the principal cause of bank failures. In this context, particular incidents of macroeconomic change have been said to provide the background to re-valuations which cause instability and can trigger financial institution failures. In other words, banks fail because they are unable to deal with the level of macroeconomic uncertainty and flux, generated by forces outwith their control.

Another, not incompatible approach, has attributed bank failures, both in advanced and less advanced capitalist countries, to regional and sectoral downturns. This approach has been particularly successful in explaining the failure of agricultural banks (Smith, 1987). Belognia (1990, see also Belognia and Gilbert, 1987), for instance, was able to show that US agricultural banks that failed in the 1980s took relatively high risks and suffered the consequences during agricultural downturns. Whilst the link between the failure of a bank serving a specific industry sector and a sectoral downturn is undeniable, it is clear that such models can only explain a very small portion of bank failures. This is particularly the case for the late 1980s and early 1990s, when a significant number of large commercial banks defaulted. As far as macroeconomic causations are concerned, it is also apparent that these explanations encounter some difficulties in dealing with the conservative central banking style adopted in this time period and the

relatively stable economic growth rates of between 1 to over 3 per cent of GDP, which prevailed in the four countries from 1992 onwards.

Meso-theoretical explanations of bank failures focus on two principal intermediary causes. The first and perhaps most frequently examined hypothesis relates bank failures to the provision of deposit insurance, which is said to create a classical moral hazard problem. The second set of hypotheses centres on issues of contagion, panics and/or bank runs, and is largely based on speculations about mass psychology and collective risk perception (Kaufman, 1994). US protagonists of moral hazard theories of bank failure suggest that the creation of the Federal Reserve's discount window lender of last resort in 1916, and even more so the creation FDIC's deposit guarantees in 1934, substantially reduced market discipline (Kaufman, 1996). As a response to the availability of deposit insurance, banks increased risk exposure in their asset and liability portfolios and reduced capital ratios. As private shareholder capital was substituted by carelessly managed public or taxpayer capital as the protector of deposits, a profligate waste of funds is said to have ensued (Kane, 1985, 1992; Benston and Kaufman, 1995). Accordingly, the only escape from this trap is a reform of the deposit insurance system which re-imposes market discipline on the banking sector (Barth, 1991; Barth and Brumbaugh, 1992, Barth et al.,1992; Brumbaugh 1998). Imposing this discipline can involve allowing an 'exemplary collapse' to occur, in which depositors are not compensated (Kaufman, 1996).

There are some compatibilities between the macroeconomic and moral hazard explanations of bank failures. Indeed, one could envisage a story in which an incentive incompatible deposit insurance system would lead banks to overexpose themselves to risk. These overexposed banks would then be driven into bankruptcy by flawed macroeconomic or central bank policies. None of this, however, can distract from the flaws the moral hazard side of the argument encounters when applied to the economic context of the 1990s.

Firstly, given that deposit insurance was created before WWII, proponents of the 'moral hazard in deposit insurance' hypothesis have some difficulty in explaining why the US banking system was relatively stable up until the 1980s, or conversely, why it collapsed in the late 1980s. This has led some observers to suggest that, while there may exist a relationship between bank failure and central government-provided bank insurance, other variables, such as the increased competition within, and the oversupply of, bank services may have had a major effect on the more recent crisis (Saltz, 1997).

Another problem with deposit insurance based moral hazard arguments is that they typically do not take into account experiences outwith

the US. Thus, the industry-administered, self-funded German deposit insurance system provides effectively a full coverage of deposits. Yet, bank failures are comparatively rare.[2] One way of strengthening the moral hazard hypothesis would be to examine the impact of deposit insurance in a cross-national framework. Indeed, one could go as far as to argue that, unless such historical and comparative research is provided, analyses proposing the moral hazard hypothesis will continue to be associated with politically motivated free-market rhetoric.

The other meso-theoretical explanation of bank failures, that of contagion, fares little better when applied to the 1990s bank failures. While one could envisage a scenario where an initial bank failure causes individuals in an economically weakened region to run on banks and cause further failures, the evidence seems to be stacked against such an argument. Mishkin (1991) and Selgin (1992) have argued that bank runs, in response to an actual or perceived default can, in theory, speed-up a series of insolvencies. Yet they are unlikely to create a shock, unless the respective banks are already in a poor financial state. This view has been confirmed by a number of researchers who have shown that history provides little evidence for a situation where economically sound banks were driven into insolvency by panics (Benston and Kaufman, 1995; Calomiris and Gorton, 1991; Carr, Mathewson and Quigley, 1995).

If conventional macro and meso-theoretical explanations of bank failure have substantial weaknesses when applied to the early 1990s, the question is what can micro-theory offer. Micro-theoretical studies have been able to identify common characteristics of failed banks and have utilised this information to make predictions about the incidence and severity of bank failures. Today, it is understood that failed banks have a number of commonalities. These include, firstly, a high loan-to-asset ratio and a great reliance on purchase liabilities (Scott et al., 1984; Short, O'Driscoll and Berger 1985, Lane, Looney and Wansley, 1986) and, secondly, a rapid growth rate (Peterson and Scott, 1985). Banks prone to failure, moreover, include a disproportionate number of small unit banks (Scott et al., 1984) and banks where the involvement of the boards of directors in oversight is limited. While this information is useful to practitioners and investors, its explanatory value with regard to the banking failures of the early 1990s is limited. Perhaps one could explain part of the increase in bank failures in the US, Canada and the UK on the basis of an increase in small financial institutions, following deregulatory initiatives. Yet, such an explanation would tell us nothing as to why a substantial number of large and long-established financial institutions failed. Likewise, one could argue that banks in the 1990s failed because of rapid growth and high loan-to-asset

ratios. Yet, such an argument would ultimately only lead to the further question of why such rapid growth occurred, or what led banks to accept such risk exposure.

3. ALTERNATIVE VIEWS

The previous section of this paper has suggested that conventional explanations of bank failures fare poorly when applied to the insolvencies of the early 1990s. This is one of the key arguments of this paper. Its corollary is that there is a set of alternative explanations for the insecurity of financial institutions in the early 1990s which must be sought in a different arena; namely that of corporate governance and regulatory oversight. In the recent past, a small but growing branch of largely applied research has highlighted the role played by inadequate governance structures and governance violations in explaining recent bank failures. Perhaps not unsurprisingly, this research has been pioneered in the US, where the savings and loan crisis has provided an obvious example of a breakdown of governance structures with all its attendant consequences.

As early as 1988, Graham and Homer identified insider abuse as a significant factor in the collapse of US national banks that failed between 1979 and 1987. According to Graham and Homer, insider dealings contributed to the failure of closed institutions in 35 per cent of all cases, while material fraud was present in 11 per cent. This view was confirmed by a successive study of bank failures of the early 1990s which was conducted by the US General Accounting Office (GAO). In its report titled 'Bank Insider Activities' (1994), the GAO found that of 286 bank failures, occurring in the calendar years 1990 and 1991, a majority of 61 per cent (175 banks) could be linked to insider activities. The assets of the 175 banks with evidence of insider problems totalled $33.7 billion, or about 43 per cent of the total assets of all failed banks during the two year period. Losses to the Federal Deposit Insurance Corporation amounted to about $5.4 billion, or 55 per cent of total losses during the two year period. In a total of 76 cases, or 26 per cent of all banks investigated, insider activities could be clearly identified as the principal cause of the bank's failure. Approximately 90 per cent of the 286 failed banks had been identified as having negligent or passive directors whose conduct contributed to the banks' failure. The nature of insider activities covered a broad spectrum, including improper loans to company officers, improper transactions with affiliates such as an associated company controlling a member bank, as well as outright fraud and excessive compensation.

A breakdown of governance can take many forms, and the list produced by the GAO represents only one variant of governance failures which has arisen in a specific institutional and regulatory context. If we assume that inadequate governance structures, having arisen from deregulatory activities and/or other technical factors such as an increased complexity of financial markets, are at the root of bank failures in the early 1990s, one would expect similar breakdowns in governance to occur in different contexts. The following analysis, therefore, focuses on the possible relationship between governance contexts and bank failures across advanced capitalist countries.

4. THE INCIDENCE OF BANK FAILURES

The governance-breakdown hypothesis on bank insolvencies suggests that good governance structures are a key to the avoidance of insolvencies. The following section explores whether this hypothesis can provide a systemic explanation of bank failures in the US, Canada, the UK and Germany in the early to mid 1990s. For this purpose the correlation of documented national characteristics of legal and corporate governance and the incidence of bank failures is investigated.

4.1 Model Variables

The simple model presented here analyses the relationship between the *incidence of bank failures* for a time period from 1991 to 1997, and a number of national institutional characteristics. These include, i) the strength of the legal tradition with respect to maintaining a *rule of law*, ii) the *absence of corruption*, iii) the *risk of contract repudiation*, and iv) the quality of *accounting standards*. In addition, we include a macroeconomic variable, namely change in real GDP from the previous year (*GDP change*).

4.1.1 The Comparative Incidence of Financial Institution Failures

The analysis centres on the explanation of differences in the number of bank failures across space and time. Up until the late 1980s, bank failures were relatively rare in most developed countries, including the UK, Germany, Canada and the US (although Canada and the US saw a number of failures during the 1970s). As previously stated, in the late 1980s, the US experienced a massive wave of insolvencies. These bankruptcies continued into the early 1990s, even though the Savings and Loan crisis was largely resolved by that time. From 1993 onwards, however, the number of bank

resolved by that time. From 1993 onwards, however, the number of bank failures in the US was drastically reduced as the result of a tightening of bank regulations and greater efforts towards bank rescues. Compared to the US, bank failures were an infrequent event in Canada and Germany, with between zero to a maximum of four banks failing per year. In the early 1990s, a similar situation applied to the UK. Yet, due to the relatively large number of small financial institutions failing from 1992 onwards in the UK, UK counts of financial institution failures exceeded those of the US by 1993.[3]

Table 1: Bank Failures 1991-1997[4]

	1991	1992	1993	1994	1995	1996	1997
Canada	4	3	2	2	1	1	1
UK	11	35	38	39	52	71	46
US	115	97	36	4	0	0	1
Germany	1	1	0	1	2	0	1

For the purpose of the regression model the variable *incidence of bank failures* was transformed into the variable *incidence of bank failures per million inhabitants*. In terms of this variable, the US initially experienced by far the highest rates of bank failures. This reversed in 1993, when the UK came on top. Canada generally experienced a higher per population rate of failures than Germany, but remained below UK counts throughout the time series.

4.1.2 Governance Environments

One of the principle hypotheses of this paper is that the *incidence of bank failures* is affected by external conditions that encourage, or discourage, the creation of appropriate governance structures in financial institutions. In global terms, all four countries included here possess conditions favourable to the maintenance of adequate governance conditions in the financial sector. Yet, when compared to each other, marked differences exist.

4.1.2.a Rule of Law

Scores for the variable *rule of law* have been collected in the 'International Country Risk Guide,' and assess the law and order tradition of a national legal system.[5] In the context of the governance failure hypothesis of banking insolvencies, it could be argued that a high scoring *rule of law* nation should have fewer or less severe bankruptcies, as potential

malfeasants would expect a more intense prosecutorial effort and/or more severe penalties. In a country scoring low on *rule of law*, this would not be the case for a number of reasons. Here malfeasance would be encouraged by the expectation of a lower likelihood of detection, the assumption that an evasion of legal including criminal penalties was possible, and/or the expectation of delays and postponements of legal action.

As illustrated in Table 2, the UK scored lowest in terms of *rule of law*, with a score of 8.57, followed by Germany with a score of 9.23. The US and Canada both hold the maximum score of 10 (i.e. had the strongest *rule of law* regime).

4.1.2.b Absence of Corruption

The variable *absence of corruption* assesses investor's views on the integrity of state officials. Again this analysis utilises scores listed in the 'International Country Risk Guide.' Thematically, *absence of corruption* is closely related to the *rule of law* variable. In terms of the governance failure hypothesis of bank insolvencies, one would expect public sector levels of corruption to encourage the activities of malfeasants, both because of the lowered levels of detection found in a relatively corrupt environment, and because of the expectation of malfeasants that an evasion from legal proceedings is possible.

As illustrated in Table 2, Canada was given the highest on the *absence of corruption* variable with a maximum score of 10, followed by the UK with a score of 9.1, Germany with a score of 8.93, and the US with a score of 8.63.

4.1.2.c Risk of Contract Repudiation

Risk of contract repudiation is also a variable collected in the 'International Country Risk Guide.' It is relevant to the governance failure hypothesis of bank insolvencies for a number of reasons. Firstly, nations in which contract repudiation is relatively unproblematic, represent an easier target for malfeasants who benefit from violating agreed contractual terms, be it with shareholders and/or other stakeholders. Secondly, the ease of contract repudiation is likely to affect the extent and speed at which the costs of organisational failures are passed on. Thus, in a country with relatively strict rules upholding contracts, an organisation's failure would be relatively self contained, whereas it could encourage further misconduct amongst affiliates under more lenient contractual conditions. Table 2 illustrates that the *risk of contract repudiation* is lowest in Germany, with a score of 9.77, being closely followed by the UK with a score of 9.62. Both the US and Canada rank lower with scores of 9.0 and 8.96 respectively.

4.1.2.d Accounting Standards

Data on the quality and stringency of *accounting standards* has been collected by the 'Center for International Financial Analysis & Research Inc.,' where these have been derived from 1990 annual company reports. The stringency of *accounting standards* is relevant in the context of the governance failure hypothesis of bank insolvencies for a number of reasons. Firstly, stringent *accounting standards* are likely to deter potential malfeasants from a number of actions which are detectable if accounting practices are thorough. Secondly, *stringent accounting standards* are likely to provide an early warning system for the identification of harmful misconduct. Thirdly, stringent *accounting standards* may themselves be a reflection of a culture which values openness, monitoring and auditing, which is inherently unconducive to insider and self-dealing.

Table 2 illustrates that, amongst the countries included in this study, the UK ranks highest in terms of its *accounting standards* with a score of 78 out of 100. (This is only exceeded by a score of 83 in the case of Sweden). This is followed by Canada with a score of 74, the US with a score of 71, and Germany with a remarkably low score of 62.

Table 2: Governance Variables

(1) ICRG score on *rule of law* (average)
(2) ICRG score on *absence of corruption* (average)
(3) ICRG score on *contract repudiation* (average)
(4) CIFA&R score on *accounting standards* (average)

	(1)	(2)	(3)	(4)
Canada	10.00	10.00	8.96	74
UK	8.57	9.10	9.63	78
US	10.00	8.63	9.00	71
Germany	9.23	8.93	9.77	62

4.1.3 Macroeconomic Indicators

In order to control for the impact of economic changes on bank failures, a macro-economic variable, namely the percentage change in real GDP from the previous year (*GDP change*), has been included. Conventional analyses would suggest that macroeconomic factors are a principal force behind bank failures, whereas the failure of governance hypothesis would attribute little significance to this variable. The two hypothesis, of course are not incompatible. In fact, one could envisage a scenario, in which a bank with weak governance structures would be more severely affected by small

economic disturbances, than one with strong internal auditing mechanism and a strong tradition of external accountability.

As previously discussed, the time period investigated in this paper saw only relatively minor macroeconomic disturbances. In 1991 all countries emerged from a relatively brief recessionary period.[6] From 1992 onwards a recovery of GDP growth rates took place which tapered off by 1995, with growth rates declining to a relatively stable 1 to 2.5 per cent in all four countries.

4.2 Model and Outcomes

The results of the analysis of this small panel of four countries with seven years' data are displayed in Table 3. Table 3 shows a number of regression models which assume a relationship between the independent variable *incidence of bank failures* (per million inhabitants) and the institutional and macroeconomic variables discussed above.

The first numerical column - UNRESTRICTED OLS - lists the results of a linear regression of all institutional and macroeconomic variables with the dependant variable 'incidence of bank failures per million inhabitants'. Only the variable *rule of law* resulted in significant slopes at the .05 level with the expected negative sign. Both the variables *absence of corruption* and the macroeconomic variable *GDP change* had the expected negative sign, but were not significant. The variables *risk of contract repudiation* and *accounting standards* had a positive slope, but were not significant.

In the successive analysis, all variables were entered, except for *accounting standards* (which showed low parameter values in the UNRESTRICTED OLS, model and had some degree of multicollinearity with *rule of law*). In the case of the RESTRICTED OLS model, all three institutional variables *rule of law*, *absence of corruption* and *risk of contract repudiation* yielded the expected negative slopes, which were significant in case of *rule of law* and *risk of contract repudiation*. The macroeconomic variable *GDP change* was not significant and followed the wrong sign.

Following Stimson (1985) the model was re-tested in order to avoid problems arising from collinearity within the panel data.[7] Both the LSDV (fixed effects one-way model) and the GLSE model essentially confirmed the previous patterns.[8] In both models, the three institutional variables had the expected negative slopes, with *rule of law* and *risk of contract repudiation* having significant coefficients at the .10 to .15 levels in the LSDV and the .01 to .05 levels in the GLSE model, respectively. In both models the macroeconomic variable, meanwhile, followed the wrong sign and was not significant. Overall the results showed a high degree of consistency across

the models tested, which is important given our relatively small sample size. This gives some indication that the *incidence of bank failures* is indeed related to the *rule of law* regime of a country as well as the *risk of contract repudiation* in a specific legal environment.

