FOR AGENDA

SM/99/189

CONTAINS CONFIDENTIAL INFORMATION

July 22, 1999

To: Members of the Executive Board

From: The Acting Secretary

Subject: **Denmark—Selected Issues**

This paper provides background information to the staff report on the 1999 Article IV consultation discussions with Denmark, which was circulated as SM/99/179 on July 15, 1999.

Mr. Vittas (ext. 35634) or Ms. Krajnyak (ext. 34536) is available to answer technical or factual questions relating to this paper prior to the Board discussion.

Unless the Documents Section (ext. 36760) is otherwise notified, the document will be transmitted, in accordance with the procedures approved by the Executive Board and with the appropriate deletions, to the WTO Secretariat on Friday, July 30, 1999; and to the European Commission, the Food and Agriculture Organization, the Organisation for Economic Cooperation and Development, and the World Food Programme, following its consideration by the Executive Board.

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INFORMATION

INTERNATIONAL MONETARY FUND

DENMARK

Selected Issues

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Approved by the European I Department

July 21, 1999

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Denmark: Basic Data

Total area	43,094 square kilometers
Total population (1998)	5.3 million

	1998		1996	1997	1998	1999 1/	2000 1/
	In billions of krone (at current prices)	In percent of GDP	(Percentage change at 1990 prices)				
Demand and supply							
Private consumption	600	51.4	2.7	3.6	3.5	2.2	1.8
Public consumption	298	25.5	3.2	1.1	2.6	1.8	1.2
Gross fixed investment	243	20.8	4.9	10.6	6.1	-1.0	1.1
Residential buildings	50	4.3	5.0	8.8	3.7	-4.0	-2.0
Inventory accumulation 2/	6	0.5	0.0	0.1	0.9	-0.4	-0.2
Total domestic demand	1,145	98.2	3.3	4.5	4.8	1.0	1.3
Exports of goods and nonfactor services	402	34.5	3.7	5.5	0.1	1.5	2.6
Imports of goods and nonfactor services	382	32.7	3.7	9.8	4.7	0.8	1.9
Foreign balance 2/	20	1.7	0.1	-1.3	-1.7	0.3	0.3
GDP	1,167	100.0	3.3	3.1	2.9	1.2	1.5
				(In percent of GDP)			
Saving							
Private			19.5	17.2	17.2	...	...
Public			0.9	1.9	2.8	4.2	...
	(in thousands)			(Percentage change)			
Employment and unemployment							
Labor force	2,880		-0.4	1.1	0.7	0.1	0.1
Employment	2,700		1.3	2.1	2.2	0.4	-0.1
Unemployed 3/	182		8.6	7.7	6.3	6.0	6.2
				(Percentage change)			
Prices and incomes							
GDP deflator			2.2	1.8	1.4	2.9	2.4
Consumer price index			2.1	2.2	1.7	2.5	2.5
Hourly wages (Private sector)			3.9	4.2	5.5	4.3	4.2
Unit labor costs (manufacturing)			-0.7	3.4	3.1	2.9	2.7

1/ Staff projections.
2/ Change as percent of previous year's GDP.
3/ In percent of labor force.

Denmark: Basic Data (concluded)

	1998	1996	1997	1998	1999 1/	2000 1/
	In billions of krone	(In percent of GDP)				
Public finances						
General government						
Expenditure	648	58.8	57.1	55.6	54.7	53.7
Revenue	660	57.8	57.3	56.5	57.1	55.8
Financial balance	11	-1.0	0.1	1.0	2.5	2.1
Central government balance 2/	23	-2.0	0.7	2.0	0.3	1.2
General government debt	657	64.8	61.1	56.3	53.4	49.3
		(In billions of DKr., unless otherwise noted)				
Balance of payments						
Merchandise trade balance (f.o.b.)		43.7	35.5	23.0	25.1	28.4
Non-factor services balance		10.0	2.2	-3.1	-2.7	-2.0
Net factor income		-26.8	-22.6	-25.7	-26.5	-25.0
Net transfers		-9.2	-8.9	-10.2	-9.7	-10.1
Current account		17.7	6.1	-15.9	-13.8	-8.7
(In percent of GDP)		1.7	0.5	-1.4	-1.1	-0.7
Financial account		7.4	38.3	-12.8	...	...
Foreign direct investment		-10.0	-9.3	16.7	...	...
Portfolio investment		34.3	33.9	-41.8	...	...
Other		-8.7	35.4	13.5	...	...
Errors and omissions		-8.2	-21.7	-1.2	...	...
Net increase (+) of foreign exchange reserves		25.1	44.4	-28.7	...	...
Foreign exchange reserves (US$, e. o. p.)		13.4	18.2	13.8	...	...
		(Percentage changes, end of period)				
Monetary data 3/						
Broad money (national definition)	476	7.2	5.2	2.9	3.9	...
Domestic credit	715	8.7	6.2	13.5	2.5	...
		(Period averages in percent)				
Interest rates 4/						
Three-month euro rate		3.9	3.7	4.2	3.0	...
differential with Germany		0.7	0.4	0.7	0.4	...
Yield on ten-year government bonds		7.2	6.3	4.9	4.9	...
differential with Germany		1.0	0.6	0.4	0.4	...
		(Levels)				
Exchange rates 4/						
DKr per US$ (end of period)		5.9	6.8	6.4	7.1	...
DKr per US$ (annual average)		5.8	6.6	6.7	6.8	...
Euro per US$		0.78	0.88	0.90	0.96	...
Nominal effective rate (1990=100) 5/		108.0	105.0	105.6	104.1	...
Real effective rate (1990=100) 6/		101.2	98.3	100.1	100.1	...

1/ Staff projections, unless otherwise stated.
2/ The balance on the central government's current, investment, and lending account.
3/ Data for 1999 refer to April 1999 compared with April 1998.
4/ Data for 1999 refer to June 23, 1999.
5/ Data for 1999 refer to June 1999.
6/ Based on consumer price index; data for 1999 refer to April 1999.

INTRODUCTION

1. While some imbalances have emerged in the Danish economy, there are few pressing short-term problems requiring immediate attention. The three background studies included in this paper thus attempt to shed some light on issues of interest from a more medium-term perspective: the causes of recent developments in the current external balance; the implications for fiscal policy of Denmark's decision to remain for the time being outside the EMU; and an assessment of the potential role that foreign-currency denominated debt could play in countering the costs of fluctuations in domestic output.

2. For the quarter century prior to 1990, Denmark ran current account deficits. This legacy has influenced the sensitivity of policy makers to the most recent dip of the current account into deficit following eight straight years of current account surpluses. Chapter I analyzes the factors associated with the recent deterioration in the current account to provide an assessment of the underlying strength of the external position and decomposes the current account balance into a cyclical component and a structural component. While several factors are implicated in the worsening external performance—for instance, the unwinding of an unsustainable increase in the export market share following German unification—the underlying current account is found to remain in surplus, amounting to about ½ percent of GDP. However, the analysis suggests that the underlying surplus has also diminished in recent years. To counter this tendency, policies which strengthen private savings would be called for. Recent measures introduced in Denmark are expected to raise private savings and improve the external current account.

3. Denmark has demonstrated a long-standing commitment to stable exchange rates by fixing its exchange rate (most recently with a peg to the newly-introduced euro) and maintaining economic policies consistent with its level. Because of Denmark's open capital markets, the fixed exchange rate policy has limited its ability to pursue an independent monetary policy and thus fiscal policy has been the major instrument for stabilization policy. Since Denmark has chosen to remain an EMU "outsider," but at the same time has anchored its exchange rate to the euro, Chapter II asks whether this special arrangement places an increased burden on fiscal policy in mitigating output fluctuations. A tentative answer is provided within the context of a two-country stochastic model calibrated to reflect some characteristics of the Danish economy and its links with the euro area. Simulations are performed to quantify the expected variability of output and inflation under an "outsider" case, and an "insider" counterfactual scenario, in which Denmark is assumed to join EMU. These results suggest that there are elements of the outsider arrangement (in this case, related to variations in the risk premium) which lead to an increased need for fiscal policy flexibility and under certain circumstances the difference between the two regimes can become substantial.

4. Long-run challenges for Danish fiscal policy also stem from a more domestic source—the aging of the population in combination with the comparatively high level of social benefits provided to the populace in retirement. To prepare for the future pressure on the fiscal accounts, the official strategy attaches significant weight to reducing the level of

sovereign debt. In this context, but also with a view to strengthening the external position, the authorities also aim to reduce and eventually eliminate net external debt. Even though the fiscal constraints likely to arise in the future represent sound reasons for reducing net external debt, recent theoretical work suggests that there may be other reasons, namely macro-economic risk diversification considerations, for maintaining a positive level of foreign currency-denominated debt. Uncertainty in consumption due to output variations can potentially be "shared" with foreigners by issuing foreign currency-denominated debt. Chapter III examines whether these potential diversification benefits are significant enough to make it desirable for Denmark to maintain a positive level of gross foreign currency-denominated debt. For this risk-sharing method to be effective, fluctuations in output and inflation between Denmark and its trading partners need to take on a specific configuration. Using Denmark's largest trading partners, Sweden, Germany, and the 11 EU countries, the empirical evidence shows that the issuance of foreign currency-denominated debt would not aid Denmark in hedging output fluctuations primarily because output fluctuations are only loosely tied to those of its trading partners.

I. Current Account Performance in 1993-98[1]

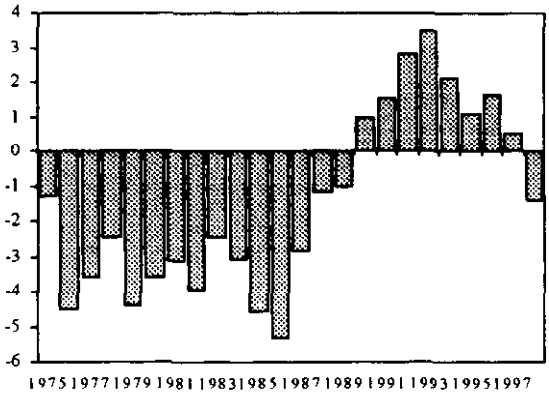
A. Introduction and Summary

5. The external current account in Denmark swung from a surplus of 3½ percent of GDP in 1993 to a deficit of 1.4 percent of GDP in 1998. Over the same period, the manufacturing sector experienced significant losses in market shares both at home and abroad. This chapter analyzes the factors accounting for these developments in an attempt to facilitate an assessment of the underlying strength of the external position. It begins with a brief review of recent developments and a discussion of structural features of the external current account. The next section looks at the decline in export market share and concludes that it reflects primarily cyclical factors and the unwinding of an unsustainable export market gain immediately after the German unification. In the fourth section an attempt is made to decompose the current account balance into a cyclical/temporary and structural component. It is found that while both factors have contributed to the weakening of the current account, the underlying current account remained in surplus, equivalent to about ½ percent of GDP; in 1998.

B. Background

6. The external current account in Denmark recovered from a deficit of 5½ percent of GDP in 1986 to a surplus of 3½ percent of GDP in 1993; but this remarkable improvement was subsequently followed by a gradual weakening culminating in a deficit of 1.4 percent of GDP in 1998 (the first deficit in a decade, Figure I-1).[2] The initial improvement was supported by fiscal consolidation, policies that stimulated private savings, and strong foreign demand; increasing off-shore oil and gas extraction and low growth (average annual rate of 0.8 percent in 1987-92) have also been contributing factors.[3] The subsequent weakening of the external current account reflects a combination of strong domestic demand and weak external demand. A package to *inter alia* eliminate excess demand and strengthen the external position was adopted in mid-1998. It is to be phased in over 1999-2002 and is

Figure I-1.Current Account Balance
(In percent of GDP)



[1] Prepared by Anastassios Gagales.