Table 3: Regression Models: Incidence of Bank Failures

Dependent Variable: Incidence of Bank Failures (per million inhabitants)				
MODELS:	Unrestricted OLS	Restricted OLS	LSDV	GLSE
Rule of Law				
	-0.369 R^2=.459	-0.872	-0.589	-0.868
	(-4.697)	(-7.162)	(-1.751)	(-6.412)
Absence of Corruption				
	-0.068 R^2=.011	-0.073	-0.055	-0.071
	(-0.546)	(-0.967)	(-0.705)	(-0.830)
Risk of Contract Repudiation				
	0.312 R^2=.115	-0.998	-0.373	-0.985
	(1.040)	(-4.680)	(-1.515)	(-4.183)
GDP Change				
	-0.849 R^2=.004	0.164	1.730	0.206
	(0.305)	(1.025)	(0.723)	(0.126)
Accounting Standards				
	0.034 R^2=.000	R^2adj=.678	R^2adj=.804	R^2adj=.679
	(0.041)			

Notes: t-statistics are listed in parenthesis. Unadjusted and adjusted Coefficients of Determination (R^2) are listed next to slope parameter or at bottom of column respectively.

5. THE SEVERITY OF BANK FAILURES

The analysis of the relationships between institutional variables and the severity of bank failures presented in this section largely follows the previous investigation into the relative incidence of bank failure, with the exception of the use of a different dependent variable *intervention expenditure*. In addition, the independent variable *rule of law* has been replaced by the variable *accounting standards* which yielded more significant parameters in the UNRESTRICTED OLS model. The variable *intervention expenditure* represents the amount spent by the respective national deposit insurance corporation on the bank failures occurring in a specific year. The regression models utilise the variable relative

intervention expenditure which expresses expenditures as a fraction of national GDP. Due to differences in national regulations, such as a cap on insured deposits of £20,000 in the UK, this variable represents only a proxy to the severity of bank failures in terms of depositor assets lost.

As shown in Table 4, the relationship between this dependent variable and the independent institutional variable was less clear than in the case of the *incidence of bank failures*. In the UNRESTRICTED OLS model, all variables followed the expected negative sign, with *absence of corruption* and *accounting standards* yielding significant parameters. This pattern was essentially repeated in the RESTRICTED OLS MODEL. The LSDV model generally delivered less significant parameters, with only *absence of corruption* being identified as significant. This differed from the GLSE model where the macroeconomic variable was identified as significant and the variables *accounting standards* and *contract repudiation* as borderline significant.

Table 4: Severity of Bank Failures

Dependent Variable: Intervention Expenditure (by GDP)				
MODELS:	Unrestricted OLS	Restricted OLS	LSDV	GLSE
Accounting Standards				
	-0.004	R^2=.003 -0.012	-0.150	-0.036
	(-0.266)	(-0.860)	(-1.143)	(-1.525)
Absence of Corruption				
	-0.099	R^2=.014 -0.221	-0.104	-0.141
	(-0.615)	(-1.363)	(-1.873)	(-1.177)
Risk of Contract Repudiation				
	-0.337	R^2=.081 -0.579	-0.422	-0.9621
	(-1.515)	(-2.499)	(-1.143)	(-1.525)
GDP Change				
	-4.641	R^2=.064 -7.606	-2.546	-9.327
	(-1.335)	(-2.209)	(-1.085)	(-2.102)
Rule of Law				
	0.222	R^2=.001 R^2adj=.265	R^2adj=.161	R^2adj=.119
	(0.097)			

Notes: t-statistics are listed in parenthesis. Unadjusted and adjusted Coefficients of Determination (R^2) are listed next to slope parameter or at bottom of column respectively.

While the results regarding the link between the stringency of the legal system and a reduction in the severity of bank failures are clearly less conclusive than those concerning the incidence of bank failures, they indicate

that there is a tentative link between the severity of bank failures, the *risk of contract repudiation* and the level of *accounting standards*.

6. CONCLUSION

The findings of this study are preliminary in the sense that this study requires both a broader data set and a more detailed model specification. However, within the parameters of this brief and preliminary analysis, it can be concluded that there are some indications that banking failures during the 1990s can be partially attributed to governance related variables, such as the *rule of law*, the *risk of contract repudiation* and *accounting standards*.

Assuming that these findings can be confirmed in future research, this invites a number of tentative public policy conclusions. Today accounting standards in Europe vary widely. Scandinavian countries generally have some of the most stringent accounting standards with Sweden scoring 83 and Finland 77 in the previously mentioned rankings. The UK also maintains a high standard of accounting stringency with a score of 78. Other European countries, notably France (with a score of 55), Germany (with a score of 62), Italy (with a score of 62) and Greece (with a score of 55) rank much lower. Likewise, there are broad differences within the legal systems of these nations and the degree to which they allow contract repudiation and evasion. On a scale of 1 to 10, Germany ranks top in terms of a low *risk of contract repudiation* with a score of 9.77, whereas Greece scores 6.62. If failures in corporate governance lie at the root of bank insolvencies, one major task facing joint European financial regulators may be to ensure that national standards of accounting and monitoring do not fall below set minimum requirements.

SOURCES

Data on bank defaults in the US was derived from the Federal Deposit Insurance Corporation's (FDIC) Bank Failures and Assistance Transaction Bulletin. Previously unpublished data was made available to the authors by the Canadian Deposit Insurance Corporation (CDIC), the UK Investors Compensation Scheme, and the Bundesverband Deutscher Banken (Federation of German Banks). Data on risk assessments and accounting standard rankings were derived from various years of the Country Risk Guide. In addition, our analysis of country characteristics draws extensively from a study by La Porta, R., Lopez-de-Silanes, F., Shleifer, A., Vishny, R., (1996) titled "Law and Finance," National Bureau of Economic Research, Working Paper 5661, Cambridge, MA: NBER. This paper was generously made available to the authors by Professor Shleifer.

NOTES

1 All quantities denoted as $ refer to US Dollars and all quantities denoted as £ refer to UK Pound Sterling.

2 Over the past two decades the German solidaristic protection system has been characterised by a relatively low incidence of bank failures. However, in some instances, individual bank failures have led to massive losses for the deposit insurer.

3 Due to the broad coverage of its deposit insurance scheme, UK data on investor compensation are not entirely comparable with US, Canadian and German data. In our regression model we utilised information provided by the UK Investors Compensation Scheme (ICS) which included financial institution failures which would not have been listed in the reports of the other countries. We examined the possible problems arising from this artificial inflation of the incident count through a sensitivity analysis which indicated that the impact of this divergence in reporting conventions was likely to be negligible.

4 A comparable set of data on bank failures and their costs to insurers is available for the four countries investigated roughly from 1990 to 1991 onwards. We have chosen to limit ourselves to the time period from 1991 to 1997 in order to allow for an investigation of the cost of bank failures which we plan to conduct in the near future.

5 The International Country Risk Guide has been published by the PSR group for over twenty years and presents the most frequently used reference guide for political risk variables. The risk ratings are determined by country risk experts and reviewed by the PRS group's senior advisers using the Coplin O'Leary methodology. Some of the variables used in this analysis are part of the PRS Group's IRIS dataset which is constructed by Steve Knack of the University of Maryland. All PRS data is avaible online via subscription on htttp:\\www.icrgonline.com.

6 Germany's increase in GDP is a statistical artefact resulting from the reunification of West and East Germany.

7 Because of the relatively small sample size (n=28) fewer variables were included in the in LSDV and GLSE models (via high entry specifications) to compensate for losses in degrees of freedom.

8 The Least Squares Dummy Variables Model (Covariance Model) assumes that within a country the error term's variance is fixed, but varies across countries. Accordingly LSDV varies the intercept across countries. The General Least Squares Error Model assumes that the errors within each country are isolated from those of other countries and follow an identical structure. The GLSE model does not estimate country-specific errors. Rather it assumes that these components are part of the error term when the model is estimated. As long as the country specific effects are uncorrelated with the rest of the pooled independent variables, this is a workable assumption and the GLSE model should produce more reliable results than the LSDV model.

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Chapter 11

THE PROSPECT OF DOLLARIZATION:
Are the Americas an Optimum Currency Area?

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Abstract: Economic theory suggests that dollarization is beneficial if the dollarizing economy's country-specific shocks are mild and synchronized with those of the U.S.; whereas in the presence of major asynchronous shocks, floating exchange rates are more stabilizing. Using annual data from 1950 to 1997, output fluctuations of 19 (North, Central, and South) American countries are decomposed into common and country-specific shocks. This reveals that country-specific shocks are large and generally asynchronous, so that the Americas, *as a whole*, are not an optimum currency area. Ranking *individual* countries in terms of stabilization costs, the results suggest that Canada, Honduras, and Colombia are among the best candidates for dollarization, while Peru and Argentina are among the worst.

Key words: Dollarization, Optimum Currency Area, Monetary Integration.

1. INTRODUCTION

Enthusiasm for "dollarization," the replacement of national currencies in the Americas by the U.S. dollar, is spreading fast and for a growing number of countries. Despite cautious comments by the U.S. Treasury Secretary (Summers, 1999), the prospect of dollarization has been endorsed by academic economists (Barro, 1999) and the business community (Wall Street Journal, 1999a, 1999b; Financial Times, 1999).

This paper asks whether the Americas constitute an optimum currency area and, thus, whether dollarization is likely to be stabilizing. Economic theory suggests that the answer depends on the relative magnitude of, and synchronization between, the U.S. and the dollarizing economy's shocks: dollarization is more likely to be beneficial if the dollarizing economy's

country-specific shocks are mild and synchronous with U.S. shocks; whereas in the presence of major asynchronous shocks, monetary independence with floating exchange rates is more likely to be more stabilizing than dollarization.

Annual data from the 1950-1997 period are used to decompose the output fluctuations of 19 North, Central, and South American countries (including the U.S.) into common and country-specific shocks. The decomposition reveals that while common shocks are of sizable magnitude, they pale in comparison to most of the country-specific disturbances. At the low end, Canada, Guatemala, Colombia, and the U.S. have the smoothest country-specific shocks, whereas Argentina, Chile, Panama, and Peru have been the most volatile. Next, the paper examines the degree of synchronization between the U.S. and each of the other eighteen economies. Canada, not surprisingly, is the most highly correlated with the U.S., while Peru is the most negatively correlated with the U.S.

In summary, the paper finds that country-specific shocks in the Americas are both large and generally asynchronous. This implies that the Americas, *as a whole*, are not an optimum currency area. *Individual* countries, however, can be ranked in terms of the stabilization costs dollarization would impose on them. The results suggest that Canada, Colombia, and Honduras are among the best candidates for dollarization, while Argentina and Peru are among the worst.

The remainder of the paper is organized as follows. Section 2 discusses the optimum currency area concept and the economics behind the criteria used in this study. Section 3 describes the data and the econometric methodology, and section 4 presents the empirical results. Section 5 concludes with a discussion of the implications of these findings.

2. THEORETICAL BACKGROUND

Dollarization is a special case of monetary unification. In a typical monetary union (such as the European monetary union or the monetary union of the 50 U.S. states), the participating economies adopt a common currency (the euro or the dollar) and establish a common central bank to which they surrender monetary authority. Under dollarization, the participating economies also adopt a common currency (the U.S. dollar) and surrender monetary authority to a single central bank, but now it is the currency and the central bank of one of the participants, the U.S. While there is a difference, therefore, which has to do with the distribution of power within the common monetary authority, the rest of the economic considerations are very similar.

In particular, in both cases participation means effective loss of independent monetary policy for all participants (except the U.S. under dollarization). In other words, the question of whether the U.K. should join the European monetary union and adopt the euro is economically similar to whether Argentina should dollarize.

When is monetary union among several economies desirable? The answer depends on whether the economies in question constitute an *optimum currency area*. The concept was introduced by Mundell (1961) and extended by McKinnon (1963) and Kenen (1969) who proposed a number of different criteria.[1]

While these approaches focused mainly on the costs of monetary unification, more recently the discussion has evolved to a comparison of costs and benefits. Corden (1973) in an early contribution, Cohen (1989), De Grauwe (1992), and Eichengreen (1992), among others, classify and weigh the pros and cons of monetary integration. The list of benefits includes a reduction in transaction costs, elimination of exchange-rate uncertainty, and enhanced credibility for the monetary authority. Costs (all deriving from the inability to conduct independent monetary policy) include loss of seignorage, inability to select the most desired point on a short-run Phillips curve, and inability to devalue or revalue for stabilization purposes.

Focusing on dollarization, when are the benefits more likely to exceed the costs for a given candidate-economy? Just as in the more general case of monetary union, the answer critically depends on the nature of shocks that hit the economy (see the Appendix for a more formal discussion in the context of a simple, but widely used, model). For any set of economies, there are two types of such shocks: *common* shocks that affect all the economies in a similar way (oil shocks, for example), and *economy-specific* shocks that are associated with a single economy (domestic fiscal disturbances, for example). First suppose there is no dollarization, so that each economy can pursue its own independent monetary policy. In principle, this enables each monetary authority to respond both to common and economy-specific shocks and minimize their business-cycle effects. The disadvantage is that this discretionary policy will create credibility problems that will raise the long-run (expected and actual) inflation rate.

Now suppose an economy dollarizes. Independent monetary policy is now ruled out. The U.S. Federal Reserve is still quite able (and, let's assume, willing) to respond to common shocks, but much less so to (non-U.S.) economy-specific ones. While in practice, some (non-U.S.) economy-specific shocks may receive some attention, the average dollarized economy will be left with less ability to counteract its domestic disturbances. Therefore, the cost of dollarizing will be small only if most of the shocks that

impinge on the economy are common rather than economy-specific. More formally:

Proposition 1. The milder economy-specific shocks are relative to common shocks, the more likely is a set of economies to be an optimum currency area (see the Appendix for a proof).

But there is an additional complication. Presumably, the Fed will still try to smooth some U.S. economy-specific shocks. But because monetary policy is now common, this will spread the consequences of the U.S. shocks to the dollarized economies. For example, a monetary tightening designed to limit inflationary pressures in the U.S. will also affect a dollarized Argentina. Is this propagation of the responses to U.S.-specific shocks desirable or detrimental? The answer depends on how the dollarized economies' country-specific shocks are correlated with those of the U.S. If these shocks are highly synchronized, so that overheating in the U.S. and Argentina are always simultaneous, then the actions of a common monetary authority are a very good substitute for monetary independence. If, however, economy-specific shocks are asynchronous, monetary union will actually amplify domestic fluctuations. More formally:

Proposition 2. The more positively correlated economy-specific shocks are, the more likely is a set of economies to be an optimum currency area (see the Appendix for a proof).

Despite the wide recognition of the importance of these propositions as criteria for an optimum currency area,[2] empirical research along these lines is limited.[3] Furthermore, most of the existing studies do not distinguish between common and economy-specific shocks, and as a result, their estimates of overall correlations overestimate the correlations between economy-specific shocks. Stockman (1988) and Emerson (1992, Annex D), separately identify common and nation-specific shocks for several European countries, finding that both types are empirically important, but both studies address only the relative magnitude of the two types of shocks (Proposition 1), and not their correlations (Proposition 2). The next section describes how Stockman's technique is used in this paper to evaluate both propositions for a set of American countries.

3. DATA AND METHODOLOGY

Two data sets are utilized. *Data Set I* (PWT 5.6) uses GDP from the Penn World Tables, Mark 5.6, expressed in PPP-adjusted constant 1985 prices, as documented in Summers and Heston (1991) and updated in 1995. These series are available annually from 1950 to 1990. *Data Set II* (IFS)

uses annual real GDP, in 1990 prices, from the International Financial Statistics of the IMF (IFS on CD-ROM, March 1999). The period covered is from 1968 to 1997. Both data sets include the same nineteen American countries: Canada, Costa Rica, the Dominican Republic, El Salvador, Guatemala, Honduras, Mexico, Panama, the U.S.A., Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela.[4]

Let $\Delta y_{it} = (GDP_{it} - GDP_{it-1}) / GDP_{it-1}$ denote the rate of growth of real GDP in economy i at time t. Following Stockman (1988), the following equation is estimated:

$$\Delta y_{it} = w_i + v_t + u_{it} \qquad (1)$$

where w_i is a constant term specific to economy i, v_t is a shock common to all economies at time t, and u_{it} is the i-th economy's specific shock. Econometrically, w_i and v_t are treated as fixed economy- and time-effects, respectively.