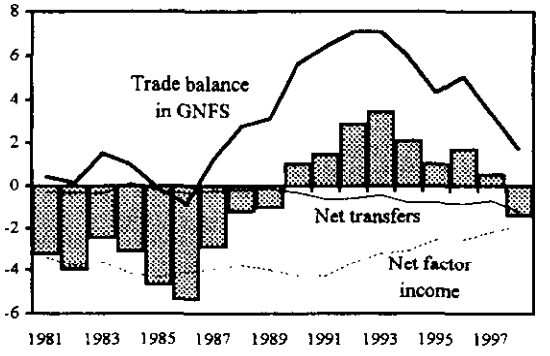
[2] Unless otherwise indicated, all ratios are calculated with respect to nominal GDP.

[3] The recovery of the current account in the 1980s has been reviewed in SM/95/62.

expected to raise the savings ratio and the current account by 1 percentage point of GDP by 2002.

7. Trade in goods and nonfactor services accounts for the bulk of current account flows and dominates the evolution of the current account balance; both *merchandise trade*[4] *and nonfactor services* exhibited very similar patterns (Figure I-2). Net factor income remained largely flat in the 1980s but improved in the 1990s as a result of external debt reduction and the decline in interest rates. Net transfers, mainly to the EU, rose in the 1990s but their overall impact on the current account was small. The rest of this chapter focuses on the trade balance and its components.

Figure I-2. Current Account and its Components (In percent of GDP)



8. It is useful to decompose the trade balance into terms of trade and volume effects[5] and to examine how the latter can be further decomposed into volume changes of exports and imports (Figure I-3). The terms of trade for goods and nonfactor services improved by 6.3 percent in 1988-98. This contributed to the improvement of the trade balance in 1988-93 and mitigated its deterioration in 1994-98, but the effect was quite small compared to the overall change in the trade balance. At constant prices, the trade surplus peaked at 6¼ percent of GDP in 1993 and declined by 6 percentage points of GDP in the subsequent five-year period.

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[4] The quality of trade statistics has deteriorated since the replacement in 1993 of the old custom–based system of collecting information on intra-EU trade flows. There have also been large discrepancies between trade statistics and other information on trade (e.g., balance of payments statistics, VAT revenues and other countries' exports). For instance, Germany's industrial imports from Denmark fell by more than 30 percent in 1993 whereas Danish exports to Germany fell by only 3 percent. Investigations on these discrepancies are ongoing.

[5] The decomposition can be written as $(X-M)=(x-m)+[(Px-P)\cdot x-(Pm-P)\cdot m]/Y$ where X and M stand for exports and imports measured in percent of nominal GDP; x and m denote exports and imports at constant prices in percent of real GDP; Px, Pm and P denote respectively the deflators of exports, imports and GDP. The bracketed term captures the terms of trade effect; its size depends on the change in the relative price of exports/imports (cumulatively relative to the base year) and the extent to which the country is a net exporter (net exporters benefit more from a terms-of-trade improvement).

Figure I-3. Decomposition of the Trade Balance, 1988-98
(in percent of GDP)

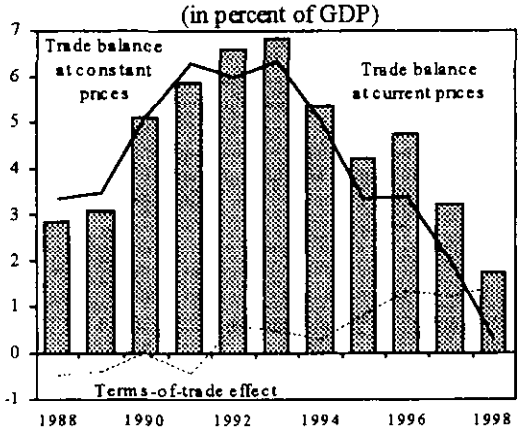
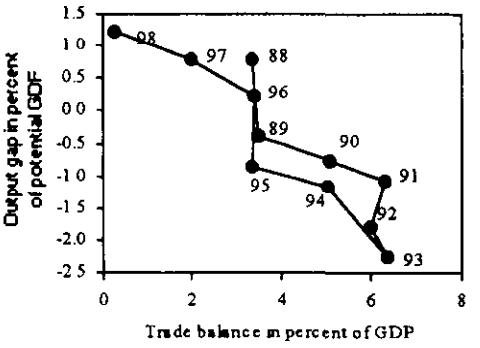


Figure I-4. Trade Balance and Domestic Output Gap, 1988-98

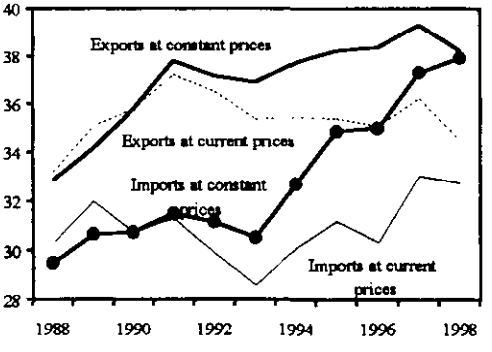


9. There is a clear negative correlation between the trade balance and the output gap (Figure I-4). This correlation suggests that strong demand may have been the driving force behind the weakening of the current account since 1994. The composition of demand has also shifted: whereas domestic and foreign demand contributed roughly equally to GDP growth before 1994, in the subsequent period GDP growth was driven by strong domestic demand and weakening net external demand.

10. The following structural characteristics of the Danish external sector are useful for the subsequent discussion:

- Exports and imports of goods and non-factor services account each for about 35 percent of GDP (Figure I-5). The ratios of trade flows to GDP exhibit a pronounced upward trend when calculated at constant prices, apparently the result of increasing globalization. They appear trendless when they are at current prices, reflecting a faster growth of the GDP deflator relative to the trade deflators.

Figure I-5. Trade in Goods and Services
(In percent of GDP)



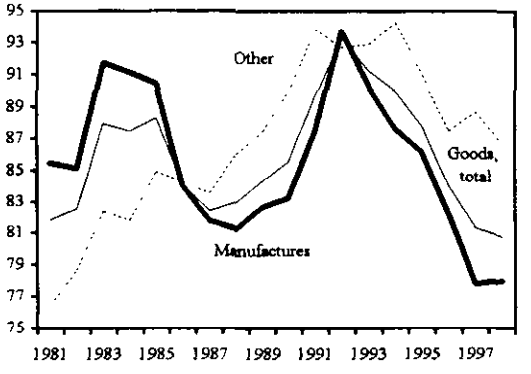
- Since the mid-1980s Denmark has been a small net exporter of crude oil and gas. Thus oil price gyrations have only a small direct effect on the trade balance. However, large investment related to oil exploration exacerbated the current account deficit in the first half of the 1980s and transfers to foreign investors partially offset the improvement of the trade balance in the subsequent period.

- The EU is the destination for 65 percent of Danish merchandise exports. The main trading partner is Germany (21 percent of Danish exports) followed by the United Kingdom, Sweden, Norway, and the United States. The main changes in the geographic pattern of trade over the past decade have been: the rise in the share of Germany since unification; the drop in the share of the United Kingdom; the doubling in the share of CEECs to 7 percent; and the rise in the share of Asia from 6 percent in the mid 1980s to 9 percent currently.

C. Export Performance of Danish Manufacturing

11. Export performance, as measured by the share of Danish exports in foreign imports, has deteriorated sharply since 1993. The loss of market share was particularly pronounced (14 percent) in the case of manufacturing (Figure I-6). The deterioration was larger than the one experienced in the upswing during the first half of 1980s and was accompanied by increased import penetration, as measured by the share of Danish imports to final total demand.

Figure I-6. Export Performance, 1981-98



12. The following equation for manufactured exports was estimated to help quantify the causes of the recent deterioration in export performance:

$$ln(xmv/xmv_{-1}) = \underset{(0.23)}{0.93}\cdot ln(xmvmkt/xmvmkt_{-1}) - \underset{(0.19)}{0.11}\cdot ln(reer/reer_{-1}) - \underset{(0.003)}{0.006}\cdot DGAP$$

$$-\underset{(0.13)}{0.49}\cdot[(ln(xmv_{-1}) \underset{(0.88)}{-4.34} - \underset{(0.06)}{1.19}\cdot ln(xmvmkt_{-1}) + \underset{(0.20)}{0.70}\cdot ln(REER_{-1}) - \underset{(0.01)}{0.02}REL_{-1} + \underset{(0.05)}{0.06}\cdot D9498)]$$

OLS 1975-98; S.E. of regression = 0.03; D.W. = 2.4; R^2 = 0.69, S.E. in parentheses.

Where *xmv* denotes the volume of manufacturing exports, *xmvmkt* measures the size of foreign market in manufactured goods (weighted average of manufacturing import volumes of Danish trading partners); REER denotes the real effective exchange rate (unit labor cost-based), *DGAP* denotes the deviation of the final domestic demand from its trend; *REL* stands for the relative price of manufactured exports to the GDP deflator; finally, *D9498* is a dummy for the period 1994-98 intended to capture structural breaks in export performance. The equation was estimated with annual observations for 1975-98 from the OECD Economic Outlook databank.

13. The reduced form export equation contains explanatory variables pertaining to domestic and foreign demand for and the supply of manufactures. The coefficient estimates are plausible and reasonably robust to changes in the econometric specification.

- The coefficient of the error correction term in the above equation indicates a fairly rapid response of exports to deviations from their longer-term path: half of the deviation is eliminated within one year. Moreover, export growth moves in tandem with contemporaneous export market growth (its coefficient, 0.93, is insignificantly lower than unity).

- The greater than unity long-term elasticity with respect to export market growth is influenced by sizeable market share gains in the early part of the sample. Re-estimating the equation in the post 1980 period yields an elasticity slightly below unity which is consistent with a creeping erosion of market share during that period.

- The real effective exchange rate accounts for only a small part of the variability in exports. The size of the elasticity is generally low, although it varies somewhat depending on the measure used: it is larger when the price of manufactured exports relative to those of foreign competitors is used as an explanatory variable instead of the unit labor cost based real effective exchange rate.

- *DGAP* is a proxy for domestic demand pressure and capacity utilization. Its negative coefficient captures the tendency of producers, at times of buoyant domestic demand, to shift from foreign to the domestic market (but due to its correlation with *REER*, it captures other effects as well). Such shifts tend to be accompanied by rises in export prices above those of competitors' and an appreciation of the real effective exchange rate.

- *REL* intends to capture the supply response to the declining price of manufactures relative to the GDP deflator. This decline, which has been ongoing since the early 1980s, must have triggered some reallocation of resources away from manufacturing and toward sectors with rising relative prices (e.g., services). The coefficient of *REL* has the appropriate sign but is insignificant numerically and statistically.

14. The coefficient of the dummy variable *D9498* (although not statistically significant) indicates that in the last cyclical upswing export performance deteriorated by 6 percent relative to earlier periods. This deterioration may reflect factors not captured by the equation such as the lower savings rate, the larger share of high import content items in total demand during that period, and some permanent deterioration in export performance related to:

- The opening up of trade of several newly industrialized countries and Central and East European countries. Liberalization led to rapid export growth in these countries and, indirectly, contributed to Denmark's loss of export market share. Meanwhile, Danish exporters maintained their market share in imports of OECD countries from other OECD countries.

- The change in the pattern of specialization towards high value-added high quality products and the relocation of production lines (especially the labor intensive ones) to low wage countries.[6] This is a desirable change that improves terms of trade and at the same time reduces export volumes; export market shares, adjusted for quality, may have been maintained. In this connection it is noteworthy that market shares in nominal terms have shown smaller declines (higher prices can be thought of as proxies for better quality).

- The return of export market shares in Germany to more sustainable levels (see below).

15. The table below summarizes the contribution of the various explanatory variables to the increase of manufactured exports. Whereas in 1988-93 export market growth and domestic demand pressures contributed roughly equally to export growth, the increase in exports in 1994-98 was driven by export market growth; meanwhile, domestic demand pressures, the appreciation of the real effective exchange rate and unaccounted factors lowered export growth and the export market share. At the same time, the overall profitability in manufacturing remained comfortable and shortages in skilled labor seemed to have constrained supply.

Contributions to the Increase in Manufacturing Export Volumes 1/

	1988-93	1994-1998
Actual increase	13.5	10.3
Explained by changes in:		
Export market growth	9.0	21.8
Real effective exchange rate	0.8	-1.8
Domestic demand pressure	5.4	-3.9
Residual 2/	-1.7	-5.8

1/ Percentage changes are approximated by the change in the logarithm.
2/ It includes also the effect of the dummy variable.

D. The Underlying Current Account

16. This section shifts focus to the overall external performance of the Danish economy by looking at the underlying current account, namely the level of the external current account

[6] Large Danish enterprises moved production lines abroad in the early 1990s and smaller ones started to follow suit in the mid 1990s. This should show in the external current account as reduced exports and higher net factor income.

that would prevail if temporary and cyclical factors were absent and if trade volumes and prices had adjusted fully to the current exchange rate.[7]

17. The calculation of the underlying current account requires estimates of trade elasticities and a quantification of the effect of special factors.

18. Elasticities of exports and imports in goods and nonfactor services with respect to economic activity and the exchange rate were estimated using annual data for the period 1975 to 1998.[8] Several specifications were tried to test for the robustness of the estimates.

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[7] The underlying current account is calculated by eliminating from the actual current account the effect of temporary and cyclical factors and unrealized effects of past exchange rate changes. It is given by the formula below which is based on standard trade equations that link trade flows to the real effective exchange rate and economic activity at home and abroad and the assumption that the impact of a change in the real effective exchange rate is completed in three years (in proportion to 60:25:15); export prices (in foreign currency) are unaffected by changes in the real effective exchange rate (small country assumption), while import prices are subject to immediate and full pass-through:

$$(CA/Y)_{underlying} = CA/Y - [(M/Y)\cdot\beta_m + (X/Y)\cdot\beta_x]\cdot[\,0.40\cdot(R_t - R_{t-1}) + 0.15\cdot(R_{t-1} - R_{t-2})] + (M/Y)\cdot\gamma_m\cdot YGAP - (X/Y)\cdot\gamma_x\cdot YGAPF - (\textit{effect of transitory exceptional factors})$$

where *X, M, CA* and *Y* denote respectively the nominal domestic currency value of exports, imports, current account, and output; exports and imports are defined exclusive of re-exports and the import content of exports. *YGAP* and *YGAPF* are the deviations of actual from potential output in the home country and in trading partners (positive values indicate that real GDP is above potential); R is the logarithm of the real effective exchange rate (increase indicates appreciation); and β_m, β_x, γ_m, and γ_x are import and export elasticities with respect to the real effective exchange rate and economic activity at home and abroad. The second term on the RHS of the above expression measures the volume effect of past exchange rate changes that have yet to materialize; the third and fourth terms measure the impact of output gaps at home and abroad; and the last term captures the effects of transitory factors. The above formula is an adaptation of a similar formula in *Exchange Rate Assessment: Extensions of the Macroeconomic Balance Approach*, (1998) Occasional Paper 167, edited by P. Isard and H. Faruqee. It has been modified to take into account the high import content in Danish exports; it also abstracts from within the year changes in the exchange rate given that the focus is on the underlying current account rather than on assessing a particular level of the exchange rate.

[8] Lumping together goods and nonfactor services did not alter significantly the econometric estimates. This probably reflects the fact that non-factor services account for 20 percent of total trade and their share has been fairly stable when calculated at current prices (at constant prices it declined by 2 percentage points in the past decade).

Besides export market volume and the real effective exchange rate, the export equation included also the domestic output gap as explanatory variable, to test for the hypothesis that in periods of strong domestic demand producers switch from foreign to the domestic market. Moreover, a dummy for the post-1990 period was introduced to capture the effects of the German unification. In the import equation the dependent variable (the volume of imports) was redefined by excluding the estimated import content of exports.[9]

- The elasticity of exports with respect to export market volume hovered around 1.2 and differed marginally from unity (which would had been consistent with a constant market share). The elasticity of imports (adjusted for the import content of exports) with respect to domestic activity was about 1.4 and significantly higher than unity. This greater than unity elasticity raises the amplitude of cyclical movements in imports and, together with a trend increase in total demand, leads to increasing import penetration.

- The elasticity of exports and imports with respect to the real effective exchange rate depended on the definition used. Relative prices of exports relative to those of competitors tended to give the highest coefficient values; CPI and GDP deflator based measures gave slightly lower estimates (around 0.8 in the case of exports and 0.7 in the case of imports), and those based on unit labor costs (ULC) gave the lowest. The low elasticity with respect to ULC-based indicators suggests that profits act as a shock absorber: lower profit margins offset wage increases to maintain competitiveness.

- The coefficient of the domestic output gap in the export equation had the right (negative) sign but was insignificant (both numerically and statistically). This is probably due to the correlation between the gap and the real effective exchange rate.

19. While permanent shocks (e.g. the development of off-shore oil production in the mid-1980s) which have lasting effects on the current account should be included in the underlying current account balance, transitory/extraordinary events that are unrelated to, and not captured by the output gap (or other cyclical indicators) and the other determinants of trade flows need to be excluded from it.[10] The following special factors were considered:

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[9] The import content was set at 20 percent of total exports based on non-sample information. Attempts at directly estimating this coefficient gave implausible estimates.

[10] Special factors are not entirely independent from the output gap or the real effective exchange rate. For example, the export surge related to the German unification affected the level of economic activity and, probably, the real effective exchange rate. Such secondary effects were not taken into account in the calculations.

- German unification. This led to an export surge in the early 1990s as Danish exporters were quick to take advantage of new business opportunities: their market share in German imports increased from 1.8 percent in 1988 to 2.6 percent in 1993. However, as other exporters caught up, some of the initial gains in market share were eroded and by 1997 market share had receded to 2.4 percent. This temporary surge in exports reached 1 percent of Danish GDP in 1993 and faded out in the subsequent period.[11]

- Deviations of the terms of trade from their trend. The terms of trade improved continuously in the past decade adding to the improvement in the underlying current account, measured at current prices.

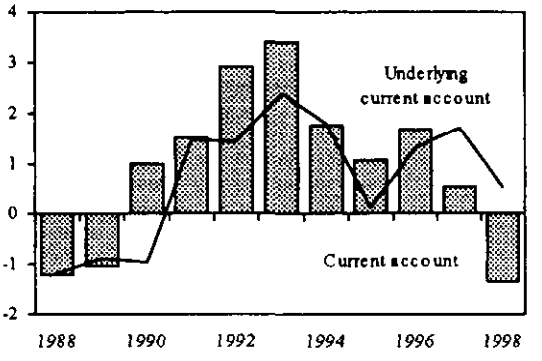
- Gyrations in pork exports stemming primarily from the BSE-crisis in the UK in 1996, pig diseases in the Netherlands and the Taiwan Province of China in 1997, and the collapse of exports to Russia in 1998. Corresponding to these shocks, pork prices soared in 1996-97 and collapsed in 1998. The temporary shocks were calculated as the percentage deviation of pork prices from their normal level times the share of pork exports to GDP.

- Other special events. These include a major strike in 1998 (estimated to have worsened the current account by 0.1 percentage point of GDP); the temporary closure of shipyards in 1998, mainly due to intense competition following the depreciation of the Korean won (estimated to have contributed 0.2 percent of GDP to the weakening of the current account); the temporary increase of electricity exports to Sweden and Norway in 1996-97 due to inadequate rainfall in those two countries (estimated to have improved the current account by 0.1-0.3 percent of GDP).

[11] The temporary effect was estimated by smoothing $(\omega-\varpi)M_G/GDP$ where ω, ϖ denote the actual and "normal/sustainable" share of Danish exports in the German market, M_G stands for total German imports, and GDP for nominal Danish GDP.

20. Based on the above methodology, the underlying current account is estimated to have deteriorated by 2 percentage points of GDP in 1994-98, compared with an almost 5 percentage points of GDP deterioration in the actual current account (Figure I-7, and tabulation below). Cyclically strong domestic demand and temporary events contributed each 1½ percentage points of GDP to the decline in the current account.[12] By comparison, the improvement of the current account in 1988-93 was driven primarily by a 5½ percentage points of GDP improvement in the underlying current account. In 1998, the underlying current account was in surplus of ½ percent of GDP compared with an actual current account deficit of 1½ percent of GDP and a savings-investment "norm" equivalent to a surplus of 1½ percent of GDP.[13]

Figure I-7. External Current Account Balance (In percent of GDP)



[12] The cyclical components of trade flows are assumed proportional to the output gaps. This abstracts from that the different components of demand differ in their import content and, hence, in their impact on the current account: a positive domestic output gap driven by buoyant exports tends to strengthen the current account whereas one driven by strong domestic demand tends to worsen it. Similarly, the import compression in crisis-stricken emerging market economies in 1997-98 may have biased downward the foreign cyclical effect.

[13] The norm, estimated by regressing the current account over its fundamental determinants using a panel of 21 industrial countries, is given by:

$$S\text{-}I_{norm} = 3.145 \cdot (FE + 0.210 \cdot SUR - 0.057 \cdot DEM + 0.024 \cdot YPCAP)$$

Where *SUR* denotes the country's general government structural balance (in percent of GDP) relative to the average of the countries in the panel; *DEM* is the country's dependency ratio (population older than 64 and younger than 20 in percent of working age (20-64) population) relative to the average in the panel; *YPCAP* stands for the country's per capita income relative to that of the United States; and *FE* is country-specific constant that incorporates fixed effects and the impact of tax policies that have raised the propensity to save since 1986. See Isard and Faruqee, *op. cit.*.