Columns (1) and (4) in Table 1 estimate the equation for Data Sets I and II, respectively. For both data sets, the time fixed effects, the v_t's, are jointly highly significant, and the hypothesis that they do not statistically significantly vary by year can be safely rejected. In addition, the w_i's are also statistically different from each other. Equations (1) and (4), however, ignore persistence in output growth, which turns out to be statistically significant. In order to allow for persistence, the equation has been respecified as

$$\Delta y_{it} = w_i + \rho \Delta y_{it-1} + v_t + u_{it}\,, \qquad (2)$$

and

$$\Delta y_{it} = w_i + \rho_i \Delta y_{it-1} + v_t + u_{it}\,. \qquad (3)$$

In Table 1, columns (2) and (3) for *Data Set I*, and columns (5) and (6) for Data Set II, report the results. Note that the estimated AR(1) coefficients in (2) and (4) are highly statistically significant. In addition, allowing for persistence has not affected the properties of the v_t's, although it reverses the rejection of the hypothesis that the w_i's are not statistically different from each other for *Data Set II*. As the hypothesis that the ρ_i's in (3) and (6) are statistically equal across countries cannot be rejected, the analysis that follows is based on specifications (2) and (4) which impose the same autoregressive parameter on all economies in order to gain efficiency.[5]

Table 1. Three Time-Series Specifications
Data Set I: PWT5.6 (1950-1992) *Data Set II*: IFS (1968-1997)

	(1)	(2)	(3)	(4)	(5)	(6)
ρ	----	0.12**	----	----	0.28**	----
		(0.04)			(0.04)	
R^2 0.26	0.28	0.31	0.29	0.34	0.37	
DW	1.76	1.92	1.93	1.43	1.95	1.94
F-Tests for the Null:						
	2.47**	2.15**	1.44	2.03**	0.95	0.84
	5.20**	4.55**	4.37**	5.90**	4.36**	4.35**
	5.19**	4.67**	4.48*	6.01**	4.46**	4.46**
	----	----	1.81*	----	----	3.30**
	----	----	1.29	----	----	1.13

Notes. Standard errors in parentheses. **: significant at 1%, *:significant at 5%.
(1) and (4): $\Delta y_{it} = w_i + v_t + u_{it}$,
(2) and (5): $\Delta y_{it} = w_i + \rho \Delta y_{it-1} + v_t + u_{it}$,
(3) and (6): $\Delta y_{it} = w_i + \rho_i \Delta y_{it-1} + v_t + u_{it}$.

4. EMPIRICAL RESULTS

4.1 Size of Common and Country-Specific Shocks

Let's turn our attention first to Proposition 1. The top panel of Figure 1 plots the common shocks (the v_t's) for the 1951-1997 period.

The solid line (1952-1992) is based on *Data Set I*, and the dashed line (1970-1997) on *Data Set II*. The common shocks are sizable and have ranged from -7.30% in 1982 to 2.41% in 1962. In addition, the patterns of the two data sets agree remarkably well over their common range (1970-1992). These shocks, together with the estimated w_i's, can be used to simulate the "common trend" output path of any of the nineteen economies over time. The bottom panel of Figure 1 conducts this exercise for the U.S.

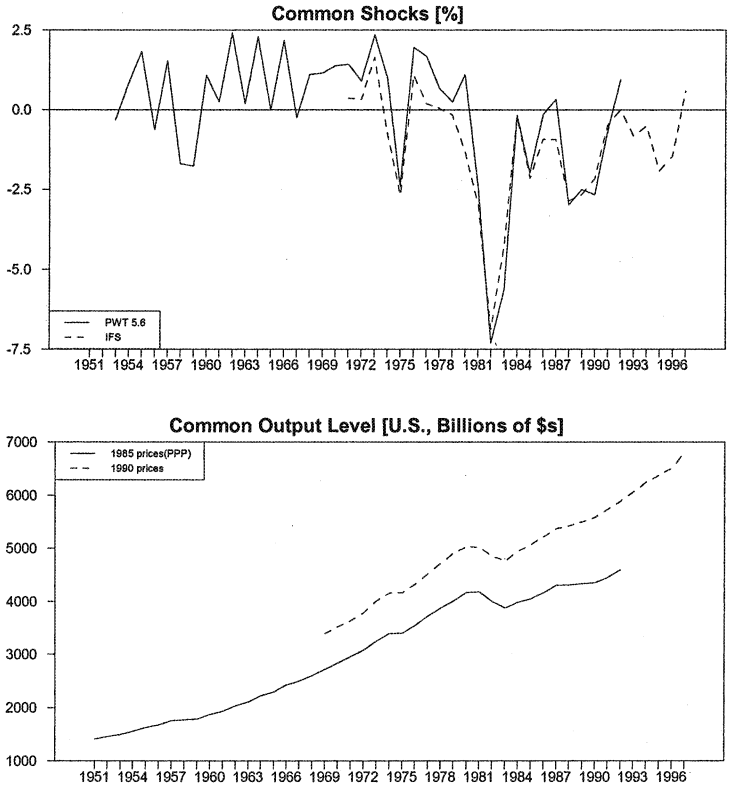

Figure 1: Common Shocks and (Implied) U.S. Common Trend

How does the common shock compare in size with the economy-specific shocks? Despite its significant variability, the common shock is much milder than most economy-specific shocks. Table 2 compares the two types of disturbances for both data sets.

Table 2. Common and Country-Specific Shocks

Common Shock	
Data Set I: PWT5.6 (1950-1992)	*Data Set II*: IFS (1968-1997)
$\sigma_v^2 = 4.50\%$	$\sigma_v^2 = 3.22\%$

	Counrty-Specific Shocks					
	Data Set I: PWT5.6 (1950-1992)			*Data Set II*: IFS (1968-1997)		
i	σ_i^2	σ_i^2/σ_v^2	Ordering	σ_i^2	σ_i^2/σ_v^2	Ordering
Canada	7.85%	1.75	5	3.70%	1.15	3
Costa Rica	14.69	3.27	8	5.91	1.84	6
Dominican Rep.	35.16	7.82	19	11.33	3.52	12
El Salvador	11.69	2.60	7	9.92	3.08	9
Guatemala	4.40	0.98	1	1.81	0.56	1
Honduras	7.81	1.74	4	7.55	2.34	8
Mexico	10.83	2.41	6	10.07	3.13	10
Panama	22.27	4.95	14	26.65	8.28	18
U.S.A.	7.78	1.73	3	4.45	1.38	5
Argentina	24.16	5.37	16	22.45	6.97	15
Bolivia	14.90	3.31	10	4.26	1.32	4
Brazil	14.83	3.30	9	12.24	3.80	13
Chile	26.84	5.97	18	30.55	9.49	19
Colombia	4.94	1.10	2	2.18	0.68	2
Ecuador	15.30	3.40	11	22.84	7.09	16
Paraguay	26.41	5.87	17	7.21	2.24	7
Peru	24.03	5.34	15	24.73	7.68	17
Uruguay	19.41	4.32	12	10.69	3.32	11
Venezuela	21.35	4.75	13	16.03	4.98	14

Notes: See notes to Table 1. $\sigma_v^2 = \text{var}(v_t)$ is the variance of the common shock; $\sigma_i^2 = \text{var}(u_{it})$ is the variance of a country-specific shock. "Ordering" ranks the countries in ascending order of country-specific variance.

For *Data Set I*, the variance of the common shock is 4.50, whereas for the economy-specific shocks ranges from 4.40 in Guatemala to 35.16 in the Dominican Republic. Put differently (second column of Table 2), during 1950-1992, Guatemala-specific shocks were almost exactly as volatile as the common shock, whereas Dominican Republic-specific shocks were eight times more volatile. From *Data Set II*, the variance of the common shock is 3.22, whereas the economy-specific shocks' ranges from 1.81 in Guatemala to 26.65 in Panama. The "Ordering" columns of Table 2 rank the nineteen economies in ascending order of economy-specific variance. Note that the orderings are very similar between the two data sets: the correlations

coefficient of the two orderings is 0.74. On the basis of Proposition 1, Guatemala, Colombia, Canada, and Costa Rica have the least to lose from giving up monetary independence and dollarizing. At the other extreme, the costs for Peru, Panama, Chile, and Argentina are likely to be the greatest.[6]

4.2 Synchronization and Symmetry of Economy-Specific Shocks

By itself, the fact that most of the economy-specific shocks are more sizable than the common shock is only necessary, but not sufficient to rule out an optimum currency area for these nineteen economies. It might still be the case that the economy-specific shocks are mostly positively correlated so that, despite their size, they can be largely smoothed by a common monetary authority. This, however, does not appear to be the case.

Table 3 reports correlation coefficients between each of the eighteen (non-U.S.) country-specific shocks and the U.S.-specific shock. It is worth emphasizing again that these do not test the overall synchronicity of each of the economies with the U.S., but rather the synchronicity between their country-specific shocks only. Thus, it is possible that two countries with completely asynchronous (or even negatively correlated) economy-specific shocks, might appear overall to be in phase, simply because of the effects of the common shock.

Table 3 shows that very few strong positive correlations exist, while the number of negative statistically significant correlations equals ten in both data sets. The "Ordering" columns of Table 3 rank the eighteen non-U.S. economies in descending order of correlation with the U.S. Once more, note that the orderings (and the correlations themselves) are remarkably similar between the two data sets: the correlation coefficient of the two orderings is 0.94. In both data sets, Canada is by far the most highly correlated with the U.S., distantly followed by Honduras. Also in both data sets, Peru is the most negatively correlated with the U.S. On the basis of Proposition 2, there is very little evidence that these nineteen economies constitute an optimum currency area.

Table 3. Country-Specific Shocks: Correlations with the U.S.

	Data Set I: PWT5.6 (1950-1992)		Data Set II: IFS (1968-1997)	
i	$\rho_{i,US}$	Ordering	$\rho_{i,US}$	Ordering
Canada	0.72	1	0.77	1
Costa Rica	0.27	4	0.27	3
Dominican Rep.	-0.21	12	0.17	6
El Salvador	0.34	3	0.19	5
Guatemala	-0.03	9	-0.13	11
Honduras	0.48	2	0.34	2
Mexico	-0.22	13	-0.09	10
Panama	-0.28	14	-0.25	16
U.S.A.	1.00	--	1.00	--
Argentina	-0.16	11	-0.14	12
Bolivia	0.14	6	-0.23	15
Brazil	-0.28	15	-0.07	9
Chile	0.11	7	0.15	7
Colombia	0.23	5	0.25	4
Ecuador	-0.14	10	0.07	8
Paraguay	-0.30	17	-0.18	13
Peru	-0.34	18	-0.48	18
Uruguay	-0.29	16	-0.21	14
Venezuela	0.06	8	-0.30	17

Notes: See notes to Table 1. $\rho_{i,US} = corr\ (u_i\ ,\ u_{US})$. "Ordering" ranks the countries in descending order of correlation with the U.S.

5. CONCLUSIONS AND DISCUSSION

This paper examined the prospects of dollarization, asking whether nineteen countries in the Americas comprise an optimum currency area. Economic theory suggests that dollarization will be stabilizing if (i) economy-specific shocks are small relative to the common shocks, or (/and) (ii) economy-specific shocks for countries other than the U.S. are positively correlated with U.S.-specific shocks. The empirical results presented here imply that none of these conditions is satisfied for the majority of the economies in the Americas. Simply put, the Americas are not an optimum currency area: monetary integration is unlikely to have any stabilization benefits for most of the countries, and it may actually have severe adverse effects on output variability for several of them.[7]

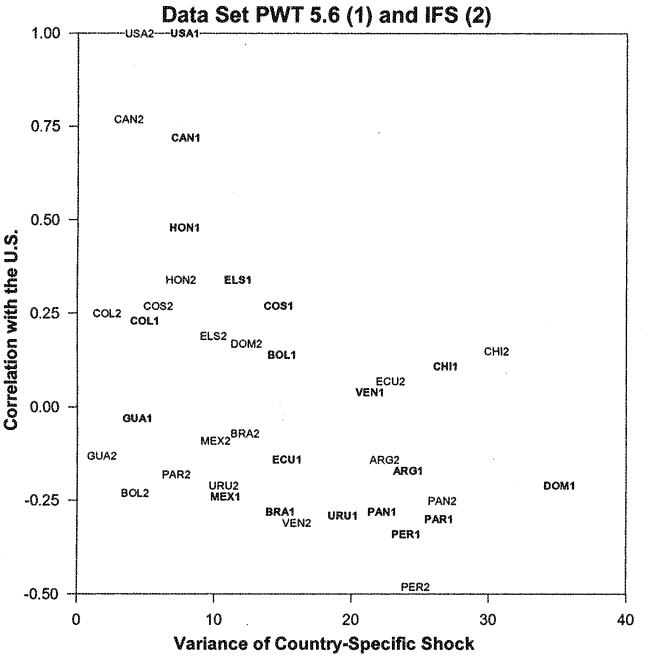

Figure 2: Correlation with the U.S. vs Variance of Country-Specific Shocks

In practice, of course, this conclusion should be qualified for four (at least) reasons. First, the stabilization costs must be balanced against any political and economic gains derived from monetary unification. These gains will be generated not only by the absence of exchange-rate fluctuations, but also by the achievement of generally lower steady-state inflation rates which will result from dollarization because of the enhanced credibility of monetary policy, as suggested by the paper's theoretical model. Second, dollarization itself may enhance the structural similarities of the economies adopting it and reduce some of the large asymmetries estimated here. This is the argument made by Frankel and Rose (1998) about the "endogeneity" of optimum currency area criteria (but see also Eichengreen, 1992; and Krugman, 1993). Indeed, a similar argument has been made in defense of the European Monetary Union and the euro. The extent to which this is likely to happen is one of the most promising areas of future research.

The third and perhaps most important qualification of our general conclusion that the Americas, *as a whole*, are not an optimum monetary area, is that it does not necessarily apply to every *individual* country. The paper's empirical results can be used to evaluate which of the economies examined here would be good candidates for dollarization, in the sense that adopting the dollar will not destabilize them, and which ones would be less good because they would have to pay a higher price in terms of stabilization costs. Figure 2 plots the correlation of each country's specific shock with that of the U.S. against the variance of each country's specific shock. This is carried out for both the PWT 5.6 (1) and the IFS (2) data sets.[8] Propositions 1 and 2 suggest that the closer an economy is to the (0,1) point, i.e. the "northwest" corner of the graph, the lower the stabilization costs associated with dollarization. Hence, Canada is clearly the best candidate for dollarization: not only is its country-specific shock highly positively correlated with the U.S., but it has also a low variance. Honduras, Colombia, and Costa Rica appear to be the next best candidates. On the other hand, Peru and Argentina appear to be the worst candidates for dollarization: not only are their country-specific shocks negatively correlated with the U.S., but they have also a high variance. It follows that dollarization by Peru or Argentina (despite its political attractiveness and potential credibility gains) may substantially amplify the business cycle there and end up being *de*stabilizing.[9] The cases of Mexico and Brazil are somewhere in between: their correlations with the U.S. are negative, but the variances of their country-specific shocks are more moderate. Finally, Chile is particularly difficult to rank as a dollarization candidate: its correlation with the U.S. is positive (albeit low), but its country-specific variance is among the highest.

Lastly, it has to be acknowledged that dollarization is, at least partly, a political process, involving more than strictly economic decisions. This is almost always the case with similar international arrangements, other examples of which are NAFTA, the accession of China to the WTO, and membership in the EU and the *euro* for various European countries. The fact that political issues are highly important, however, does not change the economic parts of the equation. If political criteria are more prominent than economic ones, an economy may dollarize when it is not optimal to do so, or may be prevented from dollarizing when the situation is optimal. In this case, fulfilling the economic criteria may not be a good predictor of actual dollarization. However, the economic effects will always depend on these criteria. Thus, whether dollarization will benefit or harm a country's economy depends on the economic criteria only.

NOTES

1. See Ishiyama (1975) for a survey of the early literature.
2. For similar discussions, see Emerson (1992, Chapter 6), Gros and Thygesen (1992 chapter 7), and Eichengreen (1992, chapter 3) for the European monetary unification, and Summers (1999), Berg and Borensztein (2000), and Karras(2002) for dollarization. Also see Lane (1999) and Alesina, Barro, and Tenreyro (2002). It must be pointed out that Propositions 1 and 2 depend on the presence of nominal rigidities that render monetary policy (potentially) stabilizing.
3. And it is mostly focused on Europe; see for example Bayoumi and Eichengreen (1992), Karras (1996), Alesina and Wacziarg (1999), and Karras and Stokes (2001). Bayoumi and Eichengreen (1994) examine whether NAFTA is an optimum currency area, while Eichengreen (1998) asks the same for Mercosur. See also Eichengreen (2000) for why success or failure of dollarization will depend on its timing.
4. Country selection has been dictated by data availability only.
5. The results are virtually identical if specifications (3) and (6) are used. Moreover, AR(2) and AR(3) processes were also tried for Δy, but the estimated higher-order autoregressive parameters were usually statistically insignificant.
6. Panama, of course, has long been dollarized. Ecuador also replaced the sucre with the dollar as of April 1, 2000.
7. This is consistent with the findings of Bayoumi and Eichengreen (1994) for monetary union in NAFTA.
8. It may be interesting to point out that the two data sets give similar points on Figure 2 for most of the countries in the sample. The prominent exceptions are Bolivia, the Dominican Republic, and Paraguay.
9. Kydland and Zarazaga (1997) have conducted a comparison of the business cycle in Argentina and the U.S.
10. Rogoff (1985), Alesina and Grilli (1992), De Grauwe (1994), and Alesina and Wacziarg (1999) have examined similar models. The main difference between these models and the present formulation is that, in addition to the economy-specific shocks, the stochastic part of (A2) has also a common component.