Contributions to the Change in the Current Account Balance
(In percent of nominal GDP)

	1988-93	1994-98
Change in current account balance	6.2	-4.7
Explained by changes in:		
Underlying current account	5.4	-1.9
Domestic output gap	1.6	-1.4
Foreign output gap	-1.6	0.5
Lagged exchange rate effects	0.4	-0.4
Special factors	0.4	-1.5

21. In June 1998, a package of measures (Whitsun Package) was adopted to stimulate private savings, cool off the housing market and strengthen work incentives. The measures, which would be phased over the four year period 1999-2002, included *inter alia* a steep cut in the tax value of interest deductions. This reduction of tax deductibility from 46.4 percent to 32.2 percent would raise the real lending rate by one percentage point and, in turn, is expected to raise the savings ratio (and improve the external current account) by one percentage point of GDP.[14]

[14] The calculations are based on an estimated unit semi-elasticity of the savings rate with respect to the real after-tax interest rate. The real after-tax interest rate is given by $r=(1+R(1-t))/(1+i)-1$ where R, t, and i denote respectively the nominal interest rate, the marginal tax rate applying to deductible interest expenses, and inflation. With nominal borrowing rate and inflation at 7 percent and 2 percent, the reduction of the marginal tax rate from 46.4 percent to 32.2 percent raises the real borrowing rate from 1.7 percent to 2.7 percent. *Ministry of Finance, Finansredegorelse 97, November 1997* and *Okonomisk Oversigt, May 1999.*

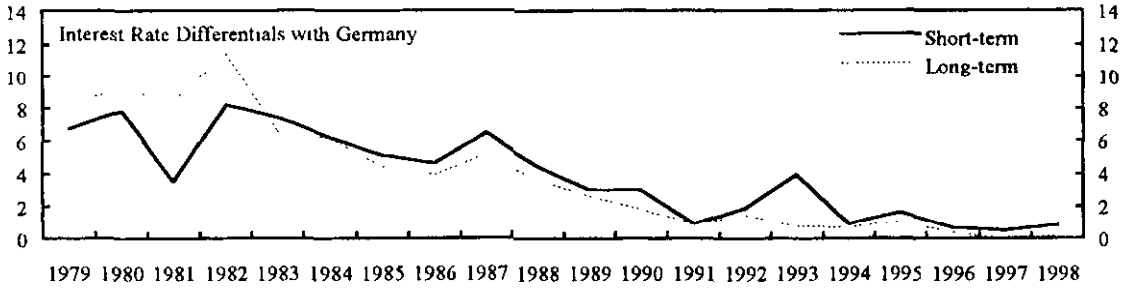
II. Is the Need for Fiscal Policy Flexibility Larger for an EMU Outsider than for an EMU Insider? Results from a Simulation Exercise[15]

A. Introduction and Summary

22. Exchange rate stability against the core European currencies, in particular against the deutsche mark, has been one of the cornerstones of macroeconomic policies in Denmark since the early 1980s. The policy of stable exchange rates has gained widespread support, and served as an anchor for policies in other areas. Because of its disciplinary role, the policy of fixed exchange rates is widely seen as a major contributing factor to Denmark's improved macroeconomic performance over the past 15 years—strong average growth; one of the best inflation performances in Europe; a shift in the current account from chronic deficits to surpluses; a marked improvement in public finances; and a strong decline in the unemployment rate since 1993.

23. Although Denmark has participated in all European exchange rate arrangements since the "snake" was introduced in 1972, the starting date of the fixed exchange rate is considered to be 1982. The new fixed exchange rate policy declared by the new government that took office in September 1982 constituted an integral part of a broad change in the overall economic policy strategy, which resulted in the correction of large macroeconomic imbalances. A tight peg to the deutsche mark has been maintained since then, and has been replaced by a peg to the euro at the beginning of 1999. Denmark's commitment to the policy of stable exchange rates helped impose policy discipline in other areas, and gained considerable credibility over the past 15 years, as reflected in declining interest rate differentials with the anchor country (Figure II-1).

Figure II-1. Denmark: Interest Rate Differentials with Germany, 1979-98



Source: IMF, International Financial Statistics.

24. Denmark was one of the first countries to satisfy the entry criteria into the European Monetary Union, but—in line with the Edinburgh Decision—it opted out of participating in

[15] Prepared by Kornélia Krajnyák.

EMU from the outset. In the policy debate, the most important argument against participation in the monetary union was some loss of political independence and less influence on decision making.[16] Following the referendum, which in 1993 accepted the Maastricht Treaty with the opt-out clauses specified in the Edinburgh Decision, the authorities announced that Denmark would continue to participate in exchange rate cooperation within the European Monetary System. This regime choice was underpinned by the argument that the policy of stable exchange rates is strongly associated with consistent policies and good macroeconomic performance in Denmark.

25. Since the Danish economy has been operating under a fixed exchange rate regime over the past 15 years, for most of this period under conditions of unimpeded international capital mobility,[17] it has adopted the monetary policy stance of the anchor country.[18] Without recourse to independent monetary policy, fiscal policy had to take on a role as a major instrument for stabilization policy, and it has been actively used as a countercyclical device.[19] In general, the "need" for fiscal policy depends on the economy's structure and its environment, which jointly determine the magnitude of output fluctuations and the effectiveness of policies. This chapter examines whether a particular structural feature of the economy—namely, the choice of not participating in the European Monetary Union, but fixing the exchange rate in ERM2—has a substantial effect on the short to medium term challenges for fiscal policy in mitigating output fluctuations.

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[16] For instance, participation in the EMU involves a transfer of monetary policy responsibilities from the national central bank to the ECB, which can be perceived as part of a wider process allocating various political prerogatives to supranational levels of government. Alesina and Wacziarg (1999) argue along these lines: "Firstly, European institutions have received policy attributions in practically every domain of public affairs—however limited these attributions may be... Secondly, the policies being transferred are in no way limited to those which seek to further the extent of economic integration within Europe. In fact, the list of policies with little or no economic content has grown steadily over time, and the extent of EU involvement in each of these policies has also deepened." page 26. Societies may dislike this process, which may have a substantial influence on the (essentially political) decision about entering the monetary union.

[17] Capital controls were phased out in the early 1980s.

[18] The idea of incompatibility of fixed exchange rates, independent monetary policy, and capital mobility goes back to Mundell (1963). Rose (1994) presents some empirical evidence on this issue.

[19] The cyclical sensitivity of the budget is one of the highest among the industrial countries. In addition, countercyclical discretionary policy action has often been undertaken. For example, the current recovery was "jump-started" by a modest fiscal stimulus in 1993, and the authorities have repeatedly tightened fiscal policy in 1998-99 to prevent overheating.

26. To provide a tentative answer, a simple two-country stochastic model is calibrated in the tradition of the monetary policy rule literature to reflect some characteristics of the Danish economy and its links with the euro area. For the small economy, two alternative exchange rate arrangements, which are likely to remain under consideration in Denmark in the near future—joining the monetary union; or remaining an "outsider"—are examined. Stochastic simulations are then used to quantify the expected variability of output and inflation in a low inflation environment under the alternative exchange rate regimes. As fiscal policy is assumed away in the model, the simulated volatility of output is interpreted as an indicator of the need for fiscal policy. To gauge whether the choice of an "outsider" fixed exchange rate regime significantly influences the challenges for fiscal policy, the variability of output under the "outsider" case and under the "insider" counterfactual scenario are compared.

27. Under the *baseline scenario*, output and inflation are found to be about 10 and 5 percent more variable, respectively, in an "outsider" regime than under an "insider" arrangement. The higher variabilities are due to variations in the outsider's risk premium, and imply that the need for fiscal policy is slightly larger in the outsider case.

28. Although differences between the "outsider" and "insider" regimes are not particularly large under the baseline, and thus the challenges facing fiscal policy are similar under the two exchange rate arrangements, some changes in the environment can widen the differences in output and inflation variability. Notably, the "outsider" country's output and inflation could become substantially more volatile in *periods of financial stress*, or in case of erosion in the credibility of the peg. *Negatively correlated output shocks* in the two economies can also lead to relatively more variable output and inflation in the "outsider" case than in an "insider" scenario, which indicates that the burden falling on fiscal policy can become significantly larger for an "outsider." Although the *monetary policy followed by the large economy* influences output variability under both the "insider" and "outsider" regimes, it is found to have no effect on the difference in the need for fiscal policy under the two exchange rate arrangements.

29. Although the above conclusions are based on a highly stylized model, they call attention to three important facts. *First*, an "EMU-outsider" fixed exchange rate regime is not equivalent to an "EMU-insider" one. In most instances, remaining an "outsider" implies higher output and inflation variability, and thus poses some additional challenges for the conduct of fiscal policy. *Second*, the differences between the two regimes can widen under certain circumstances. In particular, output fluctuations, and thus the need for discretionary countercyclical fiscal measures could be substantially larger under the "outsider" scenario than in the "insider" case. *Third*, monetary policy followed by the large economy is not immaterial for the magnitude of output fluctuations in the small economy.

30. The remainder of the chapter is organized as follows. Section B describes the model and its main parameters, and summarizes the most important assumptions. The simulation results are presented in Section C.

B. Description of the Simulation Framework

31. The simple model used in the simulations links a "large" and a "small" economy via trade and exchange rates. A *simple linear aggregate framework* often applied in the monetary policy rules/inflation targeting literature is adopted to characterize the two economies.[20] Although the relations of this model are not directly derived from microfoundations, a number of recent papers, such as Rotemberg and Woodford (1998a) and (1998b), Christiano and Gust (1998), or Erceg, Henderson and Levin (1998) present similar models based on maximizing behavior and rational expectations.

32. The asymmetry in country size is assumed to be sufficiently large so that behavioral relations in the large economy can be characterized independently of the small economy. In contrast, developments in the large economy have a nonnegligible influence on the small economy via three possible channels. First, external demand for the small country's products has a direct influence on output. Second, inflation in the small country is related to foreign inflation via import prices. Third, domestic interest rates are intimately linked to foreign interest rates. Via these channels shocks to the large economy, as well as policy changes, are transmitted to the small economy.

33. Two alternative exchange rate regimes are examined. In the first case, the small country is an "EMU-outsider"—it pegs its nominal exchange rate to the large economy's currency, but nominal interest parity holds only up to a risk premium factor. In the second case, the small country is an "EMU-insider"—currency union is modeled by assuming that the nominal exchange rate is fixed in terms of the large country's currency, and that uncovered nominal interest parity holds.

34. The stylized nature of the model necessitates a number of simplifying assumptions, which are spelled out in the remainder of this section. The most important of these assumptions are summarized in Box II-1.

The large economy

35. The large economy is assumed to operate as described by the following three relationships:

$$y_t^f = \lambda y_{t-1}^f - \alpha(i_{t-1}^f - \pi_{t-1}^f) + \varepsilon_t^{yf} \quad (1)$$

$$\pi_t^f = \varphi \pi_{t-1}^f + \kappa y_{t-1}^f + \varepsilon_t^{\pi f} \quad (2)$$

$$i_t^f = \theta_\pi \pi_{t-1}^f + \theta_y y_{t-1}^f \quad (3)$$

The variable y^f denotes the deviation of real output from trend, π^f stands for the deviation of inflation from trend, and i^f represents the deviation of nominal interest rate from trend. All

[20] See for instance Taylor (1998b) or Ball (1998).

Box II-1. Summary of Simplifying Assumptions

- *The world consists of only the small and the large country.* Notwithstanding that trade with third countries is nonnegligible in Denmark, constituting 30 percent of trade and 10 percent of GDP, economic linkages with the euro area countries are strong.[1] In addition, policies in the EMU area—especially in Germany—have also served as a reference in the policy debate and direction over the past 15 years.

- *The role of the large country is passive.* It is assumed that the large economy is not subject to country-specific inflation shocks; and that policies are consistent and sustainable over the long run.[2] Although the difference between the magnitude of output and inflation fluctuations under the "insider" and "outsider" regimes may depend on these factors,[3] attempts at quantifying their effects just a few months after the advent of the European Monetary Union would be difficult and is beyond the scope of this paper.

- *A low inflation environment is assumed.* It is assumed that inflation has no tendency to ratchet up. Although this assumption is warranted by the limitations of the model, it can also thought to be a reasonable characterization of a medium term outlook predicated on a sustained benign inflationary environment.

- *Only one (short term) interest rate is considered.* In Denmark, long-term interest rates have a strong effect on economic activity, while short-term interest rates have a much smaller impact on GDP. Thus, the effects of changes in the interest rate on output are likely to be overstated in case long-term and short-term interest rates are not closely related.[4]

- *The structure of the aggregate demand and supply relationships does not change with the exchange rate regime.* This assumption may not hold up to scrutiny, because upon entry to EMU, structural parameters may change in response to the regime shift. For example, domestic output may depend more strongly on foreign output; the way and extent of the effect of monetary policy on aggregate demand may change; or there can be shifts in the nature, distribution, and correlation of shocks. However, the lack of a convincing counterfactual gives little basis for an alternative.