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APPENDIX

This Appendix demonstrates Propositions 1 and 2 using a simple model. Suppose there are N economies indexed by i (i=1,2,..., N). The first economy

(i=1) is assumed to be the U.S., so that the corresponding currency is the U.S. dollar. Following Kydland and Prescott (1977), and Barro and Gordon (1983), each economy's loss function is

$$L_i = \tfrac{1}{2} E\left[\alpha_i (y_i - \hat{y}_i)^2 + \pi_i^2\right], \tag{A1}$$

where y denotes output, π is inflation, $\hat{y}$ is the target level of output, E takes the mathematical expectation, and α captures the importance of the output target relative to the inflation target. Aggregate supply is given by an expectations-augmented Phillips curve (with slope normalized to unity and the "natural" rate normalized to zero for simplicity):

$$y_i = \left(\pi_i - \pi_i^e\right) + v + u_i, \tag{A2}$$

where π^e denotes expected inflation, $v \sim (0,\sigma_v^2)$ is a shock common to all N economies, and $u_i \sim (0,\sigma_i^2)$ are economy-specific shocks. By assumption, the realizations of v and u become known after inflationary expectations are set, but before the central bank determines π.[10]

Case 1: Without dollarization (i.e., without a monetary union), when each economy's central bank can pursue independent monetary policy, minimizing (A1) subject to (A2) leads to the following dynamically consistent (Nash) equilibrium:

$$\pi_i = \alpha_i \hat{y}_i - \frac{\alpha_i}{1+\alpha_i}\left(v + u_i\right), \tag{A3}$$

and

$$y_i = \frac{1}{1+\alpha_i}\left(v + u_i\right). \tag{A4}$$

The variability of output is then given by

$$\text{var}(y_i) = \frac{1}{\left(1+\alpha_i\right)^2}\left(\sigma_v^2 + \sigma_i^2\right). \tag{A5}$$

Note that there is a trade-off between average inflation ($\overline{\pi}_i = \alpha_i \hat{y}_i$) and output variability: if α_i is very low (the central bank is very "conservative"), average inflation will be very low, but output very unstable.

Case 2: Next, consider dollarization: assume the N economies form a monetary union, monetary authority is delegated to the U.S. (i=1), and the dollar is adopted by all N economies. Then, at equilibrium, $\pi_i = \pi_1$ and thus $\pi_i^e = \pi_1^e$ for all i, where π_1 is given as in (A3). So,

$$y_i = \left(\pi_1 - \pi_1^e\right) + v + u_i = \frac{1}{1+\alpha_1} v + u_i - \frac{\alpha_1}{1+\alpha_1} u_1, \text{ and thus}$$

$$\text{var}(y_i) = \frac{1}{\left(1+\alpha_1\right)^2}\sigma_v^2 + \sigma_i^2 + \frac{\alpha_1^2}{\left(1+a_1\right)^2}\sigma_1^2 - 2\rho_{i1}\frac{\alpha_1}{1+\alpha_1}\sigma_i\sigma_1, \qquad \text{(A6)}$$

where $\rho_{i1} \equiv corr(u_i, u_1)$.

Comparison of Cases 1 and 2: It follows, therefore, that dollarization (provided the U.S. has a more "conservative" monetary authority, so that $\alpha_1 \leq \alpha_i$ and $\hat{y}_1 \leq \hat{y}_i$) reduces the dollarizing economy's average inflation, as: $\overline{\pi}_i^{DOLLARIZATION} = \alpha_1 \hat{y}_1 < \alpha_i \hat{y}_i = \overline{\pi}_i^{INDEPENDENT}$. At the same time, however, comparing (A6) to (A5) shows that dollarization may very well raise output variability. This is the cost of dollarization. From (A6), this cost will be smaller, the smaller is σ_v^2 compared to σ_1^2 (Proposition 1). At the same time, the cost will also be smaller, the closer ρ_{i1} is to unity (Proposition 2)

Chapter 12

THE GENESIS OF THE SOUTH-EAST ASIAN CRISIS:

The External Solvency of the Tiger Economies

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Abstract: We consider the proposition that an important cause of the 1997 Asian crisis has been the massive current account deficits and associated excessive external indebtedness of the "Tiger" economies up to 1997. Our survey of the literature on the causes of the crisis suggests that diverse symptoms such as overvalued currencies, excessive credit expansion, careless risk management and lack of foreign exchange reserves may ultimately be attributed to excessive capital inflows and external insolvency of the Tiger economies. After reviewing the relevant arguments and appropriate statistical methodologies, we test for external (in)solvency of the 7 Tigers, using data on current accounts and current account-to-GDP ratios. We find considerable evidence of current account unsustainability and external insolvency, notably for Indonesia, Malaysia, Philippines and Thailand.

Key words: Asian crisis, external solvency.

1. INTRODUCTION[i]

The Asian financial crisis of 1997 may be justly said to be one of the major economic developments of the 1990s and, commensurately, one of the biggest puzzles of the same period facing analysts. From the fact that it was

virtually totally unpredicted, to its timing, to its causes or origins, to its scale, or to its contagious effects (spreading to such diverse countries as South Korea or Indonesia), all its facets pose questions for which definite answers are unlikely to emerge for some time. Above all, the crucial question concerns the cause(s) of the crisis. As is argued in Section 2, the literature is busy searching for culprits, but consensus is inhibited partly by the nature of the task: Various "causes" may be envisaged at different levels, from the most obvious events that actually triggered the crisis or helped propagate it, down to the underlying pathologies that made a crisis possible where and when it happened. Obviously, a successful answer involves focusing not on events that ultimately are random in nature (e.g. bankruptcies occasionally happen in all countries but crises do not follow) but on anomalies that make the eruption of a crisis look, if not likely, then plausible.

Our survey of the literature in Section 2 leads us to suggest that one common theme of various explanations that have gained some ground is the excessive and unregulated external exposure of the (so-called) Tiger economies via foreign borrowing. This may be seen to be behind diverse problems or symptoms like excessive indebtedness of domestic financial institutions; leveraging of firms, particularly in non-hedged, foreign-currency denominated sums; reckless risk management; property market inflation and, possibly, bubble; overvalued currencies; and, eventually, massive capital flight that eventually lead to currency collapses. Likewise, many of the events that triggered it (bankruptcies, capital exodus, and panic) may not be more than symptoms of the recognition by markets that external debt had reached alarming proportions.

Hence, the testable hypothesis of this paper is that the current account deficits and external indebtedness of (some of) the Tiger economies was "excessive", and therefore unsustainable. Economic theory offers a conceptually clear (if not readily operational) definition of "excessive" through the notion of external solvency. Two operational criteria for assessing external (in)solvency are reviewed in Section 3. Section 4 is empirical, presenting the results on the tests of external solvency for the 7 Tiger economies: Indonesia, South Korea, Malaysia, Philippines, Singapore, Taiwan and Thailand (hereafter T7). To preamble, considerable current account changes are evident during the period leading up to 1997; with several of them being deteriorations. Formal statistical results show that external solvency may well have been jeopardised in some cases, notably for Indonesia, Malaysia, Philippines and Thailand. Section 5 considers the possible effect that the depreciation of the Chinese Yuan in 1997 may have had on current account positions of the other economies in the region,

without however substantiating this effect. Finally, a summary and conclusions together with policy recommendations are offered in Section 6.

2. THE SEARCH FOR CULPRITS: A REVIEW

Whilst a detailed chronology of events is offered elsewhere (see e.g. Kaminsky and Schmukler, 1999; CEPR, 1998) it is useful to recall a few key events and dates as pointers. It seems that the earliest signs of crisis developed independently in Thailand and Korea. In Thailand, whose baht had come under pressure as early as mid-1996, the Bangkok Bank of Commerce fails in July 1996 and Samprasong Land shows signs of financial distress in February 1997, due to the fall in the property market. In Korea, Hanbo Steel collapses in January 1997 and a couple of other chaebols follow after a while. In turn, several merchant banks come under significant pressure both as lenders of those firms and as underwriters of their international debts. Pressure on the baht and its political ramifications intensify in May and June which then leads on to massive capital flight until the eventual collapse and subsequent floating in July 1997. However, uncertainty soon spreads to Malaysia, and signs of panic are evident in bitter attacks by Prime Minister Mahathir on "rogue international speculators" and financial authorities' ambivalence towards freedom in financial transactions. The ringgit falls heavily in July and the stock market of Kuala Lumpur drops by 8% on 3 September. Towards the late summer and early autumn, the crisis engulfs Indonesia, Taiwan and Korea, where currency pegs are abolished and stock markets are subject to dramatic swings or outright losses. The spread of the crisis is intensified when foreign rating agencies downgrade stocks of various countries to junk status, when overdebted Korean and Japanese banks start calling in loans, and erroneous and haphazard policy measures are taken by panic-struck national authorities. In its various bailout packages, the IMF requires restrictive fiscal and monetary policies to be pursued which adds to the ensuing recessions and demands the closures of ailing financial institutions, which reinforces the bank runs.

We therefore have a list of possible immediate causes which include bankruptcies of various institutions; falling property prices; political instability (ailing Suharto in Indonesia); lack of foreign exchange reserves (Kaminsky *et al.*, 1998; Tornell, 1999);[ii] contagion to neighbouring countries (Glick and Rose, 1999; Kaminsky and Schmukler, 1999; Wyplosz, 1998; see also the papers in Agenor *et al.*, 1999 and the Chapter by Caporale, Pittis and Spagnolo in this volume); panic and uncertainty; "herding behaviour" (Kaminsky and Schmukler, 1999); or simply policy responses and mistakes

(Krugman, 1998; Stiglitz, 1998; Radelet and Sachs, 1998). While these observations suggest something about the timing of the crisis or may be responsible for an initial financial market disruption reaching crisis proportions, they obviously do not offer much mileage in terms of underlying pathologies that made Asian economies so vulnerable or even the likely places of a crisis in the first place.

"Deeper" explanations or fundamentals may be found when one considers the prolonged appreciation and overvaluation of several Asian currencies (Tornell, 1999); the enormous domestic credit expansion, excessive leveraging by firms and the debts amassed by banks and non-bank financial institutions and their concomitant vulnerability (Tornell, 1999; Radelet and Sachs, 1999); engagements in risky and overly speculative projects like in property markets and imprudent portfolio and risk management in international loans (Krugman, 1998; Radelet and Sachs, 1998). But even those observations, while they offer an idea of why the crisis was triggered in the countries and broad time that it did, leave it as an open possibility that such symptoms, and therefore crises, could have developed and erupted anywhere in the world and at any time.

It is only when we search at yet a third level that we focus on essential anomalies of Asian capitalism in the 1990s that make the crisis look, in retrospect, inevitable: Among those, irresponsible economic policies would be obvious targets, but, as Krugman (1998) emphasises, there was little sign of them: Public finances were in order, government deficits were not excessive, inflation was tame.[iii] Krugman firmly points the finger to inherent weaknesses of Asian capitalism, particularly the well-known problem of moral hazard: The operational environment was such that financial institutions and other firms had no incentive of being prudent in their risk management; instead, they indulged in, and tolerated, excessively risky projects which, furthermore, tended to be channelled towards unproductive real assets like property markets. Stiglitz (1998) broadly agrees with this assessment and attributes it to the rapid liberalisation of financial markets in emerging Asian economies without the necessary development of an accompanying regulatory framework and supervision practices. In other words, the Asian crisis was about dysfunctional financial markets first and foremost, while currency collapses and capital flight was just a symptom; Krugman (1998) makes this point particularly clearly.

While there should be no doubt about the weaknesses of Asian capitalism, particularly in its financial aspects, in providing propagating mechanisms for the effects of the crises, the survey of the literature reveals a common theme behind some of the symptoms: This is the exposure to international financial markets which doubtless increased after the financial

liberalisation of the last 20 years and the concomitant capital flows. Indeed, the high rates of growth and the underlying high returns enjoyed by capital have attracted large capital inflows into the region. In turn, such flows have contributed to the appreciated currencies and problematic pegs (Tornell, 1999; Milesi-Ferretti and Razin, 1998); excessive credit expansion and borrowing by banks and non-banks alike (Tornell, 1999); imprudent attitudes to risk management, speculative tendencies and property price booms (Krugman, 1998). In parallel, the capital inflows allowed and financed the development of massive in some cases current account deficits (see Section 4). Since trade inflows (i.e. essentially current account deficits) are at least in part denominated in foreign currency, such deficits are also associated with outflows of foreign currency. Thus, the shortage in foreign exchange reserves that preceded the crises (Tornell, 1999; Milesi-Ferretti and Razin, 1998) may also well be ultimately attributed to capital mobility.

One therefore may conclude that international capital mobility and the resulting capital inflows into the T7 economies may have been among the principal causes of the 1997 Asian crises. This is indeed our hypothesis and it will be empirically evaluated in Section 4. Two *a priori* objections may reasonably be advanced against such a claim. First, the fact that capital flows and external deficits existed in the Asian economies before 1997 (Krugman, 1998). Second, naturally, capital inflows and current account deficits emerge at different times in many economies without giving rise to any crises.

Against both arguments, it is only when such phenomena reach "excessive" proportions that they become a cause for concern. This proposition then allows for moderate flows to exist without any danger of crisis; it also allows for such flows to exist *for some time* before becoming apparent that they are unsustainable and before any change of financial investor mood that eventually triggers a crisis. By excessive we mean such flows or deficits that result in external debts that can no longer be financed: in this case, it is said that an economy becomes externally insolvent. Economic theory provides conditions under which such flows are reasonable and indeed sustainable without jeopardising external solvency; these arguments then lead on to appropriate statistical tests. Section 3 reviews this theory. It also substantiates the claim made earlier, that capital inflows and current account deficits are the two sides of the same coin.

3. CURRENT ACCOUNT SUSTAINABILITY AND EXTERNAL SOLVENCY – AN EXPOSITION

Debt (either public or external) is said to be sustainable (and the borrower solvent - the terms may be used interchangeably) if the borrower is able to service the debt and ultimately honour her commitments by repaying it; this is therefore the criterion by which debt is judged as excessive or not. Repaying the principal in due course essentially requires that debt should not be rolled over indefinitely; instead, at least interest payments (and some repayment of the principal) should be made by own resources.[iv] In turn, this implies that debt should grow more slowly than the rate of interest (both considered in real terms). Formally,

$$\lim_{t\to\infty} \frac{B_t}{(1+R)^t} = 0$$

where B is real external (in our case) debt and R the constant (for simplicity) real interest rate. Accordingly, discounted debt should "at the end of history" approach zero. Any deviation will represent a free lunch for the country (if positive) or for the rest of the world (if negative); both such outcomes are ruled out.

The difficulty, of course, with (1) is that, in the absence of data on debt itself, it is not readily operational. As it turns out (see for instance Trehan and Walsh, 1991; Ahmed and Rogers, 1995), a sufficient and empirically testable condition for ensuring that (1) hold is that the *change* in debt be stationary. The reason why may be best understood with reference to Figure 1. From the external budget constraint,

$$B_{t+1} - B_t = TB_t + RB_t \equiv -CA_t$$

the increase in debt on the left is affected by the trade balance (TB) and interest payments. Hence, a constant increase, say, in the debt would generate a straight line as its time profile; random fluctuations in the change would not alter significantly its outlook. In contrast, the time profile of the discount factor $(1+R)^t$ is exponential, since the latter has a constant *growth rate*; the level of the real interest rate determines its slope. Whatever the level of the deficit and whatever the level of the real interest rate initially, the two lines will cross by virtue of the fact that the B line is a straight one, while the discount factor line is exponential. At the intersection, $B_t/(1+R)^t=1$.

Allowing for sufficient time after that (as time grows to infinity), the ratio will tend to 0 and therefore (1) will be satisfied.

The above discussion therefore calls for testing for the stationarity of the capital account (i.e. the change in external debt) that would guarantee the above outcome. It is customary in the literature on capital mobility[v] to measure the capital account via its mirror image, the current account (CA above),[vi] because data on the current account is much more readily available and reliable than that on capital flows. This suggests that the current account should be stationary, which is our fist test in the next Section. Finally, commentators often take the more intuitive approach of monitoring the debt-to-income ratio. Setting implicit limits to the ratio, rather than the level of debt *per se*, also allows for the effects of a growing economy on the tolerable amount of external debt. In our context, this view requires considering the current account-to-output ratio. In particular, the stationarity of that ratio should be tested for. These tests are simple but, stationarity of the CA in particular being sufficient for solvency (see the references above), they are all that is called for.

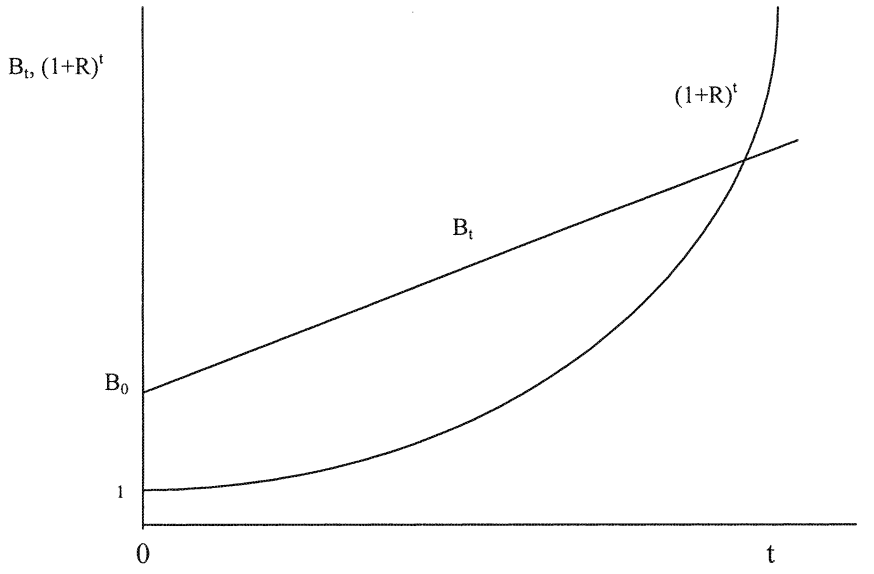

Figure 1: Time profiles of debt and the discount factor.

4. EMPIRICAL TESTS OF EXTERNAL SOLVENCY OF THE TIGER ECONOMIES

The foregoing discussions call for testing for the stationarity of a) the current account (CA below), and b) the current account-to-GDP ratio (CAY). Effectively, what we shall be testing is that capital mobility in the case of Tiger economies was "excessive" in the sense that capital inflows were so large and so persistent that gave rise to unmanageable ("unsustainable") external debt positions. As we argued in Section 2, this may have been an important weakness of Asian capitalism, underlying many of the proximate causes of the 1997 crisis. The literature provides several relevant econometric tests, among them those developed by Dickey and Fuller (1979), Said and Dickey (1984), Bhargava (1986), Phillips and Perron (1988) and Kwiatkowski *et al.* (1992). We will employ the Dickey-Fuller test as it is known to have the highest test power among the various stationarity tests (see Maddala and Kim, 1998).

Plots of CA and the CA-to-GDP (CAY) ratios[vii] (not presented for economy of space but available from the authors on request) of the 7 Tiger economies (T7): Indonesia, Korea, Malaysia, Philippines, Singapore, Taiwan and Thailand reveal important points, which are better told by dividing seven economies into three groups. First, there is what may be called a "deficit" group, which contains Indonesia, Philippines and Thailand. The deterioration in the current accounts of that group was noticeable during the 1990s. Second, Korea and perhaps Malaysia show an intermediate behaviour since their current accounts fluctuate around the zero value. Third, the "surplus" group consists of Singapore and Taiwan. For the first and third groups, the current accounts seem to show persistent deviations from the equilibrium relationship but in different directions: one that leads to insolvency and depletion of foreign reserves (first group) and another that is solvent and results in the accumulation of foreign reserves (third group). We should emphasize that the first and third groups show deviations that have detrimental and supportive effects, respectively, on the stability of the pegged exchange rate regime. It is important to keep in mind the distinction between the two groups, as the statistical tests will fail to do so, as we will see later. In other words, the statistical tests will treat them equivalently as showing deviations from stability regardless of their directions and in spite of the fact that such difference gives very different policy implications.

Table (1) lists the results on unit root tests for the CA series and the current account-to-GDP ratios. When applied to CA, the test fails to reject the null of CA non-stationarity except for Korea. As one might expect, however, the results on the current account-to-GDP ratios point to a higher

rejection of the null of stationarity.[viii] The null for this series is rejected for Malaysia, Singapore and Thailand. To translate these results into conclusions about solvency, we need to bear in mind two points made above, the distinction between deficit and surplus persistent imbalances in the current accounts and the nature of the tests based on the CA or CA-to-GDP ratio. Thus, it is clear that some of the Tiger economies were running persistent and ultimately unsustainable CA imbalances prior to the July 1997 currency crisis. Importantly, however, those imbalances in the case of Singapore and Taiwan are due to surpluses (rather than deficits). Such CA anomalies cannot plausibly be considered as culprits for the crisis as they led to the accumulation of large foreign exchange reserves and hence they helped to avert any attack on the currency.

Table 1. Testing for the Solvency of the Tiger Economies: Augmented Dickey-Fuller tests

Country	CA	CAY
Indonesia	-0.874	-1.270
	[T,0]	[NT,1]
Korea	-4.823*	-2.498
	[NT,4]	[NT,4]
Malaysia	-1.996	3.016*
	[NT,0]	[NT,0]
Philippines	-1.736	-1.377
	[T,3]	[NT,3]
Singapore	-0.655	-3.259*
	[T,0]	[NT,1]
Taiwan	-1.592	-1.430
	[NT,4]	[NT,4]
Thailand	-3.025	-4.392*
	[T,0]	[T,0]

Notes: CA stands for the Augmented Dickey-Fuller test for the current account. CAY stands for the Augmented Dickey-Fuller test for the current account-GDP ratio. A * implies statistical significance at the 5% level. The letters between square brackets imply that a deterministic trend is (T) or is not (NT) added to the model; numbers are for the size of the autocorrelation correction (lag size).

Except for Korea, Singapore and Taiwan, the rest of the T7 ran large CA deficits. Were such deficits enough to generate the feeling in financial markets that current levels of exchange rates were unsustainable and crises inevitable? The answer depends on the question of external solvency on which one might consult different indicators, as argued above. The results (and visual evidence) converge for Indonesia and the Philippines, for which

external insolvency seems to be a fairly unambiguous conclusion. Things are slightly more obscure for Malaysia and Thailand, for which the results of the two tests are not harmonious. More important are the results based on the current account, which point to insolvency. Thus, with the qualification raised by the test result based on the CA-to-GDP ratio, those economies, too, must be considered as externally insolvent by the mid-1990s.

5. POSSIBLE EFFECTS OF THE YUAN DEPRECIATION OF 1994

The raw data reveals an acceleration of the current account deficits of some of the T7 was evident during the 1990s. It has been suggested that the depreciation of China's Yuan by 50% in January 1994 was an important contributor to this deterioration and the insolvency of Tiger economies. If this hypothesis is true then the current accounts of the corresponding economies must point to a continuous deterioration following the 1994 shock. The information provided by the figures is not clear-cut and a formal statistical test needs to be conducted to address this issue.

Table 2. Testing for the effects of the Chinese Yuan depreciation

Country	Effect on Current Account	Model Specification
Indonesia	-5554.0 Rm	ARIMA (1,0)
Korea	No Effect	ARMA (1,1)
Malaysia	No Effect	Various Models
Philippines	No Effect	ARIMA (3,0)
Singapore	1958.1 S$m	ARIMA (0,0)
Taiwan	No Effect	ARIMA (4,0)
Thailand	No Effect	Various Models

Notes: Rm and S$m stand for million Rupiah and million Singapore Dollars, respectively. ARIMA and ARMA are Autoregressive Integrated Moving Average and Autoregressive Moving Average specifications, respectively.

The analysis is carried out by using the standard Perron (1990) procedure to testing for structural change in a time series.[ix] If this hypothesis is true, the current account plots must point to a structural break in each of series and the direction of the break will depend on the commercial relationship between China and the trading partner.[x] Table (2) lists the results on these tests and reveals that there are three types of effect. The first is confined to Indonesia and it shows that following the depreciation of the Yuan, the Indonesian current account deteriorated by 5554 million Rupiah annually,

demonstrating that China and Indonesia are competing against each other in world markets. Nevertheless, the sharp deterioration in the Indonesian current account commenced earlier than the Yuan shock, in 1992. So, the relationship between the Yuan depreciation and the deterioration of the Indonesian current account stated above is not plausible and the fall is a likely continuation of an earlier decline caused by other factors. Indeed, it is difficult to disentangle the effects of those other factors from that, if at all, caused by the depreciation of the Chinese currency.

The second effect is related to Singapore's current account. It shows the depreciation as a positive contributor to improvement of the Singaporean current account. Unlike the Indonesian case, the data confirms the synchronous timing of the two events whereby the Singapore CA increased following the 1994 Yuan depreciation. Indicatively, the annual growth rate of the CA in the 1995-7 period was 23.0% compared with 9.5% for the previous peak period of 1982-94. Finally, the third group contains all other countries and none of them was affected by the Yuan depreciation. Thus, overall the results provide little support for the hypothesis that the depreciation of the Yuan was the source of Asian currency crises. In fact, this conclusion is in harmony with the literature on the Asian currency crises surveyed in Section (2), which does not appear to emphasise such an effect.

6. CONCLUSIONS

This study aims to establish whether the 1997 Asian financial crisis lay in excessive external exposure of the economies involved, namely whether it was caused by a possible markets' perception that the external debt already amassed was no longer sustainable. In particular, our aim is to uncover any evidence of external insolvency among the Tiger economies prior to the 1997 crisis. This hypothesis follows from our survey of the causes of financial crises, with an emphasis on the Asian one; this suggests that various symptoms preceding the crisis (overvalued currencies, credit expansion, speculation, depletion of foreign exchange reserves) may be attributed to excessive capital mobility and the loss of external solvency.

The literature on debt sustainability/ solvency places a key restriction on the current account (and its ratio over GDP) for the external debt to be sustainable. These restrictions are sufficient theoretically, as well as testable and simple. We investigate them by appropriate empirical tests with current account data for the 7 "Tiger economies" (Indonesia, South Korea, Malaysia, Philippines, Singapore, Taiwan, Thailand). We obtain quite strong evidence of external insolvency in the 1990s in the case of Indonesia and the

Philippines; while for Malaysia and Thailand, there is considerable visual and formal evidence pointing to such a conclusion. While not all of the T7 suffered excessive capital inflows or current account deficits, several of them did, including one of the two "trigger" countries, Thailand, and the second country to be severely hit, Malaysia. "Contagious behaviour" then helped propagate the crisis (see the references cited above) to a region that must have been seen as vulnerable to financial investors for reasons that include insolvency. Krugman's (1998) objection that such external deficits existed for much of the 1990s is not hard to counter, in our view: The cause is fundamental, whereas the timing is to a large extent random. Based on these findings and our *a priori* reasoning, we conclude therefore that excessive capital mobility and external insolvency must be held among the most important causes of the recent Asian crisis. As a corollary, the international monetary system and financial integration that allowed persistent current account imbalances to develop must be considered among the "deeper" causes of the 1997 Asian crisis.

The implications of such findings are hard to overstate: International capital mobility, particularly short-term capital movements, enables such external positions to be realised and, hence, put countries' external credibility to the test. This development may become the cause of a crisis in its own right but also is the route by which domestic or other weaknesses become internationalised. Globalisation and financial integration are then seen to entail not only opportunities for investors and borrowers, savers and consumers, but also dangers for the same agents and for societies at large. Such developments, following the industrialised world's financial market liberalisation of the late 1980s, generated instances of markets being unable to judge and regulate by themselves the possible risks, with consequences inflicted on to society at large and not only to market participants. Finally, particularly harmful is financial market liberalisation when combined with deficient regulatory frameworks in the financial sphere, as appears to have been the case among the Asian "Tigers". These observations then call for a more active course of action by national and international financial authorities. Possible measures could include some reduction in the mobility of capital, along the lines of the "Tobin tax" applied to financial capital mobility and speculative money movements; better monitoring and development of regulatory frameworks by financial supervisory authorities; and international co-ordination of crisis management efforts led by international agencies including the IMF and the World Bank.

NOTES

[i] The authors share equally the responsibility for this Chapter.

[ii] However, Burnside *et al.* (1998) raise doubts about the importance of this factor.

[iii] Burnside *et al.* (1998) seem, however, to be a dissonant voice in that they ascribe an important role to prospective government budget deficits in generating the crises.

[iv] Instances when this requirement is violated include the well known "pyramid" schemes or "Ponzi games".

[v] See e.g. the survey in Obstfeld and Rogoff (1996), Chapter 3.

[vi] This follows from the fact that the sum of the two (the balance of payments) equals zero during any year; this is so if the capital account also includes the official transactions element of capital account; see Krugman and Obstfeld (1996).

[vii] The data comes from the IMF *International Financial Statistics* and is quarterly when available, otherwise annual. The periods covered vary subject to availability. The series mnemonics were private consumption c (line 96f), government consumption g (91f), investment i (gross fixed capital formation 93e+change in stocks 93i), GDP (99b.c) and GNP (99a). Then, CA and CAY were constructed as follows: CA≡GNP-c-g-i, CAY≡CA/GDP.

[viii] Somewhat counter-intuitively, the test shows stationarity of CA but rejects it for CAY in the case of Korea. Since non-stationarity of the latter series is due to an improvement, if anything (see Figure 3b), Korea must not be considered among the countries whose insolvency was most seriously at stake.

[ix] Technically, this is carried out by adding a dummy variable to the univariate model of the Dickey-Fuller test for each series. The dummies will have a value of zero for the pre- and on the depreciation period and one for the post-depreciation period.

[x] For instance, if China competes in international markets with the other south Asian economies, the coefficient on the dummy must be less than zero or negative. In this case, the Chinese output is a substitute for the output of that trading partner and any increase in China's exports reduces foreign demand for the competing trading partner. If the coefficient is positive, then the Chinese and the trading partner outputs are complementary so that any increase in China's exports will increase the output of this trading partner.

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Chapter 13

FEEDBACKS BETWEEN STOCK PRICES AND EXCHANGE RATES IN THE EAST ASIAN MARKETS

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Abstract: We examine the links between stock prices and exchange rates in six East Asian countries by using a two-stage procedure to test for causality in variance. We cannot reject the null hypothesis of causality in the first and the second moment in any of the East Asian economies examined. Strong feedbacks in both directions are found in the case of Japan, Korea, Philippines and in the post-crisis sample of Indonesia and Malaysia. On the other hand, the results for Indonesia and Malaysia for the whole sample are consistent with the portfolio approach, with stock prices leading exchange rates in the variance. The opposite holds in Thailand. Despite the considerable heterogeneity, overall the results suggest that causality links are strong and in most cases bidirectional, particularly in the second moments. The implication is that exchange rate policies should not be implemented without taking into account the repercussions on the stock market, and viceversa.

Keywords: Causality, Cross-correlation Function, GARCH, Exchange Rate, Stock Prices, Volatility.

1. INTRODUCTION

Economic theory suggests that there should be a causal relationship between stock prices and exchange rates. There is no consensus, though, on the nature of this relationship. According to the portfolio approach to exchange rate determination, one should expect the former to lead the latter with negative correlation. This is because a decrease in stock prices reduces domestic wealth, which leads to lower domestic money demand and interest rates. The reason is that agents are assumed to allocate their wealth among alternative assets, with the demand for domestic money being negatively related to both domestic and foreign interest rates, and the demand for domestic (foreign) securities being positively (negatively) related to domestic rates and negatively (positively) related to foreign rates. Therefore, when domestic wealth decreases, capital outflows and a depreciation of the currency (namely, an increase in the exchange rate) are necessary in order to balance again supply and demand of assets. From the point of view of foreign investors, the decrease in domestic stock prices leads to lower speculative demand for domestic assets, lower demand for domestic currency, and a depreciation of the exchange rate. Such mechanisms are likely to have become relatively more important as a result of the removal of barriers to capital movements and the increasing degree of integration of international financial markets.

However, there are also reasons to believe that exchange rates might lead stock prices, possibly with a positive correlation. For instance, on a micro level, a currency appreciation might decrease stock prices by reducing firms' profits (see Jorion, 1990). The response of stock prices to fluctuations in the exchange rate might depend on their degree of exposure to exchange rate risks, although the evidence is not always indicative of a strong link (see, e.g., Jorion, 1990; Bodnar and Gentry, 1993).[i] For instance, Loudon (1993) reports that industrial (resource) stocks perform better when the currency appreciates (depreciates). Aggarwal (1981) argues that the effect will be direct or indirect for multinational and domestic firms respectively, and that the net effect is ambiguous, as either a profit or a loss could be registered. In the case of the former type of firm, both assets and liabilities will change, the value of the firm's foreign operation being affected. Hence it is not clear how stock prices will be affected. In the case of the latter, lower export sales and the lower costs of imported inputs will have opposite effects on net profits (and on stock prices), and it is not possible to establish a priori which one will prevail. On a macro level, a stronger exchange rate makes exports less competitive, thereby lowering stock prices. By contrast, for an import denominated country, an appreciation of the currency lowers input costs, and therefore has a positive impact on the stock market (see Smith, 1992).

On the whole, one might argue that it is plausible to expect that there should be a feedback loop, with each variable influencing the other. The policy implications of such a finding would clearly be important, as they would suggest that exchange rate policies should not be implemented without taking into account the repercussions on the stock market, and vice versa.

The available empirical evidence is mixed. Moreover, existing studies often use inappropriate testing strategies, and examine causality in only one direction, which could clearly result in invalid inference. Some examples of early studies, all focusing on the US, are Aggarwal (1981), Solnik (1987), and Smith (1992), who found a positive effect of the exchange rate on stock prices, and Soenen and Hennigar (1988), who reached opposite conclusions. Bodnar and Gentry (1993) carried out similar tests for Japan and Canada, providing weak evidence of a link.

More recent studies examine interactions between stock prices and exchange rates using the concept of Granger causality and cointegration techniques. For instance, Bahmani-Oskooee and Sohrabian (1992) report bidirectional causality in the case of the US, whilst Abdalla and Murinde (1997) conclude that there is unidirectional causality in the case of four emerging markets, namely India, Korea, Pakistan and the Philippines. Granger, Huang and Yang (1998) argue that daily (as opposed to monthly) data are more adequate for capturing the effects of capital movements, and also that it is more appropriate to estimate unit root and cointegration models with breaks, along the lines suggested by Zivot and Andrews (1992) and Gregory and Hansen (1996) respectively, as well as computing the impulse response functions. They conclude that in the Asian economies in most cases the stock market is the leader, or there are feedback interactions which should not be ignored when giving policy prescriptions.