- *The assumed stochastic structure is highly simplified.* In particular, permanent shocks to inflation are abstracted away, and exchange rate related shocks are assumed to be unrelated to output and inflation shocks. Abstracting from permanent shocks is considered to be permissible as the paper focuses on the scope for short to medium term stabilization policy, and not on secular trends. The stochastic independence assumptions imply that policy responses to idiosyncratic disturbances on the goods, labor, and foreign exchange markets, rather than possible consequences of systemic shocks are examined. Arguably, the former is more relevant for quantifying the scope for countercyclical policy.

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[1] Statistisk Tiårsoversigt 1998.

[2] These assumptions together with the parametrization of the model imply that output and inflation fluctuations in the large economy under the baseline are small relative to fluctuations observed in the small economy. (Since the creation of EMU represents a regime change, it is unclear whether matching the historical magnitude of the "synthetic euro area" fluctuations would be a meaningful objective.)

[3] For example, if the large economy was not pursuing sustainable and consistent policies, the "outsider" country's risk premium could conceivably become negative, a possibility which is not considered in the simulations.

[4] Hansen (1997).

three variables are assumed to be stationary. This simplifying assumption is applied to avoid divergence in inflation rates due to different stochastic shocks in the two economies. Nonstationarity would trivially and necessarily result in the unsustainability of a fixed exchange rate regime.[21] λ, α, φ, κ, θ_π and θ_y are nonnegative parameters, while ε^{yf} and $\varepsilon^{\pi f}$ are independently and identically distributed stochastic disturbances, which are assumed to originate from the behavior of the private sector.

36. Equation (1) is a standard reduced form aggregate demand relationship for a closed economy: output depends negatively on the lagged real interest rate. For more realistic dynamics, some degree of output persistence is assumed with $\lambda \in [0,1]$. Equation (2) is a stylized aggregate supply relationship in the form of a Phillips curve: inflation depends on its own lagged value, and on the level of economic activity. Equation (3) captures the monetary policy rule in the form of a (lagged) Taylor rule: nominal interest rates are set based on past output and inflation developments.[22] Monetary policy is tightened whenever inflation or output exceed their target value (which are assumed to be zero), and relaxed whenever inflation or output fall below their respective targets.

37. The motivation for modeling the large country's monetary policy in the form of a Taylor rule is provided by a series of papers by Taylor and Clarida et al.[23] These studies find evidence that the behavior of the Fed and of the Bundesbank is well-approximated by a Taylor rule over select periods of the post-Bretton Woods era. It is probably not misguided to assume that the ECB's monetary policy would ex ante be possible to describe in a similar fashion.

The small economy

38. The small economy's structure is kept as close as possible to the large economy's. In particular, the following relationships describe output and inflation:

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[21] With φ=1, inflation would be nonstationary. In this case, the economy described by equations (1)-(3) can stay non-explosive only if the monetary policy response to inflation is aggressive enough. In this case, if a structurally similar other country "borrowed" this monetary policy, and was hit by stochastic shocks not perfectly correlated with the disturbances of the anchor country, it would become explosive with probability one. In a richer model, where real interest rates are linked to the marginal product of capital and thus to capital accumulation and reallocation, this outcome could be avoided.

[22] Assuming that the shocks are realized *after* the policymaker sets interest rates for period t, lagged output and lagged inflation are sufficient statistics for the state of the economy, and an appropriately parametrized lagged Taylor rule and non-lagged Taylor rule will be equally efficient in stabilizing the economy.

[23] Taylor (1993) and (1998a), Clarida-Gertler (1996), Clarida-Galí-Gertler (1997) and (1998).

$$y_t = \lambda y_{t-1} - \alpha(i_{t-1} - \pi_{t-1}) + \beta y_t^f + \gamma e_{t-1} + \varepsilon_t^y \quad (4)$$

$$\pi_t = \delta w_t + (1-\delta)(\ln(E_t) - \ln(E_{t-1}) + \pi_t^f) + \delta\varepsilon_t^{\pi^f} \quad (5)$$

Equation (4) represents an open economy aggregate demand curve. In addition to the (lagged) real interest rate, foreign output (y^f), which proxies for external demand, and the real exchange rate (e, measured in logs), which captures price competitiveness of foreign and domestic goods, also influence output.[24] Equation (5) expresses domestic inflation as a weighted average of price increases in domestically produced and imported goods, with w denoting domestic wage growth (measured as deviation from trend),[25] and E standing for the nominal exchange rate (measured in DKK/euro so that an increase corresponds to a nominal depreciation). Using the relationship $\Delta\ln(E) = \Delta e - \pi^f + \pi$, and rearranging (5) yields the more convenient form (5'):

$$\pi_t = w_t + \frac{1-\delta}{\delta}(e_t - e_{t-1}) + \varepsilon_t^{\pi^f} \quad (5')$$

Wage growth is determined by a reduced form Phillips curve relationship:

$$w_t = \varphi\pi_{t-1} + \kappa y_{t-1} + \varepsilon_t^w \quad (6)$$

where φ and κ are positive parameters, and ε^w is a stochastic disturbance term.

39. Assuming that the nominal exchange rate is constant,[26] the evolution of the real exchange rate is determined by inflation differentials:

$$e_t = e_{t-1} + \pi_t^f - \pi_t \quad (7)$$

40. Finally, the model is closed by specifying the relationship between domestic and foreign interest rates. When the small country is an "insider", currency union implies that uncovered interest parity holds, i.e.

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[24] The real exchange rate is based on the GDP deflator.

[25] Trend wage growth in the small country and trend inflation in the large country are assumed to be the same.

[26] Denmark pegs its currency to the euro with a 2.25 percent band. For simplicity, nominal exchange rate movements within the band are abstracted away, and it is assumed that the "outsider" arrangement involves strictly fixing the exchange rate to the large country's currency.

$$i_t = i_t^f \tag{8a}$$

If the economy is an "outsider" pegging its currency to the large economy, domestic interest rates are linked to the large country's interest rate via covered interest parity, that is, the nominal interest rate will be determined by the foreign interest rate up to a risk premium ρ.

$$i_t = i_t^f + \rho_t \tag{8b}$$

$$\rho_t = \rho(e_t) + \varepsilon_t^\rho \tag{9}$$

Equation (8b) is the interest parity relationship, while equation (9) specifies the risk premium, which is assumed not to take negative values. In order to assure the risk premium's nonnegativity, restrictions (to be discussed below) are imposed on the functional form, and on the stochastic process ε^ρ.

41. Comparing equations (8a) and (8b)-(9) makes it obvious that the only feature differentiating the "outsider" regime from the "insider" one is the presence of the risk premium.

Shocks and parameters

42. The major parameters of the model are based on Ball (1998), and the (annual) ADAM model of the Danish economy maintained by the Statistical Office of Denmark and used by the Ministry of Finance and the Ministry of Economic Affairs. However, inasmuch as the stylized model described above deviates both from models commonly used in the monetary policy rule literature and from the more detailed and realistic ADAM model, complete consistency of parameters could not be achieved. Table II-1 reports the baseline parameter values used in the simulations.

Table II-1. Baseline Parameter Values

Name	Value	Description
λ	0.5	Output persistence
α	0.5	Sensitivity of output with respect to real interest rate
β	0.2	Sensitivity of output with respect to foreign output
γ	0.3	Sensitivity of output with respect to the real exchange rate
δ	0.6	Share of domestic wages in price index
φ	0.4	Wage and price persistence
κ	0.5	Slope of aggregate supply
θ_π	1	Sensitivity of interest rate rule with respect to inflation
θ_y	0.5	Sensitivity of interest rate rule with respect to output
$Var(\varepsilon^y)$	1	Variance of foreign output shocks
$Var(\varepsilon^{y^f})$	1	Variance of domestic output shocks
$Var(\varepsilon^{\pi^f})$	0.25	Variance of common price shocks
$Var(\varepsilon^w)$	0.25	Variance of domestic price shocks
$Var(\varepsilon^\rho)$	0.06	Variance of shocks to risk premium
$Corr(\varepsilon^y,\varepsilon^{y^f})$	0	Correlation of foreign and domestic output shocks in baseline

43. Of the *aggregate demand parameters* common to the small and the large country, output persistence (λ) is assumed to be 0.5, which implies that 75 percent of the adjustment of aggregate demand to shocks happens within 2 years, and 99 percent of the adjustment is completed within 7 years. A one percentage point increase in the real interest rate is assumed to decrease output by 0.5 percent over the short run.

44. The small country's *foreign trade related parameters* are based on the income and price elasticities of exports and imports estimated for Denmark for the ADAM model. The (long-run) elasticity of exports with respect to export market growth was estimated at 0.4, which—assuming an export to GDP ratio of about 40 percent—translates approximately into a 0.2 percent change in domestic output in response to a 1 percent change in foreign output ($\beta=0.2$). When calculating the current account, it is assumed that an output gap of 1 percent increases imports by 0.6 percent of GDP, which again, under an import to GDP ratio of 40 percent approximately corresponds to the estimated income elasticity of imports.[27] In the simulations it is assumed that a one percent depreciation of the real exchange rate improves the current account by 0.3 percent of GDP ($\gamma=0.3$). With exports to GDP and imports to GDP ratios at about 40 percent, this corresponds to a current account elasticity of 0.75 with respect to the real exchange rate. This value is close to the estimated (long-run) unit elasticity in ADAM.

45. Parameters of the *Phillips curve* relationship are based on estimates for selected European countries.[28] The assumed inflation persistence of 0.4 (the parameter φ) is consistent with the ADAM estimates for Denmark on one hand,[29] and with the average persistence estimated for EMU countries in Kincaid and others (1997) on the other. The slope of the Phillips curve (the parameter κ) is calibrated at 0.5. This is consistent with a 1 percentage point increase of the actual unemployment rate to above the structural unemployment rate leading to 0.4 percentage point lower inflation rate (as estimated in Kincaid and others (1997) for Germany), and a labor share of about 2/3.[30]

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[27] This parameter (the income elasticity of imports) is necessary only for auxiliary calculations and does not appear in the equations.

[28] Kincaid and others (1997), Chapter I, "Labor Market Asymmetries and Macroeconomic Adjustment."

[29] The lagged inflation term in the ADAM wage adjustment equation corresponds to the average of inflation over the previous two years, which is conceptually equivalent to a one year lag.

[30] In ADAM, a 1 percentage point increase in the actual unemployment rate is estimated to decrease wage growth by 0.8 percentage points, regardless of the structural unemployment rate. As all variables are assumed to be detrended in the model, this estimate cannot be directly used.