In this paper we examine the links between stock prices and exchange rates by using a two-stage procedure to test for causality in variance developed by Cheung and Ng (1996). Their method involves estimating as a first step univariate time series models which allow for time variation in both conditional mean and variance, and computing as a second step the cross-correlation function (CCF) of the squared residuals standardized by the conditional variance. A $\varkappa^2$ test statistic for the null of non-causality can then be constructed. Cheung and Ng (1996) report the results from Monte Carlo simulations showing that the test has desirable properties not only asymptotically, but also in finite samples of typical size. In smaller samples, an adjustment should be made to obtain a more accurate approximation to the asymptotic distribution.

As they point out, causality in variance can be seen as an extension of the standard concept of Granger causality in mean, and it is of considerable economic interest, especially in the case of asset prices, because changes in variance might be related to the flow of information, in particular the time required

to process it (see Engle *et al.*, 1990). The test they develop is essentially an extension of the McLeod and Li (1983) procedure. Its main advantage is that it is relatively easy to implement, as it does not require the formulation of a multivariate GARCH model – examining the dynamic interactions between variances within such a framework is particularly challenging, one of the reasons being that the distribution of the maximum likelihood estimator is not known (see Engle and Kroner, 1993). On the downside, this statistic cannot detect nonlinear causality or any causality links which produce zero-cross correlations. A similar statistic can be constructed also for causality in mean, thereby making it possible to analyze the joint determination of causality in both the mean and the variance. This is important, as the existence of the former implies that the independence assumption required to compute the statistic for the latter is not valid, which might affect it. Cheung and Ng (1996) provide two empirical examples using Japanese and US stock price indices.

The remainder of the paper is organized as follows. Section 2 outlines the specification and estimation methodology. Section 3 presents the empirical results, and the final section summarizes the main conclusions.

2. TESTING FOR CAUSALITY-IN-VARIANCE

In this section, we briefly describe the two-stage cross correlation function (CCF) test for causality in variance introduced by Cheung and Ng (1996).

Let us consider two stationary and ergodic time series, X_t and Y_t with Ω_t containing all available information up to time t. X_t is said to cause Y_t if for some t

$$E(Y_{t+1}|\Omega_t) \neq E(Y_{t+1}|\Omega_t \backslash \{X_s \mid s \leq t\}), \tag{1}$$

where $\Omega_t \backslash \{X_s | s \leq t\}$ denotes the set of elements of Ω_t that are not in $\{X_s | s \leq t\}$, and X_t causes Y_t instantaneously if

$$E(Y_{t+1}|\Omega_t \cup \{X_{t+1}\}) \neq E(Y_{t+1}|\Omega_t). \tag{2}$$

If (1) is not true, Y_t is not caused by X_t and if (2) does not hold, then Y_t is not caused instantaneously by X_t. If X_t causes Y_t and Y_t causes X_t, then $Z_t' = (Y_t', X_t')$ is a feedback system.

The concepts defined in (1) and (2) can be extended to causality in variance. More precisely, X_t is said to cause Y_t in variance if for some t

$$E\big((Y_{t+1} - \mu_{y,t+1})^2|\Omega_t\big) \neq E\big((Y_{t+1} - \mu_{y,t+1})^2|\Omega_t \backslash \{X_s \mid s \leq t\}\big), \tag{3}$$

$$E\big((Y_{t+1} - \mu_{y,t+1})^2|\Omega_t \cup \{X_{t+1}\}\big) \neq E\big((Y_{t+1} - \mu_{y,t+1})^2|\Omega_t\big), \tag{4}$$

where $\mu_{y,t+1}$ is the mean of Y_{t+1} conditioned on Ω_t. Since the relations defined above are too general to be empirically testable, more structure is required in order to make the general causality concept applicable in practice. Suppose X_t and Y_t are generated as follows:

$$X_t = \mu_{x,t} + h_{x,t}^{.5}\varepsilon_t, \tag{5}$$

$$Y_t = \mu_{y,t} + h_{y,t}^{.5}\xi_t, \tag{6}$$

where $\{\varepsilon_t\}$ and $\{\xi_t\}$ are two independent white noise processes with zero mean and unit variance. Their conditional means and variances are

$$\mu_{z,t} = \sum_{i=1}^{\infty} \beta_{z,i} Z_{t-i}, \tag{7}$$

$$h_{z,t} = \alpha_{z,0} + \sum_{i=1}^{\infty} \alpha_{z,i}\left\{(Z_{t-i} - \mu_{z,t-i})^2 - \alpha_{z,0}\right\}, \tag{8}$$

where $\beta_{z,i}$ and $\alpha_{z,i}$ are parameter vectors and $Z = X, Y$. Specifications 6 and (8) are the widely used ARMA models and generalized autoregressive conditional heteroskedastic (GARCH) processes respectively. The parameter values are all statistically significant as a consequence of the stationarity assumption.

Let U_t and V_t be the squared standardized residuals,

$$U_t = \left((X_t - \mu_{x,t})^2 / h_{x,t}\right) = \varepsilon_t^2, \tag{9}$$

$$V_t = \left((Y_t - \mu_{y,t})^2 / h_{y,t}\right) = \xi_t^2, \tag{10}$$

$r_{uv}(k)$ be the sample cross-correlation at lag k,

$$r_{uv}(k) = c_{uv}(k)\left(c_{uu}(0)c_{vv}(0)\right)^{-1/2}, \tag{11}$$

where $c_{uv}(k)$ is the kth lag sample cross covariance given by

$$c_{uv}(k) = T^{-1}\sum (U_t - \bar{U})(V_{t-k} - \bar{V}), \quad k = 0, \pm 1, \pm 2, \ldots, \tag{12}$$

and $c_{uu}(0)$ and $c_{vv}(0)$ are the sample variances of U and V respectively. Since $\{U_t\}$ and $\{V_t\}$ are independent, the existence of their second moments implies (see Hannan, 1970)

$$\begin{pmatrix} \sqrt{T}r_{uv}(k) \\ \sqrt{T}r_{uv}(k') \end{pmatrix} \to AN\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}, \quad k \neq k'. \tag{13}$$

The cross correlation of the squared standardized residuals can be used to detect casual relations and identify patterns of causation in the second moment.

Since both U_t and V_t are unobservable, their estimators have to be used to test the hypothesis of no causality in variance. In place of $r_{uv}(k)$, the sample cross correlation coefficient $\hat{r}_{uv}(k)$, computed from the consistent estimates of the conditional means and variances of X_t and Y_t, will be used. Let $\hat{\beta}_{z,i}$ and $\hat{\alpha}_{z,i}$ be a consistent estimator of the true parameters $\beta_{z,i}$ and $\alpha_{z,i}$, then $\hat{r}_{uv}(k)$ is defined as:

$$\hat{r}_{uv}(k) = r_{uv}(k). \tag{14}$$

The sample cross covariances $\hat{c}_{uv}(k)$ and the sample variances $\hat{c}_{uu}(0)$ and $\hat{c}_{vv}(0)$ are similarly defined. A chi-square test statistic

$$S = \sum_{i=j}^{k} \hat{r}_{uv}(i)^2 \tag{15}$$

can be constructed to test the null hypothesis of noncausality. It has a chi-square distribution with $(k - j + 1)$ degrees of freedom and it can be used to test the hypothesis of no causality from lag j to lag k. The proposed test has a well-defined asymptotic distribution and is asymptotically robust to distributional assumptions (see Cheung and Ng, 1996, for a more detailed discussion).

3. APPLICATIONS TO THE EAST ASIAN MARKETS

In this section we apply the test described above to investigate the casual relations between stock returns and exchange rates in several East Asian markets. Checking for causality in both mean and variance is the goal of our analysis. After describing the data, we discuss the results.

3.1 Data

We employ daily data (five days per week) for six countries: Malaysia, South Korea, Thailand, Philippines, Indonesia and Japan (see Figure 1 and 2), over the period 1/1/1987–20/1/2000 for a total of 3265 observations. The exchange rates are the local currencies against the US dollar while the stock prices are the price index of the local stock exchanges. Since we are interested in the relation between the stock returns and the changes in the exchange rate, we take the first difference of the logarithm of the stock price index and exchange

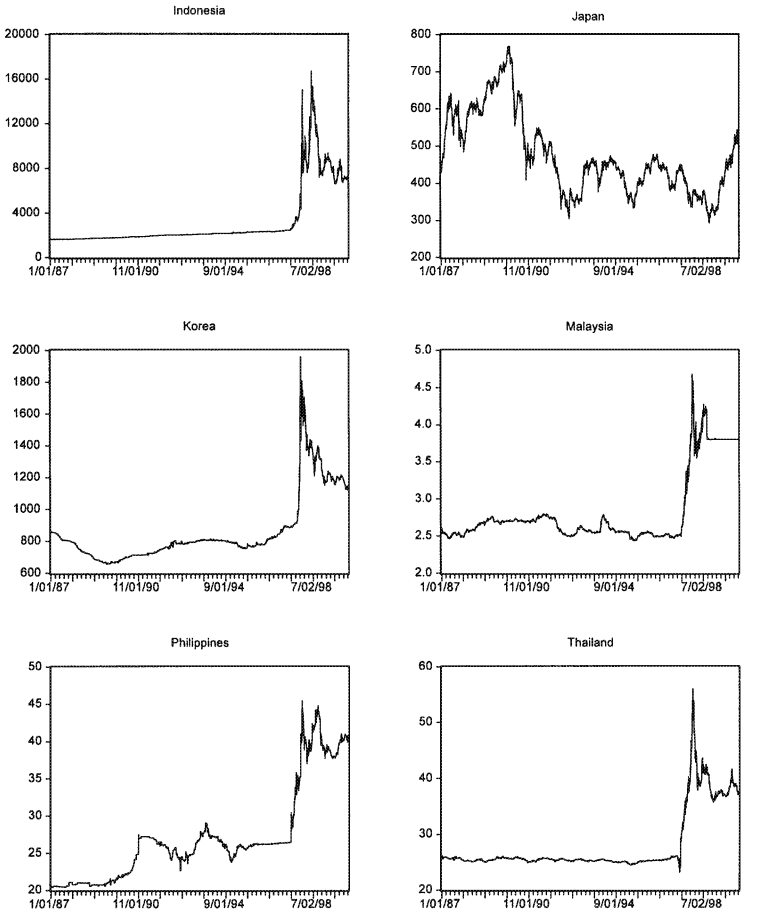

Figure 1: Exchange rates.

rate respectively. Both stock returns and exchange rates show an increase in volatility in the middle of 1997. The Asian crisis, in fact, began in Thailand in the late spring of 1997 with sustained speculative attacks on the local currency, and continued with its flotation in early July 1997. Within days, speculators had attacked the currencies of Malaysia, the Philippines and Indonesia. The Korean currency was attacked later on. Recently there has been an extensive debate on why currency crises tend to be regional and how they spread and affect clusters of countries tied together by international trade (see Glick and Rose, 1999). Although contagion is not the focus of the present paper, the possibly regional nature of currency crises justifies the inclusion of Japan in our analysis. The data were all obtained from Datastream.

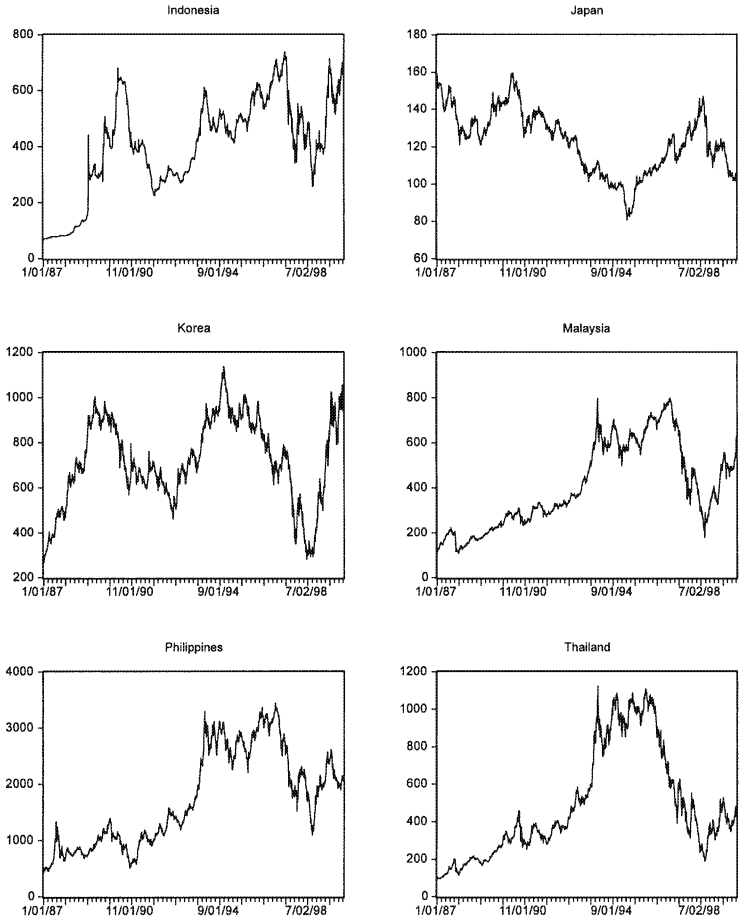

Figure 2: Stock index.

3.2 Empirical results

High frequency financial time series such as stock returns and exchange rates exhibit changes in variance over time. These changes tend to be serially correlated, with groups of highly volatile observations being clustered together. Various approaches to modelling changes in variance have been put forward. The specification we have chosen for exchange rates, EX_t, and stock returns, R_t, is the widely used ARMA(p, q) with GARCH(1, 1) process

$$X_t = \alpha + \sum_{i=1}^{p-1} \beta_i X_{t-i} + \sum_{i=0}^{q} \gamma_i \omega_{t-i}, \quad \omega_t \sim N(0.h_t), \tag{16}$$

$$h_t = \phi_0 + \phi_1 h_{t-i} + \phi_2 \omega_{t-1}^2, \tag{17}$$

where $X_t = EX_t$, R_t and $\omega_t = \varepsilon_t, \xi_t$. The values of p and q are initially set equal to fifteen and two respectively, in order to capture likely seasonal factors.[ii] The standard F-test and the Akaike and Bayesian information criteria will be used to drop insignificant parameters. It is well known that parameters estimated from GARCH models tend to deviate from normality, therefore standard errors robust to non-normality (see Bollerslev and Wooldridge, 1990) are computed reported. To ensure that the chosen models well describe the first and the second moment we apply the Box–Pierce portmanteau statistics checking the first ten sample autocorrelations of the standardized residuals and the squared standardized residuals, denoted by $Q_{(8)}$ and $Q^2_{(8)}$ respectively. We then compute the sample cross-correlation of the standardized and squared standardized residuals, where the lag corresponds to the number of days the exchange rate lags stock returns (positive lag) and viceversa (negative lag).[iii] If any cross-correlation causality patterns are found, the significant and relevant exogenous variables are then added to the original models. In order to check for any misspecification and possible structural breaks, we also perform a recursive estimation. An initial sample of eight years has been considered with increments of one year.

3.2.1 Indonesia. For Indonesia all estimated parameters appear to be significant at conventional levels according to the Bollerslev–Wooldridge standard errors. Looking at the sample correlation function reported in Panel A of Table 1a, we find evidence of causality in variance, with stock returns affecting the exchange rate up to lag thirteen, thirty-one and thirty-five. There is evidence of causality in the levels too, with the eleventh lag of the exchange rate negatively causing the stock returns. The positive sign found in the variance correlation suggests that stock returns volatility has a positive cluster effect on the other market. We add the significant exogenous variables; this leads to the estimation and evaluation of two augmented models.[iv] Table 1 shows maximum-likelihood estimates and diagnostic tests for both the original and augmented models. Panel B of Table 1a reports the sample CCFs of the residuals from the augmented models, showing any significant cross-correlation. However, we find that $\phi_1 + \phi_2 > 1$, which suggests the possibility of an integrated process. A recursive estimation confirms that the mechanism generating the data is different for the whole sample, in fact we identify a break occurring on the 1/10/1997 (Table 1b). Therefore, we split the sample and an analysis for the two sub-samples will follow.

Pre-crisis The first sample goes from 1/1/1987 to 1/10/1997. All estimated parameters appear to be significant. Looking at the sample correlation function reported in Panel A of Table 1sub1a, the results found for the whole sample

Table 1: Indonesia

Parameters	Exchange rate		Parameters	Returns	
	Original model	Augmented model		Original model	Augmented model
α	.0002 [.0001]	.0001 [.0001]	α	.0002 [.0001]	.0002 [.0001]
ϕ_0	.0002 [.0001]	.0001 [.0001]	β_1	.4463 [.0861]	.4471 [.0863]
ϕ_1	.9396 [.0198]	.9341 [.0221]	β_{10}	.0739 [.0228]	.0736 [.0232]
ϕ_2	.0673 [.0257]	.0753 [.0284]	γ_1	−.1476 [.1102]	−.1485 [.1103]
φ_{13}	.0004 [.0004]		δ_9		−.0061 [.0463]
			ϕ_0	.0000 [.0000]	.0000 [.0000]
			ϕ_1	.8881 [.0262]	.8881 [.0261]
			ϕ_2	.1398 [.0379]	.1401 [.0378]
$Q_{(8)}$	3.391	4.59		12.263	12.239
$Q^2_{(8)}$	13.937	11.419		3.379	3.368
Log-lik	15582.79	15531.96		10545.27	10545.30

Note: Bollerslev–Wooldridge standard errors are calculated. P-values are reported in squared brackets.