46. The specification of parameters related to the *foreign exchange market* is ad hoc, and should be considered as a tentative benchmark.[31] While in a two-country model there is no meaningful foreign exchange market for an "EMU-insider", in the case of an "EMU-outsider" fixed exchange rate regime, influences originating from the foreign exchange market appear in the *specification of the risk premium*. The risk premium is assumed to include three components: a "ceteris paribus" constant outsider premium; a "credibility cost" component; and a random shock. The base level of the risk premium is an irrelevant nuisance parameter and does not influence the simulation results. 50 basis points, a value close to Denmark's experience over the past 6 months, was chosen as its numerical value. The "credibility component" intends to capture the idea that an appreciated real exchange rate puts the peg under stress, as market participants start to question its sustainability. The "price" of defending the nominal exchange rate is a higher risk premium, and it is assumed that this "price" is quadratic in the extent of real appreciation. This element of the risk premium was calibrated such that the "credibility cost" of a 1 percentage point real appreciation is 5 basis points, while a 2 percentage point real appreciation costs 20 basis points.[32] The third (stochastic) component of the risk premium captures disturbances on the foreign exchange market. To summarize, the risk premium was formulated as:

$$\rho_t = 0.5 + 0.05 \cdot dev(e_t)^2 + \varepsilon_t^{\rho} \qquad (9')$$

where *dev(.)* is an operator which determines the extent of real appreciation.[33]

47. The *large country's monetary policy rule* is parameterized based on a numerical search for the optimal lagged Taylor rule. Assuming that the policymaker minimizes a weighted sum of the variance of inflation and the variance of output, the expected value of the

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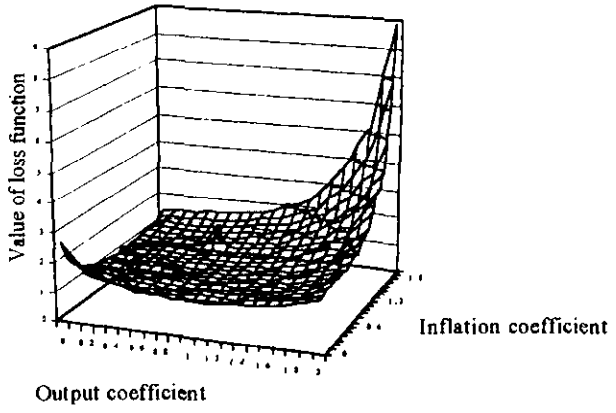
[31] As is well-known, empirical research on nominal exchange rates is far from fruitful, cf. for example Meese (1990) and Frankel and Rose (1994) for an overview.

[32] In general, the credibility of the peg would also depend on policy response to the real appreciation. Since monetary/exchange rate policy is the only instrument in the model, this consideration does not enter in the specification.

[33] It is assumed that "credibility costs" are inherently asymmetric in the sense that while an appreciated real exchange rate leads to an increase in the risk premium, a depreciated real exchange rate does not trigger a matching decline. It should also be noted that the real exchange rate is supposed to be appreciated if its value falls below the threshold 0.83. The rationale for this is that in full deterministic equilibrium, the effect of a permanently higher real interest rate on output in the "outsider" country would be offset by a slightly depreciated real exchange rate. Correspondingly, the "outsider" country would run a small current account surplus. Thus, the choice of exchange rate regime is not neutral for the composition of aggregate demand in the model.

loss function was calculated for a range of monetary policy rule parameters. Figure II-2 shows the results when the weight on output is 0.25 and the weight on inflation is 0.75. The graph illustrates that the loss function is fairly flat whenever the monetary policy function's parameters are between 0.5 and 1. This feature is not sensitive to the loss function's weights. In light of this, a monetary policy function that changes the interest rate one for one in case of deviations of inflation from the target, and changes the interest rate by 0.5 percent for a 1 percent change in the output gap was chosen. According to the monetary policy rule recommended by Taylor (1993), the interest rate would react more to inflation—there would be a 1.5 percent change for every percentage point deviation from the inflation target. Due to the parameterization of the model, this would clearly be suboptimal in the current setting because of the smaller persistence of inflation.[34] With smaller inflation persistence, a larger policy response to inflation deviations would be destabilizing.

Figure II-2. Denmark: Social Cost of Inflation and Output Variability



48. Five *stochastic shocks* are considered, which are assumed to be independent in the baseline. The large country is subject to output shocks (ε^{y^f}), which do not have a direct impact in the small country. In contrast, the large economy's inflation shocks (ε^{π^f}) fully influence the small country's inflation as well, so they can be considered common shocks and can be thought of as truly exogenous to both countries, e.g. effects of oil and commodity

[34] It is frequently assumed in the literature, cf. Taylor (1998b) or Ball (1998) that inflation (or supply) shocks are permanent, in line with Blanchard and Quah (1989). Other models, for example Erceg, Henderson and Levin (1998) or Christiano and Gust (1999), examine monetary rules under the assumption of less than fully persistent supply shocks. In addition, Ricketts and Rose (1995) find empirical evidence in the G-7 countries which indicates that inflation is mean-reverting in low inflation regimes. Here, it is assumed that all shocks, including supply shocks are temporary, which is consistent with the latter strand of theoretical models, and the evidence presented by Ricketts and Rose.

price changes. Similarly, the small country is hit by output and inflation shocks (ε^y and ε^w, respectively). The latter could be interpreted as supply shocks emanating from, say, wage bargaining behavior, and are taken to be orthogonal to common inflation shocks. These four stochastic disturbances—domestic and foreign output and inflation shocks—are assumed to be normally distributed with zero mean. Variances of the inflation shocks are calibrated at 0.25, meaning that about 5 percent of the time, the magnitude of the shock exceeds 0.5 percent; and about 1 percent of the time it exceeds 1 percent. Output shocks are assumed to be larger, with variance about unity, and in the baseline, the correlation between the two countries' output shocks is taken to be zero. The remaining stochastic disturbances are shocks to the risk premium (ε^ρ). Shocks to the risk premium are drawn from a truncated normal distribution; are constrained to be larger than minus 20 basis points (so that the risk premium does not fall below 30 basis points); and have a zero mean and a 14 basis point standard deviation.

49. Table II-2 presents the historical and simulated variance of the output gap, inflation, and the current account for the small country, as well as the correlation coefficients between these variables. The calibrated model generates an output gap variance that exceeds somewhat the observed variance in Denmark over the past 12 years. Correspondingly, the stochastic model displays fluctuations with amplitude larger than that of the Danish business cycle. The length of the fluctuations is about 12-15 periods, longer than the empirical counterpart of 7 to 8 years (see Figures II-3 for typical simulated paths of select variables). As to the variance of inflation, historical data provide little help, because they are derived from a period of relatively high and variable inflation. It can be hypothesized, that a supposed low inflation environment would be characterized by substantially lower inflation variability than observed in the past. The model generates a current account that is markedly less variable than Denmark's actual current account in the recent past. Historically, the variance of the current account was of the same magnitude, or larger, as the variance of the output gap, while the simulated variance is about one third of that. Regarding the correlation coefficients, the model generates a strong negative correlation between the output gap and the current account, which is in accordance with the historical behavior of these variables. In the model, inflation and the output gap are positively correlated with a coefficient about 0.5. The empirical correlation coefficient between these two variables for the 1987-1998 period is 0.44, very close to the simulation results, but its value strongly depends on the time period examined.[35]

[35] For example, the correlation coefficient is -0.44 for the 1980-1998 period.

Table II-2. Variance and Covariance of the Output Gap, Inflation, and the Current Account 1/

	Variance, Output gap	Variance, Inflation	Variance, current account	Correlation, output gap and inflation	Correlation, output gap and current account
Historical (1987-1998)	3.25 2/	8.27	3.48	0.44	-0.87
Simulated "EMU outsider"	3.87	1.14	1.13	0.55	-0.74
Simulated "EMU insider"	3.50	1.09	0.99	0.52	-0.76

1/ Variances around zero.
2/ Variance over the 1980-1998 period.

Figure II-3a. Denmark: A Simulated Path of Output

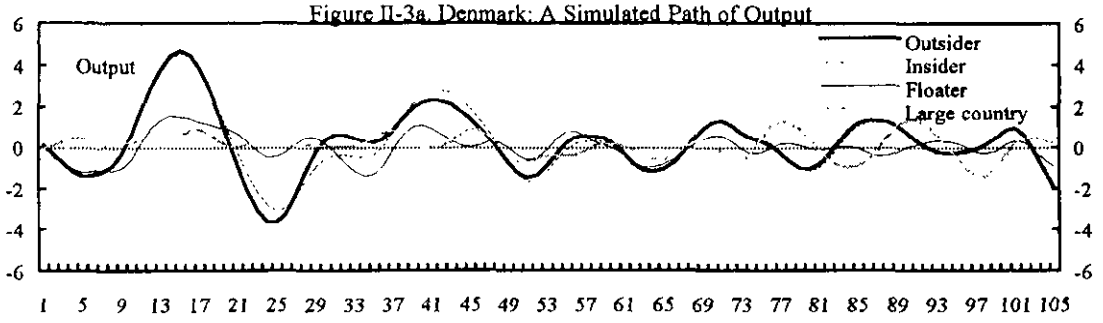


Figure II-3b. Denmark: A Simulated Path of Inflation

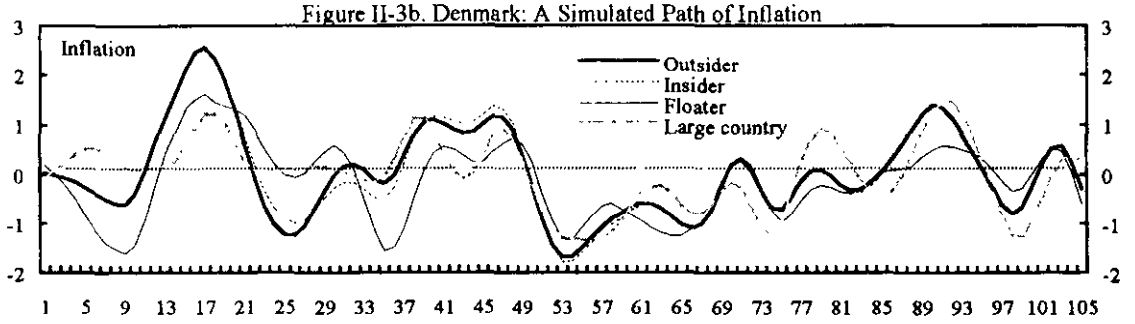
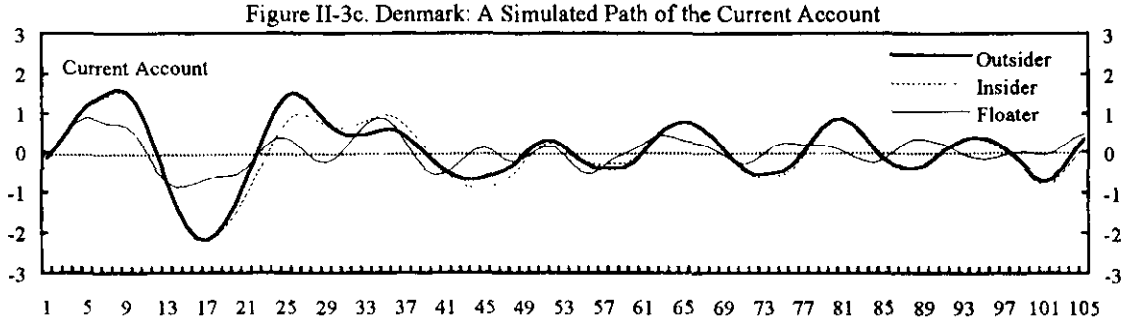


Figure II-3c. Denmark: A Simulated Path of the Current Account



Source: Staff estimates

50. The shortcomings of the simulated model—longer business cycles and less volatile current account—originate in the simplifying assumptions, namely, in the highly stylized treatment of the large economy. As a result, the large economy displays long and relatively small fluctuations in the simulations, which tend to lengthen the cycles in the small economy and to compress the volatility of its current account. The creation of the European Monetary Union clearly represents a regime change, which may have an influence on the European business cycle. Although it can be speculated that with stronger links between the EMU member countries after the creation of the monetary union, there will be greater need to insure against country-specific shocks, and fluctuations will diminish, it is also possible that integration will lead to more synchronized business cycles in member countries, and thus to larger fluctuations for the monetary union as a whole.