Table 1a: Cross-correlations in the levels and squares of standardized residuals from the models reported in Table 1

	Panel A		Panel B	
lag k	$\hat{r}_{\varepsilon\xi}(k)$	$\hat{r}_{uv}(k)$	$\hat{r}_{\varepsilon\xi}(k)$	$\hat{r}_{uv}(k)$
−10	.000	.000	−.006	−.003
−9	.006	−.009	.000	−.005
−8	−.014	−.001	−.016	−.001
−7	.021	−.003	.014	−.006
−6	−.01	.007	−.026	.016
−5	.000	.005	.020	−.003
−4	−.007	.007	.011	.007
−3	−.027	−.005	−.009	.003
−2	−.026	−.009	−.026	−.003
−1	−.027	−.004	−.020	.007
0	−.049	.009	−.047	.007
1	−.022	−.002	−.023	−.003
2	−.007	−.003	−.004	−.002
3	−.005	−.008	.001	−.004
4	−.011	−.008	−.008	.002
5	.014	−.006	.004	−.006
6	−.007	−.005	.013	−.005
7	.017	−.002	.025	−.002
8	−.009	−.008	−.015	−.003
9	.001	.002	.013	.003
10	.017	−.001	.027	.011

Note: "*" indicates significance at 5%.

Table 1b: Recursive estimation

	Ex-rate		Returns	
Sample	ϕ_1	ϕ_2	ϕ_1	ϕ_2
1987–94	.600	.14	.877	.189
1987–95	.600	.14	.879	.171
1987–96	.600	.14	.881	.161
1987–97	.600	.14	.879	.158
1987–98	.942	.066	.885	.149
1987–99	.940	.067	.885	.146
1987–00	.939	.067	.888	.139

are confirmed. In fact, we find evidence of causality in variance, with stock returns affecting the exchange rate up to lag thirty-one. There is evidence of causality in the levels too, with the eleventh lag of the exchange rate negatively causing the stock returns. The positive sign found in the variance correlation suggests that stock returns volatility has a positive cluster effect on the other market. Table 1sub shows maximum-likelihood estimates and diagnostic test on both the original and augmented models. Panel B of Table 1sub1a reports the sample CCFs of the residuals from the augmented models, showing any significant cross-correlation.

Post-crisis The second sample goes from 2-10-1977 to 20-1-2000. All estimated parameters appear to be significant at conventional levels. Looking at the sample correlation function reported in Panel A of Table 1sub2a, we find feedbacks in variance and in the levels in both directions; as for the whole sample, the negative sign found in the level correlation suggests that the two series move in opposite directions, while volatility shows a positive cluster effect between the two markets. We add the significant exogenous variables,[v] for the stock returns. EX^2_{t-4}, EX^2_{t-8} and EX^2_{t-10} turned out to be insignificant. Table 1sub2 shows maximum-likelihood estimates and diagnostic test on both the original and augmented models. Panel B of Table 1sub2a reports the sample CCFs of the residuals from the augmented models, showing that there are still few significant cross-correlation coefficient. Its lower value suggests that it may be driven by factors other than the ones captured by these two series.

3.2.2 Japan. For Japan, again, all parameters are significant, with estimated values which are typical of GARCH models applied to high-frequency financial data. A recursive estimation shows that the parameters are stable for the whole sample (see Table 2b). We find feedbacks in variance in both directions, with stock returns affecting the exchange rate up to lag twenty-nine, and feedback in the levels too; in particular, the negative sign found in the

Table 1sub1: Indonesia

Parameters	Exchange rate		Parameters	Returns	
	Original model	Augmented model		Original model	Augmented model
α	.000 [.000]		α	.000 [.000]	.000 [.000]
ϕ_0	.000 [.000]		β_1	.460 [.090]	.443 [.090]
ϕ_1	.60 [.319]		β_{10}	.068 [.027]	.062 [.028]
ϕ_2	.15 [.128]		γ_1	−.116 [.127]	−.098 [.126]
			δ_{11}		−.381 [.119]
			ϕ_0	.000 [.000]	.000 [.000]
			ϕ_1	.879 [.031]	.879 [.032]
			ϕ_2	.155 [.046]	.157 [.046]
$Q_{(8)}$	11.229			13.962	14.029
$Q^2_{(8)}$	4.295			2.315	2.294
Log-lik	13413.26			9200.33	9204.99

Note: See note Table 1.

Table 1sub1a: Cross-correlations in the levels and squares of standardized residuals from the models reported in Table 1sub1

	Panel A		Panel B	
lag k	$\hat{r}_{\varepsilon\xi}(k)$	$\hat{r}_{uv}(k)$	$\hat{r}_{\varepsilon\xi}(k)$	$\hat{r}_{uv}(k)$
−10	−.001	.004	−.001	.004
−9	.013	−.009	.014	−.009
−8	−.003	.001	.001	.002
−7	.035	−.000	.042	.000
−6	−.015	.002	−.016	.002
−5	−.009	−.001	−.003	−.001
−4	−.030	.014	−.031	.014
−3	−.038	−.003	−.034	−.004
−2	−.014	−.003	−.015	−.004
−1	−.026	−.005	−.027	−.005
0	−.021	.000	−.023	.000
1	−.014	.000	−.013	−.000
2	−.006	−.005	−.004	−.005
3	−.004	−.009	−.004	−.008
4	−.007	−.011	−.008	−.011
5	.019	−.007	.016	−.007
6	−.030	−.002	−.033	−.001
7	−.001	−.003	−.002	−.003
8	.005	−.006	.002	−.006
9	−.000	.002	−.002	.002
10	.013	−.000	.013	−.000

Note: See note Table 1a.

Table 1sub2: Indonesia

Parameters	Exchange rate		Parameters	Returns	
	Original model	Augmented model		Original model	Augmented model
α	−.000 [.000]	.001 [.000]	α	.000 [.000]	−.000 [.000]
δ_1		−.157 [.049]	β_1	.162 [.049]	.139 [.046]
ϕ_0	.000 [.000]	.000 [.000]	β_{10}	.101 [.043]	.083 [.037]
ϕ_1	.587 [.170]	.760 [.095]	δ_1		−.074 [.032]
ϕ_2	.105 [.054]	.154 [.066]	ϕ_0	.000 [.000]	.000 [.000]
ϕ_3	.029 [.083]	.076 [.131]	ϕ_1	.813 [.092]	.536 [.111]
ϕ_4	−.086 [.129]	−.086 [.106]	ϕ_2	.117 [.044]	.179 [.052]
φ_1		.163 [.071]	φ_1		.028 [.011]
$Q_{(8)}$	11.987	3.117		4.626	1.861
$Q^2_{(8)}$	7.820	14.632		2.659	2.485
Log-lik	1257.68	1303.81		1369.83	1409.22

Note that few added exogenous variables are not reported here for lack of space.

Table 1sub2a: Cross-correlations in the levels and squares of standardized residuals from the models reported in Table 1sub2

	Panel A		Panel B	
lag k	$\hat{r}_{\varepsilon\xi}(k)$	$\hat{r}_{uv}(k)$	$\hat{r}_{\varepsilon\xi}(k)$	$\hat{r}_{uv}(k)$
−10	−.041	.043	−.016	.046
−9	−.028	.019	.002	−.007
−8	−.084*	−.021	−.030	−.036
−7	−.045	−.025	−.061*	−.035
−6	−.019	.048	−.020	.020
−5	.088*	.004	.002	−.031
−4	.108*	.151*	.054*	.059*
−3	−.008	−.014	−.002	−.063*
−2	−.052*	−.020	−.030	−.065*
−1	−.081*	.007	.017	−.027
0	−.171*	.124*	.081*	.034
1	−.048	.028	−.026	.003
2	−.043	.005	−.029	−.004
3	.005	−.010	.034	.004
4	−.034	.071*	−.008	−.015
5	−.009	.040	−.002	−.007
6	.091*	−.011	−.002	−.019
7	.065*	−.002	−.016	−.024
8	−.039	.062*	−.024	.017
9	.043	.105*	.015	−.007
10	.034	−.050*	.048	−.047

Note: See note Table 1a.

Table 2: Japan

Parameters	Exchange rate		Parameters	Returns	
	Original model	Augmented model		Original model	Augmented model
α	−.000 [.000]	.000 [.000]	α	.000 [.000]	.000 [.000]
β_{10}	.063 [.018]	.063 [.018]	γ_1	.118 [.022]	.112 [.021]
δ_1		−.028 [.011]	δ_1		−.049 [.029]
ϕ_0	.000 [.000]	.000 [.000]	ϕ_0	.000 [.000]	.000 [.000]
ϕ_1	.926 [.018]	.941 [.014]	ϕ_1	.821 [.038]	.747 [.062]
ϕ_2	.049 [.013]	.038 [.010]	ϕ_2	.161 [.051]	.191 [.064]
φ_1		.002 [.001]	φ_1		.082 [.040]
$Q_{(8)}$	5.571	5.696		3.969	4.702
$Q^2_{(8)}$	4.716	4.714		3.533	3.261
Log-lik	11974.73	11989.2		10640.1	10656.21

Note: See note Table 1.

Table 2a: Cross-correlations in the levels and squares of standardized residuals from the models reported in Table 1

	Panel A		Panel B	
lag k	$\hat{r}_{\varepsilon\xi}(k)$	$\hat{r}_{uv}(k)$	$\hat{r}_{\varepsilon\xi}(k)$	$\hat{r}_{uv}(k)$
−10	−.007	.006	−.006	.006
−9	−.017	.006	−.017	.003
−8	−.029	.000	−.028	.000
−7	.006	.002	.005	.003
−6	.005	.059*	.002	.054*
−5	.023	−.001	.020	−.007
−4	−.000	−.002	−.002	−.004
−3	.007	.052*	.002	.020
−2	−.018	−.011	−.017	−.017
−1	−.022	−.001	−.015	−.014
0	−.051*	.062*	.028	.000
1	−.008	.045	−.014	.019
2	−.011	−.009	−.010	−.021
3	−.001	−.004	−.003	−.013
4	.004	−.000	.004	−.010
5	.005	−.020	.003	−.028
6	−.018	−.010	−.021	−.016
7	.015	−.008	.015	−.012
8	.000	−.005	−.001	−.012
9	.014	.009	.013	.002
10	−.000	.010	.005	.009

Note: See note Table 1a.

Table 2b: Recursive estimation

	Ex-rate		Returns	
Sample	ϕ_1	ϕ_2	ϕ_1	ϕ_2
1987–94	.866	.060	.737	.258
1987–95	.860	.056	.754	.236
1987–96	.909	.050	.747	.233
1987–97	.924	.046	.763	.217
1987–98	.934	.039	.790	.193
1987–99	.909	.062	.803	.178
1987–00	.926	.049	.821	.161

level correlation suggests that the two series move in opposite directions while volatility shows a positive cluster effect between the two markets (see Panel A of Table 2a). The augmented models are then estimated.[vi] From Panel B of Table 2a, which reports the sample CCFs of the residuals from the augmented models, it can be seen that there is still one significant cross-correlation coefficient. Its lower value suggests that it may be driven by factors other than the ones captured by these two series.

3.2.3 Korea. The preferred specifications for South Korea lead the estimated parameters are statistically significant, and robust (see Table 3b) with the conditional volatility highly persistent. There is evidence of feedback in the variance in both directions, with the stock return affecting the exchange rate up to lag thirty, and in the levels too, with the tenth lag of the exchange rate causing the stock returns and the stock return affecting the exchange rate up to lag twenty-five[vii] (see Panel A of Table 3a). The negative sign found in the level correlations are confirmed in the augmented models, suggesting that the two series move in opposite directions, whereas the observed volatility indicates a positive cluster effect between the two markets. There are still a few significant cross-correlation coefficient significant at the 5% level. The remaining evidence of causality suggests a more intricate causal structure in the second moment, not completely captured by these two series.

3.2.4 Malaysia. In the case of Malaysia the estimated parameters for the exchange rates are not stable for the whole sample (see Table 4b). In order to take into account the break which occurred in the latter part of 1997 we also split the sample into a pre-crisis and post-crisis sub-sample. The sample correlation function indicates that there is positive feedback in the variance in both directions, whilst in the levels the ninth and fourteen lag of the exchange rates cause stock returns (see Panel A of Table 4a). The negative sign found in the level correlation suggests once again that the two series move in opposite directions, while volatility shows a positive cluster effect between the two markets.

Table 3: Korea

Parameters	Exchange rate		Parameters	Returns	
	Original model	Augmented model		Original model	Augmented model
α	−.000 [.000]	−.000 [.000]	α	.000 [.000]	.000 [.000]
δ_1		−.008 [.002]	β_1	.043 [.019]	.037 [.019]
δ_{30}		−.007 [.002]	δ_1		−.434 [.064]
ϕ_0	.000 [.000]	.000 [.000]	δ_{10}		−.141 [.071]
ϕ_1	.935 [.015]	.935 [.014]	ϕ_0	.000 [.000]	.000 [.000]
ϕ_2	.059 [.018]	.061 [.018]	ϕ_1	.883 [.014]	.874 [.015]
φ_{25}		.004 [.000]	ϕ_2	.101 [.012]	.101 [.012]
			φ_2		.036 [.015]
$Q_{(8)}$	13.835	10.552		7.880	7.249
$Q^2_{(8)}$	2.091	2.651		15.180	12.071
Log-lik	15326.32	15190.72		9443.022	9450.51

Note: See note Table 1.

Table 3a: Cross-correlations in the levels and squares of standardized residuals from the models reported in Table 3

	Panel A		Panel B	
lag k	$\hat{r}_{\varepsilon\xi}(k)$	$\hat{r}_{uv}(k)$	$\hat{r}_{\varepsilon\xi}(k)$	$\hat{r}_{uv}(k)$
−10	.007	.018	.004	.029
−9	−.020	−.007	−.017	−.007
−8	−.025	−.088	−.025	−.005
−7	−.028	−.032	−.030	−.032
−6	−.010	−.022	−.010	−.021
−5	.010	.038	.006	.037
−4	−.015	−.015	−.017	−.013
−3	−.039	−.000	−.038	−.001
−2	−.009	.003	−.009	.003
−1	−.044	−.014	−.034	−.011
0	−.109*	.038	.037	.037
1	−.025	−.021	−.021	−.021
2	.004	.077*	.006	.077*
3	−.010	−.005	−.009	.004
4	−.002	−.008	.000	−.003
5	.014	.015	.011	.026
6	−.026	−.010	−.029	−.010
7	−.013	−.007	−.011	.000
8	.001	−.006	−.003	.002
9	−.046	−.025	−.041	−.023
10	−.052*	.082*	−.025	.082*

Note: See note Table 1a.

Table 3b: Recursive estimation

	Ex-rate		Returns	
Sample	ϕ_1	ϕ_2	ϕ_1	ϕ_2
1987–94	.970	.004	.774	.137
1987–95	.976	.001	.796	.129
1987–96	.966	.028	.796	.127
1987–97	.962	.028	.810	.119
1987–98	.943	.954	.825	.125
1987–99	.938	.047	.861	.113
1987–00	.935	.059	.883	.101

Table 4: Malaysia

Parameters	Exchange rate		Parameters	Returns	
	Original model	Augmented model		Original model	Augmented model
α	.000 [.000]	.000 [.000]	α	.000 [.000]	.000 [.000]
β_2		.069 [.032]	γ_1	.197 [.020]	.203 [.019]
ϕ_0	.000 [.000]	.000 [.000]	γ_2	.062 [.022]	.055 [.021]
ϕ_1	.779 [.001]	.843 [.023]	δ_9		−.117 [.072]
ϕ_2	.341 [.004]	.212 [.034]	ϕ_0	.000 [.000]	.000 [.000]
φ_1		−.001 [.000]	ϕ_1	.851 [.032]	.725 [.036]
			ϕ_2	.127 [.023]	.183 [.037]
			φ_1		.385 [.165]
$Q_{(8)}$	14.084	9.025		9.729	9.488
$Q^2_{(8)}$	2.081	4.146		1.798	.881
Log-lik	16319.21	16216.81		10080.64	10109.29

Note: See note Table 1.

The augmented models,[viii] which include the significant exogenous variables,[ix] are then estimated. Panel B of Table 4a reports the sample CCFs of the residuals from the augmented models.

Pre-crisis With the first sub-sample going from 1-1-1987 to 20-7-1997, the sample correlation function indicates that there is not any causality in the variance, whilst in the levels the ninth causes stock returns (see Panel A of Table 4sub1a). The negative sign found in the level correlation suggests once again that the two series move in opposite directions. The augmented models, which include the significant exogenous variables, are estimated. Panel B of

Table 4a: Cross-correlations in the levels and squares of standardized residuals from the models reported in Table 4

	Panel A		Panel B	
lag k	$\hat{r}_{\varepsilon\xi}(k)$	$\hat{r}_{uv}(k)$	$\hat{r}_{\varepsilon\xi}(k)$	$\hat{r}_{uv}(k)$
−10	.022	−.010	.024	−.006
−9	−.036	.011	−.030	.011
−8	.012	.000	.015	−.000
−7	.002	−.004	−.000	−.000
−6	−.001	.002	−.005	−.005
−5	−.020	.012	−.010	.010
−4	.006	.006	.011	−.009
−3	.014	−.004	.017	.004
−2	−.023	−.009	−.019	−.012
−1	−.021	.000	−.016	.005
0	−.018	.053*	−.004	.035
1	−.002	.001	.004	−.008
2	.005	−.002	.011	−.009
3	−.002	−.004	.004	−.005
4	−.009	.006	−.006	.001
5	.016	.012	.011	.007
6	−.004	.024	.000	.001
7	.001	−.004	.005	−.006
8	−.015	−.009	−.009	−.013
9	−.052*	.002	−.029	−.002
10	−.024	−.002	−.027	−.004

Note: See note Table 1a.