C. Simulation Results

51. The model described in the previous section is utilized to quantify inflation and output variability in the small economy under the "insider" and "outsider" scenario. To accomplish this, the model is subjected to 200 realizations of a series of stochastic shocks over a 100-period horizon, and the average variances of output and inflation around zero are examined. The choice of the horizon is not motivated by the assumption that either the exchange rate regime, or the structure of the two economies is expected to remain unchanged for the foreseeable future. Rather, the dynamics of the model, in particular the relatively long fluctuations, require that a long time period spanning a number of cycles be considered to measure output and inflation variance with reasonable accuracy.

52. First, the quantitative effects of different kinds of stochastic shocks are examined in isolation to illustrate the relative importance of different shocks for output and inflation variability. When comparing the "EMU-outsider" and "EMU-insider" regimes, output and inflation variability are found to be slightly higher in the "outsider" case, but the magnitude of the differences between the two regimes is found to be minor.

53. Then, the joint effects of all stochastic shocks on output and inflation variability are considered. In the *baseline scenario*, output and inflation are found to be 10 and 5 percent more variable in the "outsider" case than in the "insider" scenario, indicating that although there is a difference in the need for fiscal policy under the two regimes, this difference is of moderate magnitude. After describing the baseline scenario, *the correlation between the output shocks* in the small and the large economy is allowed to vary. While stronger positive correlation diminishes the difference between the "outsider" and "insider" regimes, output and inflation become relatively more variable under the "outsider" arrangement when the correlation weakens and turns negative.

54. Next, output and inflation variability are traced as a function *of the large country's monetary policy rule*. Large deviations in the foreign country's monetary policy rule from the baseline are found to increase the variability of inflation and output in the small country under both exchange rate arrangements. The difference between inflation and output

variability under the two regimes, however, is not sensitive to changes in the large country's monetary policy rule.

55. Finally, it is illustrated that the difference between the "insider" and "outsider" regimes can become substantial if some of the model's assumptions are modified. In particular, more volatile financial markets and weaker credibility of the "outsider" country's peg are considered. Under either of the modified assumptions, the variables of interest become markedly more volatile for the "outsider" country. This illustrates that an "outsider" arrangement can potentially increase the vulnerability of the economy.

Output and inflation variability and the type of shocks

56. Table II-3 presents output, inflation and current account variance, allowing for stochastic shocks to the risk premium and to one additional variable. For example, in column 1 it is assumed that only shocks to the risk premium and to foreign output occur. The first two rows in Table II-3 illustrate the relative importance of the different shocks for the variability of output in the small economy. In the calibrated model, the most important source of output variability is domestic output shocks (column 3). The effects of foreign output shocks are weaker but also substantial (column 1), due partly to the fact that foreign shocks are only partially transmitted through trade, and partly to the assumption that output fluctuations in the large country are mitigated by monetary policy. In contrast, inflation shocks, in particular, common inflation shocks induce relatively little output volatility in the small economy. Rows 4 and 5 show the relative importance of different shocks for inflation variability. Foreign shocks and domestic output shocks produce similarly variable inflation in the small economy (columns 1-3), while domestic price shocks appear less important.

57. Comparing inflation and output variability under the "insider" and "outsider" regimes reveals small differences, implying that the need for countercyclical fiscal policy is similar under both arrangements. In case of common inflation shocks (column 2), there is virtually no difference between the performance of the two regimes. The "EMU-insider" and the "EMU-outsider" regimes also perform similarly when foreign output shocks are considered. The "outsider's" risk premium exceeds the deterministic benchmark level of 50 basis points by merely 2 basis points, the variance of inflation is almost the same under the two regimes, and the variance of output is only slightly higher under the "outsider" scenario than in the "insider" case (column 1).

58. If the economy is exposed to domestic output shocks (column 3) the difference between the "EMU-outsider" and "EMU-insider" regimes widens slightly. The outsider's average risk premium increases by 7 basis points (from the deterministic benchmark of 50 basis points), due to the "credibility effect": whenever foreign and domestic inflation diverge such that the real exchange rate appreciates, defending the peg requires an increase in the risk premium for an outsider country. This adds some variability to the domestic real interest rate and thus to output. Nevertheless, differences between the two regimes remain modest: output and inflation variability under the "outsider" regime are less that 10 percent

more variable than their counterparts under the "insider" scenario. A similar conclusion is achieved for the case of domestic price shocks (presented in column 4).

Table II-3. Variance of Output, Inflation and the Current Account—
One Type of Shock and Foreign Exchange Market Disturbances Considered

	Foreign output shock	Common inflation shock	Domestic output shock	Domestic inflation shock
	$\varepsilon^{yf}, \varepsilon^{E}, \varepsilon^{\rho}$	$\varepsilon^{\pi f}, \varepsilon^{E}, \varepsilon^{\rho}$	$\varepsilon^{y}, \varepsilon^{E}, \varepsilon^{\rho}$	$\varepsilon^{w}, \varepsilon^{E}, \varepsilon^{\rho}$
Var(y), EMU-outsider	0.57	0.14	2.63	0.38
Var(y), EMU-insider	0.53	0.13	2.45	0.33
Var(y^f)	1.37	0.08	0.00	0.00
Var(π), EMU-outsider	0.28	0.37	0.35	0.15
Var(π), EMU-insider	0.27	0.36	0.33	0.15
Var(π^f)	0.59	0.34	0.00	0.00
Var(CA), EMU-outs.	0.14	0.03	0.76	0.07
Var(CA), EMU-ins.	0.14	0.02	0.73	0.06
Average risk premium	0.54	0.50	0.58	0.52

Output and inflation variability and the correlation of output shocks

59. This section examines whether the correlation of foreign and domestic output shocks influences the difference in output and inflation variability under the "insider" and "outsider" regimes. As the empirical evidence regarding the actual correlation of output shocks in Denmark and the Euro area is inconclusive, zero correlation was chosen as baseline.[36] [37]

60. Table II-4 and II-5 present the results for select correlation coefficients. *The benchmark case* of no correlation (column 3) shows that under the "outsider" scenario, the need to occasionally defend the peg raises the risk premium by 13 basis points on average. The added variability in the real interest rate implies that output is by 10 percent more variable for an outsider than for an insider. Some of the added variability to output under the

[36] See for instance Bayoumi and Eichengreen (1992) and (1996), Bayoumi and Prasad (1995), Fatás (1997), Kongsted and Konnerup (1998), OECD (1999). Although it could be argued that the correlation of shocks is bound to change after entry to the currency union, cf. Frankel and Rose (1996), this possibility is not considered in the baseline.

[37] An econometrician who, after observing the behavior of the two model economies, successfully recovers output shocks in the two countries, would however conclude that the shocks are positively correlated with a correlation coefficient slightly below 0.2. The reason is that the model separates the effect of the large country's shock on the small country's output from the "true" output shock in the small country by explicitly considering trade links, while the econometrician would not make this distinction.

outsider regime is propagated to inflation, so that inflation variability is also slightly higher under the outsider arrangement. The higher variability of output under the "outsider" regime indicates that the need for countercyclical fiscal policy is larger in this case.

61. Comparing the columns of Tables II-4 and II-5 shows that output variability increases steadily under both regimes as the correlation of output shocks is varied from +1 to −1, illustrating that the burden on fiscal policy to stabilize output increases as the shocks become less synchronized. Indeed, the difference between the two polar cases is over 40 percent for the outsider regime, and 30 percent for the insider. Inflation variability shows the opposite pattern, decreasing as the correlation coefficient is varied from +1 to −1, but the differences at the two extremes are similarly sizeable. These results are the net of two opposing effects. On one hand, if output shocks are strongly positively correlated, the large economy's monetary policy is more appropriate for the small economy, so the adopted monetary policy stance should be more successful in mitigating the effects of stochastic shocks and should reduce the variability of both inflation and output. On the other hand, if output shocks in the two economies are positively correlated, the small economy in fact receives a larger output shock, because domestic booms tend to coincide with expanding export markets, and busts with weak demand abroad. Larger shocks, ceteris paribus, would increase volatility. In case of output, the first effect dominates, while in case of inflation the second effect is larger.

62. Tables II-4 and II-5 show that the difference between the variability of inflation and output under the "insider" and "outsider" regimes shrinks as output shocks in the large and the small economy become more strongly positively correlated, and thus the need for countercyclical fiscal policy becomes more similar under the two arrangements. The opposite happens under the assumption of strongly negatively correlated output shocks. In the extreme case of perfect negative correlation (column 5), output variability is 20 percent higher, and inflation is 9 percent more volatile under the "outsider" regime than under the "insider" scenario. The widening difference in output variability under the two regimes indicates that fiscal policy under an "outsider" arrangement faces a relatively larger challenge to stabilize output than in an "insider" scenario whenever output shocks in the small and the large country are strongly negatively correlated.

63. The average level of the risk premium also varies with the correlation of output shocks. It reaches its lowest level in the case of a strong positive correlation coefficient (column 1), and is highest when output shocks are strongly negatively correlated (column 5). The reason for this is that with more synchronized output movements in the two economies, inflation rates also tend to move more closely together. When inflation in the small economy tracks inflation in the large economy, the real exchange rate (which depends on the inflation differential) will become appreciated less often, and thus pressure on the "outsider's" exchange rate will occur less frequently. On average, this will result in a lower risk premium. The opposite argument applies in the case when output shocks are negatively correlated, inflation movements in the two economies are less synchronized, and the average risk premium is higher.

Table II-4. Variance of Output, Inflation and the Current Account—
Different Correlations of Output Shocks

	$Corr(\varepsilon^y,\varepsilon^{yf})$ =+1	$Corr(\varepsilon^y,\varepsilon^{yf})$ =+0.5	**$Corr(\varepsilon^y,\varepsilon^{yf})$ =0**	$Corr(\varepsilon^y,\varepsilon^{yf})$ =-0.5	$Corr(\varepsilon^y,\varepsilon^{yf})$ =-1
Var(y), EMU-outsider	2.85	3.36	**3.87**	4.41	4.73
Var(y), EMU-insider	2.78	3.17	**3.50**	3.85	3.96
$Var(y^f)$	1.46	1.47	**1.46**	1.47	1.47
Var(π), EMU-outsider	1.33	1.24	**1.14**	1.11	0.98
Var(π), EMU-insider	1.32	1.21	**1.09**	1.03	0.88
$Var(\pi^f)$	0.94	0.92	**0.91**	0.92	0.93
Var(CA), EMU-outs.	0.61	0.77	**1.04**	1.27	1.46
Var(CA), EMU-ins.	0.54	0.75	**1.00**	1.21	1.38
Average risk premium	0.54	0.58	**0.63**	0.67	0.71

Table II-5. Variance of Output, Inflation and the Current Account
in Percent of the Outsider Regime's Baseline Performance—
Different Correlations of Output Shocks

	$Corr(\varepsilon^y,\varepsilon^{yf})$ =+1	$Corr(\varepsilon^y,\varepsilon^{yf})$ =+0.5	**$Corr(\varepsilon^y,\varepsilon^{yf})$ =0**	$Corr(\varepsilon^y,\varepsilon^{yf})$ =-0.5	$Corr(\varepsilon^y,\varepsilon^{yf})$ =-1
Var(y), EMU-outsider	74%	87%	**100%**	114%	122%
Var(y), EMU-insider	72%	82%	**90%**	99%	102%
$Var(y^f)$	38%	38%	**38%**	38%	38%
Var(π), EMU-outsider	117%	109%	**100%**	97%	86%
Var(π), EMU-insider	116%	106%	**96%**	90%	77%
$Var(\pi^f)$	82%	81%	**80%**	82%	82%
Var(CA), EMU-outs.	52%	74%	**100%**	122%	140%
Var(CA), EMU-ins.	51%	72%	**96%**	116%	133%

Output and inflation variability and the foreign policy rule

64. This section examines whether the monetary policy followed by the large economy has an important influence on output and inflation variability, and thus on the need for fiscal policy in the small economy. Changes in the monetary policy rule in the foreign country can affect the small country via several channels. First, a different monetary policy rule will influence the typical variability of output and inflation in the large economy, and the resulting changes in the volatility of foreign output will be propagated to the small economy's export demand. Second, under a fixed exchange rate arrangement, changes in foreign inflation volatility will have a direct influence on the volatility of real exchange rates and inflation as well.[38] Third, changes in the large economy's interest rate response to shocks

[38] See equation (5') in Section B.

will be directly transmitted to the small economy via the (covered or uncovered) nominal interest rate parity relationship.[39]

65. Tables II-6 and II-7 present the results obtained by varying the sensitivity of the large economy's monetary policy rule to output. Because the baseline parameter values characterize a near-optimal monetary policy reaction function (as explained in Section B), the variability of output and inflation *in the large economy* is expected to remain flat or to increase as the monetary policy rule deviates from the baseline. Indeed, the simulations show that these variables remain stable for smaller deviations (columns 2 and 4), but they increase as the deviation becomes larger (columns 6 and 7).