Table 4b: Recursive estimation

	Ex-rate		Returns	
Sample	ϕ_1	ϕ_2	ϕ_1	ϕ_2
1987–94	.600	.150	.626	.230
1987–95	.600	.150	.672	.230
1987–96	.600	.150	.704	.174
1987–97	.600	.150	.720	.174
1987–98	.600	.150	.770	.174
1987–99	.860	.144	.854	.126
1987–00	.779	.341	.851	.127

Table 4sub1a reports the sample CCFs of the residuals from the augmented models showing any significant cross-correlation left.

Post-crisis The second sub-sample goes from 1-1-1987 to 20-7-1997, in this case the sample correlation function indicates that there is positive feedback in the variance in both directions, whilst in the levels the feedback appear to be negative (see Panel A of Table 4sub2a). The negative sign found in the level

Table 4sub1: Malaysia

Parameters	Exchange rate		Parameters	Returns	
	Original model	Augmented model		Original model	Augmented model
α	−.000 [.000]		α	.008 [.000]	.000 [.000]
ϕ_0	.000 [.000]		γ_1	.226 [.022]	.220 [.022]
ϕ_1	.533 [.213]		γ_2	.055 [.023]	.053 [.023]
ϕ_2	.133 [.059]		δ_9		−.217 [.118]
ϕ_3	.044 [.066]		ϕ_0	.000 [.000]	.000 [.000]
			ϕ_1	.728 [.052]	.737 [.048]
			ϕ_2	.169 [.050]	.168 [.046]
$Q_{(8)}$	9.155			8.275	7.827
$Q^2_{(8)}$	15.432			1.165	1.103
Log-lik	13112.74			8582.04	8560.41

Note: See note Table 1.

Table 4sub1a: Cross-correlations in the levels and squares of standardized residuals from the models reported in Table 4sub1

	Panel A		Panel B	
lag k	$\hat{r}_{\varepsilon\xi}(k)$	$\hat{r}_{uv}(k)$	$\hat{r}_{\varepsilon\xi}(k)$	$\hat{r}_{uv}(k)$
−10	−.041	−.001	−.049	−.004
−9	−.055*	.002	−.016	.001
−8	−.010	−.012	−.012	−.012
−7	−.015	−.002	−.015	−.002
−6	−.006	.012	−.006	.012
−5	.009	.000	.008	.000
−4	.009	.003	.010	.003
−3	.015	−.001	.015	−.000
−2	.021	−.005	.020	−.005
−1	.023	−.006	.023	−.006
0	.016	.026	.022	.024
1	−.014	.010	−.009	.009
2	−.031	−.009	−.027	−.010
3	.005	.008	.009	.008
4	.008	−.015	.009	−.014
5	.004	.016	.003	.017
6	−.020	.003	−.020	.003
7	−.003	−.007	−.003	−.007
8	−.002	.003	−.001	.002
9	−.023	−.001	−.022	−.002
10	.031	.005	.034	.005

Note: See note Table 1a.

Table 4sub2: Malaysia

Parameters	Exchange rate		Parameters	Returns	
	Original model	Augmented model		Original model	Augmented model
α	.000 [.000]	.000 [.000]	α	.001 [.000]	.000 [.000]
β_1	.194 [.071]	.026 [.065]	γ_1	.109 [.049]	.094 [.045]
δ_1		−.126 [.010]	γ_2	.086 [.055]	.050 [.050]
δ_5		−.018 [.008]	δ_1		−.623 [.127]
ϕ_0	.000 [.000]	.000 [.000]	ϕ_0	.000 [.000]	.000 [.000]
ϕ_1	.813 [.148]	.609 [.107]	ϕ_1	.867 [.052]	.548 [.085]
ϕ_2	.158 [.120]	.167 [.068]	ϕ_2	.134 [.042]	.208 [.057]
φ_1		.013 [.004]	φ_1		.511 [.311]
$Q_{(8)}$	9.260	11.405		8.802	3.949
$Q^2_{(8)}$	2.207	11.652		1.053	6.059
Log-lik	2530.24	2397.59		1537.02	1600.40

Note that few lag exogenous variables are not reported for lack of space.

Table 4sub2a: Cross-correlations in the levels and squares of standardized residuals from the models reported in Table 4sub2

	Panel A		Panel B	
lag k	$\hat{r}_{\varepsilon\xi}(k)$	$\hat{r}_{uv}(k)$	$\hat{r}_{\varepsilon\xi}(k)$	$\hat{r}_{uv}(k)$
−10	−.037	−.020	−.022	−.040
−9	−.118*	.065*	.066*	.014
−8	−.010	−.015	−.043	−.076*
−7	.051*	.066*	−.051*	.023
−6	.042	−.012	.014	−.066*
−5	−.065*	.047	.036	.044
−4	.026	−.006	.026	−.030
−3	.000	.010	.031	−.035
−2	.000	−.018	.027	−.079*
−1	−.039	.011	.001	−.001
0	−.194*	.175*	.372*	−.003
1	−.148*	.036	.048	−.039
2	−.060*	.012	.025	.007
3	−.016	.016	.038	−.045
4	−.091	.036	−.020	−.042
5	.001	.074*	−.037	.041
6	.017	.013	.016	−.005
7	.055	−.008	.020	−.009
8	.018	−.000	−.011	−.029
9	−.000	−.006	−.010	−.021
10	.031	−.010	.052*	−.047

Note: See note Table 1a.

Table 5: Philippines

Parameters	Exchange rate		Parameters	Returns	
	Original model	Augmented model		Original model	Augmented model
α	.000 [.000]	−.000 [.000]	α	.000 [.000]	.000 [.000]
β_4	−.063 [.022]	−.091 [.029]	β_1	.202 [.021]	.207 [.020]
δ_{28}		−.014 [.006]	β_8	.036 [.018]	.035 [.018]
ϕ_0	.000 [.000]	.000 [.000]	δ_2		−.091 [.047]
ϕ_1	.962 [.011]	.866 [.036]	ϕ_0	.000 [.000]	.000 [.000]
ϕ_2	.027 [.008]	.096 [.039]	ϕ_1	.898 [.018]	.885 [.020]
φ_0		.010 [.002]	ϕ_2	.090 [.018]	.094 [.019]
φ_1		−.002 [.001]	φ_0		.014 [.015]
			φ_{34}		.036 [.020]
$Q_{(8)}$	14.773	11.163		11.584	10.926
$Q^2_{(8)}$	3.521	7.917		5.809	3.903
Log-lik	13180.28	13226.77		9365.94	9300.30

Note: See note Table 1.

correlation suggests once again that the two series move in opposite directions, while volatility shows a positive cluster effect between the two markets. The augmented models, which include the significant exogenous variables, are estimated. Note that EX^2_{t-5} and EX_{t-1}, EX_{t-2}, EX_{t-4}, EX_{t-7} turned out to be insignificant and were not included. Panel B of Table 4sub2a reports the sample CCFs of the residuals from the augmented models. There are still few significant cross-correlation coefficients that may be driven by factors other than the ones captured by these two series.

3.2.5 Philippines. For the Philippines the parameters turned out to be stable for the whole sample according to Table 5b. Here we find evidence of feedback in the variance in both directions with stock returns affecting the exchange rate up to lag thirty-four, and in the levels too, with the second lag of the exchange rate causing stock returns and the twenty-eighth lag stock return affecting the exchange rate (see Panel A of Table 5a). The negative sign found in the level correlation suggests that the two series move in opposite directions, whereas the observed volatility indicates a positive cluster effect between the two markets.[x] Panel B of Table 5a reports the sample CCFs of the residuals from the augmented models.

Table 5a: Cross-correlations in the levels and squares of standardized residuals from the models reported in Table 5

	Panel A		Panel B	
lag k	$\hat{r}_{\varepsilon\xi}(k)$	$\hat{r}_{uv}(k)$	$\hat{r}_{\varepsilon\xi}(k)$	$\hat{r}_{uv}(k)$
−10	−.009	−.007	−.000	−.006
−9	−.024	−.013	−.023	−.019
−8	.011	−.007	.006	−.006
−7	−.012	.004	−.006	−.006
−6	.012	−.000	.012	−.009
−5	.025	.032	.023	.036
−4	−.014	−.011	−.019	−.015
−3	−.025	.005	−.019	−.010
−2	−.019	.036	−.011	.005
−1	−.020	.017	−.022	−.007
0	.007	.096*	−.001	.014
1	.005	−.002	.006	−.007
2	−.059*	.000	−.015	−.003
3	.014	.001	.009	.004
4	.000	−.007	−.010	−.011
5	−.039	−.007	−.039	−.011
6	−.009	−.014	−.006	−.021
7	.010	−.009	.007	−.010
8	−.003	−.003	−.004	−.007
9	−.017	−.010	−.013	−.020
10	.024	.022	.015	.012

Note: See note Table 1a.

Table 5b: Recursive estimation

	Ex-rate		Returns	
Sample	ϕ_1	ϕ_2	ϕ_1	ϕ_2
1987–94	.908	.004	.920	.067
1987–95	.813	.009	.917	.068
1987–96	.794	.012	.922	.065
1987–97	.870	.006	.925	.065
1987–98	.942	.033	.921	.073
1987–99	.950	.030	.910	.083
1987–00	.962	.027	.898	.090

3.2.6 Thailand. In the case of Thailand the estimated parameters are stable for the whole sample (see Table 6b). We find that the exchange rate causes stock returns in the second moment up to lag fifteen, but there is no evidence of causality whatsoever in the levels (see Panel A of Table 6a). The positive sign found in the variance correlation suggests that the exchange rate has a positive cluster effect on the stock markets. The added variable is slightly insignificant, however its inclusion is motivated by the CCFs of the residuals from the augmented models showing any significant cross-correlation left, as illustrated in Table 6a.

Table 6: Thailand

Parameters	Exchange rate		Parameters	Returns	
	Original model	Augmented model		Original model	Augmented model
α	−.000 [.000]		α	.000 [.000]	.000 [.000]
β_5	−.053 [.034]		β_1	.417 [.109]	.372 [.100]
β_9	.063 [.024]		γ_1	−.257 [.114]	−.210 [.105]
ϕ_0	.000 [.000]		ϕ_0	.000 [.000]	.000 [.000]
ϕ_1	.924 [.012]		ϕ_1	.884 [.013]	.880 [.015]
ϕ_2	.066 [.017]		ϕ_2	.112 [.014]	.112 [.015]
			φ_{15}		.030 [.021]
$Q_{(8)}$	11.298			6.069	6.425
$Q^2_{(8)}$	8.151			14.841	14.845
Log-lik	15963.57			9246.9	9203.30

Note: See note Table 1.

Table 6a: Cross-correlations in the levels and squares of standardized residuals from the models reported in Table 6

	Panel A		Panel B	
lag k	$\hat{r}_{\varepsilon\xi}(k)$	$\hat{r}_{uv}(k)$	$\hat{r}_{\varepsilon\xi}(k)$	$\hat{r}_{uv}(k)$
−10	−.006	.017	−.005	.017
−9	.015	.001	.015	.000
−8	−.001	.010	−.002	.010
−7	−.005	.006	−.005	.006
−6	.006	−.004	.004	−.004
−5	.024	.041	.024	.040
−4	−.018	−.018	−.018	−.017
−3	.003	.017	.004	−.165
−2	.000	−.002	.000	−.001
−1	−.035	.012	−.036	.012
0	−.023	.033	−.019	.033
1	.013	.008	.010	.008
2	−.018	.016	−.020	.015
3	.013	−.001	.014	−.000
4	−.033	.003	−.035	.003
5	−.024	.023	.024	.024
6	.038	−.006	.038	−.006
7	−.010	−.006	−.009	−.006
8	.002	−.019	.003	−.018
9	.017	.015	.019	.016
10	.006	.012	.006	.012

Note: See note Table 1a.

Table 6b: Recursive estimation

	Ex-rate		Returns	
Sample	ϕ_1	ϕ_2	ϕ_1	ϕ_2
1987–94	.599	.108	.848	.139
1987–95	.635	.005	.856	.128
1987–96	.627	.024	.858	.122
1987–97	.623	.038	.863	.117
1987–98	.618	.054	.860	.127
1987–99	.924	.056	.870	.122
1987–00	.924	.066	.884	.113

4. CONCLUSION

In this paper we have examined the links between stock prices and exchange rates in six East Asian countries by using a two-stage procedure to test for causality in variance developed by Cheung and Ng (1996). Whilst the existing literature only considers feedbacks in levels, the approach we have taken has the advantage of also allowing for interactions in the second moments, which are likely to be very important in the case of financial series. Furthermore, contrary to the vast majority of studies, we have employed daily (rather than monthly) data, which are more appropriate for short-run phenomena such as capital movements. We cannot reject the null hypothesis of causality in the first and the second moment in any of the East Asian economies examined. The results indicate a feedback interaction in the variance for Malaysia, where either market can take the lead, whereas the exchange rate seems to lead the stock returns in the levels. In the case of Japan, Korea, Philippines and the post-crisis samples of Indonesia and Malaysia we found evidence of bidirectional feedback both in the first and in the second moment. For Thailand and in the pre-crisis samples of Indonesia and Malaysia we did not find any causation effect in the second moment; however, the exchange rates leads the returns in the mean. The results for Indonesia indicate that the exchange rate leads the stock returns in the level, whilst the opposite holds true in the case of the variance. Although there is considerable heterogeneity, overall the results suggest that causation links are strong and in most cases bidirectional; more specifically, the causal relationship between the foreign exchange and the stock market seems to be predominantly negative in the levels, whilst positive in the second moment. The causal structure is therefore more complex than implied by a portfolio model, and a variety of mechanisms seem to be operating.

These findings are consistent with interpretations of the East Asian crisis stressing the fact that both financial and foreign exchange markets were vulnerable, and that it was the interaction between the two which eventually led to a

collapse (see Corbett and Vines, 1999). A further implication is that exchange rate policies should not be implemented without taking into account the repercussions on the stock market, and viceversa. Clearly, if it were the case that the foreign exchange market consistently led the stock market, controlling the exchange rate should be the main priority of the policy-makers. By contrast, were the stock market unambiguously the leader, the focus should be on stabilising it by means of domestic policy measures. In the presence of bidirectional links, authorities face a difficult balancing act. The initial policy response to the 1997 currency crises in South East Asia was to avoid a monetary contraction, given the concern that higher rates would worsen the conditions of the already fragile financial sector (see Corsetti *et al.*, 1998). Only after speculative attacks had led to a massive depreciation of the local currencies was monetary policy tightened. Higher interest rates, aimed at avoiding capital flows and further currency attacks, were in fact one of the main conditions set by the IMF for granting loans, the others being fiscal discipline and banking sector restructuring. However, tight monetary policy did not substantially slow down currency depreciation, but caused a credit crunch. It has been argued that this reflects the existence of a currency/interest rate "Laffer curve", such that the appropriate policy measure would have been a cut in interest rates to restore confidence and strengthen the currency. But there is also evidence that low interest rates in the early stages of the crisis exacerbated the depreciation, and that the credit crunch was mainly a consequence of the pre-existing financial difficulties of lending institutions. The debate is still open, but our findings do indicate that careful consideration should be given to both domestic and international factors when designing policy, especially as capital controls are gradually being removed in these countries. It would also be useful to examine contagion by means of a causality-in-variance test in a multivariate framework. Developing such a test can be seen as a natural extension of the bivariate analysis conducted in the present paper, and will be the object of future work.[xi]

Notes

[i] Bartov and Bodnar (1994) argue that the failure to find strong empirical support reflects sample selection bias and mispricing; they report a significant negative relationship between abnormal returns and lagged changes in the exchange rate, which, in their opinion, can be attributed to the fact that investors do not use all freely available information.

[ii] Since stochastic volatility models are subject to discreet jumps in their parameters due to discreet jumps in the unconditional variance, we also perform a recursive estimation of the GARCH parameters.

[iii] Sample cross-correlations with thirty six lags (i.e., the other market index's lagged returns or lagged squared returns) have been computed but for lack of space we just report the first ten. The complete set of results is available on request from the authors.

[iv] Note that EX_{t-11} was insignificant and the inclusion of EX_{t-9} was suggested by the Box–Pierce statistics. R^2_{t-31} and R^2_{t-35} also turned out to be insignificant.

[v] Note that R_{t-2}, R_{t-4} and R^2_{t-4} turned out to be insignificant.

[vi] R^2_{t-3} and R^2_{t-6} and R^2_{t-29} turned out to be insignificant and were not included.

[vii] EX^2_{t-10} and EX^2_{t-20} and EX^2_{t-25} turned out to be insignificant and were not included.

[viii] The inclusion of EX_{t-2} was suggested by the Box–Pierce statistics.

[ix] Note that EX_{t-14} turned out to be insignificant.

[x] The inclusion of R^2_{t-1} was suggested by the Box–Pierce statistics

[xi] See, however, (Engle and Kroner, 1993) on the difficulties this involves.

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