66. Columns 1 and 2 in Tables II-6 and II-7 illustrate cases when the foreign monetary policy rule is more responsive to output than under the baseline (presented in column 3), while columns 4 through 7 show scenarios where the policy responsiveness is lower than in the baseline. Looking at the rows that report inflation and output variance reveals that both inflation and output variability show a slight U-shaped pattern in the small economy under both regimes. While inflation variability is minimal under the baseline (column 3), the lowest output variability is reached when foreign interest rates are somewhat less sensitive to output than under the baseline policy rule (column 5). This means that the need for countercyclical fiscal policy action in the small country would be smaller if monetary policy in the large economy responded *less* to output than in the baseline. The intuition is straightforward—the baseline monetary policy is not optimal for the small economy for output stabilization purposes. Changes in foreign output are only partially transmitted to the small economy through trade, so the interest rate response to output under the baseline foreign monetary policy rule is "excessive" from the small country's point of view. Hence, decreasing the foreign monetary policy rule's sensitivity of interest rates to output somewhat helps decrease output variability in the small economy under a fixed exchange rate regime. The beneficial effects of importing a monetary policy stance that is more appropriate are, however, somewhat mitigated by the adverse effects of higher output variability in the large economy (which follow from the fact that this monetary policy rule is not optimal for the large economy). Lowering the foreign interest rate rule's sensitivity to output beyond a threshold leads to higher output variability in the small economy as well, due to two effects. First, the rise in foreign output variability associated with a sub-optimal monetary policy rule is transmitted through trade, and continues to contribute to higher output variability in the small economy. Second, below some threshold value, monetary policy response with respect to foreign output becomes "insufficient" even from the small country's point of view.

67. The "insider" and "outsider" regimes are characterized by the same respective output variances in the baseline scenario than in the case of a monetary policy that is completely non-responsive to output (columns 3 and 7 in Tables II-6 and II-7). However, inflation variance is about 15 percent higher in the polar case than under the baseline. The difference in inflation and output variability under the two regimes is not sensitive to changes in the

[39] Equation (8a) and (8b) in Section B.

foreign monetary policy rule. Output remains about 10 percent more variable, and inflation variability is about 6 percent higher under an "outsider" regime than under an "insider" arrangement regardless of the sensitivity of the large country's monetary policy rule to output.

Table II-6. Variance of Output, Inflation and the Current Account—
Different Degrees of Responsiveness of Monetary Rule to Output

	θ_y=0.75	θ_y=0.625	Baseline θ_y=0.5	θ_y=0.375	θ_y=0.25	θ_y=0.125	θ_y=0
Var(y), EMU-outsider	4.13	3.87	3.87	3.79	3.55	3.84	3.87
Var(y), EMU-insider	3.73	3.50	3.50	3.42	3.23	3.45	3.45
Var(y^f)	1.48	1.47	1.46	1.47	1.51	1.59	1.68
Var(π), EMU-outsider	1.17	1.14	1.14	1.18	1.16	1.27	1.34
Var(π), EMU-insider	1.12	1.09	1.09	1.12	1.11	1.21	1.27
Var(π^f)	0.88	0.91	0.91	0.94	0.98	1.05	1.12
Var(CA), EMU-outsider	1.11	1.02	1.04	0.98	0.91	0.94	0.89
Var(CA), EMU-insider	1.06	0.98	1.00	0.94	0.88	0.90	0.84
Average risk premium	0.62	0.62	0.63	0.62	0.62	0.62	0.62

Table II-7. Variance of Output, Inflation and the Current Account
in Percent of the Outsider Regime's Baseline Performance—
Different Degrees of Responsiveness of Monetary Rule to Output

	θ_y=0.75	θ_y=0.625	Baseline θ_y=0.5	θ_y=0.375	θ_y=0.25	θ_y=0.125	θ_y=0
Var(y), EMU-outsider	107%	100%	100%	98%	92%	99%	100%
Var(y), EMU-insider	96%	90%	90%	88%	83%	89%	89%
Var(y^f)	38%	38%	38%	38%	39%	41%	43%
Var(π), EMU-outsider	103%	100%	100%	104%	102%	111%	118%
Var(π), EMU-insider	98%	96%	96%	98%	97%	106%	111%
Var(π^f)	77%	80%	80%	82%	86%	92%	98%
Var(CA), EMU-outsider	107%	98%	100%	94%	88%	90%	86%
Var(CA), EMU-insider	102%	94%	96%	90%	85%	87%	81%

68. Tables II-8 and II-9 present the simulation results when the sensitivity of the foreign policy rule with respect to inflation is varied. Columns 1 and 2 represent cases when monetary policy in the large economy responds more to inflation than under the baseline (presented in column 3). Columns 4 through 7 show scenarios under monetary policy rules that are less sensitive to inflation. The results are qualitatively similar to the case of changing sensitivity to output. First, output and inflation in the large economy become more variable as the monetary policy rule deviates from the baseline. Second, both output and inflation variance display a U-shaped pattern in the small country. While the variance of inflation is minimal under the baseline (column 3), the variance of output reaches its minimum when the foreign monetary policy rule reacts less to inflation than under the baseline (column 4).

Third, the difference between output and inflation variability under the two regimes is not sensitive to changes in the large economy's monetary policy rule.

69. Quantitatively, substantial deviations from the baseline in the sensitivity of the large economy's monetary policy rule with respect to inflation have stronger implications for the small country's output and inflation variability than similar deviations in the sensitivity with respect to output. In the extreme case when monetary policy does not respond to inflation (column 7 in Table II-9), output is about 20 percent more variable under both regimes than in the baseline, and inflation variability exceeds its baseline level by about 40 percent. The comparable magnitudes in cases when monetary policy does not respond to output (from column 7 of Table II-7) are 0 and about 15 percent, respectively. The large differences stem from the fact that while shocks to foreign output are only partially transmitted to the small economy through trade, inflation shocks to the large economy fully affect inflation in the small country.[40] Thus, whether the imported monetary policy is "appropriately" responsive to inflation has more important repercussions for the small country than its responsiveness to output.

Table II-8. Variance of Output, Inflation and the Current Account—
Different Degrees of Responsiveness of Monetary Rule to Inflation

	θ_π=1.5	θ_π=1.25	Baseline θ_π=1	θ_π=0.75	θ_π=0.5	θ_π=0.25	θ_π=0
Var(y), EMU-outsider	4.48	3.92	3.87	3.64	3.80	4.13	4.74
Var(y), EMU-insider	4.15	3.55	3.50	3.28	3.38	3.71	4.25
Var(y^f)	1.86	1.60	1.46	1.41	1.42	1.48	1.63
Var(π), EMU-outsider	1.37	1.22	1.14	1.14	1.21	1.35	1.60
Var(π), EMU-insider	1.32	1.17	1.09	1.09	1.14	1.29	1.52
Var(π^f)	1.07	0.98	0.91	0.92	0.95	1.01	1.14
Var(CA), EMU-outsider	1.18	1.03	1.04	0.95	0.93	0.98	1.08
Var(CA), EMU-insider	1.15	0.99	1.00	0.91	0.88	0.92	1.00
Average risk premium	0.62	0.62	0.63	0.62	0.62	0.62	0.62

Table II-9. Variance of Output, Inflation and the Current Account
in Percent of the Outsider Regime's Baseline Performance—
Different Degrees of Responsiveness of Monetary Rule to Inflation

	θ_π=1.5	θ_π=1.25	Baseline θ_π=1	θ_π=0.75	θ_π=0.5	θ_π=0.25	θ_π=0
Var(y), EMU-outsider	116%	101%	100%	94%	98%	107%	122%
Var(y), EMU-insider	107%	92%	90%	85%	87%	96%	110%
Var(y^f)	48%	41%	38%	36%	37%	38%	42%
Var(π), EMU-outsider	120%	107%	100%	100%	106%	118%	140%
Var(π), EMU-insider	116%	103%	96%	96%	100%	113%	133%
Var(π^f)	94%	86%	80%	81%	83%	89%	100%
Var(CA), EMU-outsider	113%	99%	100%	91%	89%	94%	104%
Var(CA), EMU-insider	111%	95%	96%	88%	85%	88%	96%

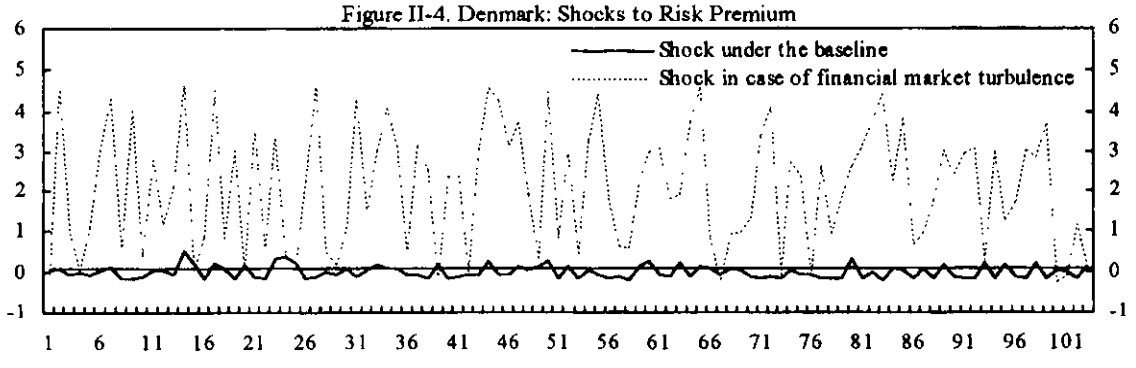
[40] See equation (5) in Section B.

Output and inflation variability and the vulnerability of the peg

70. The previous results, which found that under the baseline the difference between the "insider" and "outsider" regimes is quite small in terms of output and inflation volatility, and therefore the challenges facing fiscal policy are similar under the two exchange rate arrangements, depend strongly on the joint underlying assumptions of (i) orderly conditions in international financial markets; and (ii) credible commitment by the outsider country to the exchange rate peg.[41] This section illustrates that in case these assumptions are relaxed, both output and inflation become substantially more variable under the "outsider" regime than under the "insider" arrangement, indicating a larger need for fiscal policy in the former case.

71. First, the possibility of *financial market turbulence* is considered by modifying the assumption about the distribution of stochastic shocks to the risk premium (ε^{ρ}). In particular, the distribution is assumed to have higher mean, larger variance, and fatter tails (so that extreme values of the shock become more likely).[42] The average shock is calibrated at 200 basis points, and the maximum value is assumed to be 450 basis points. These magnitudes are in the range of "shocks" observed during the 1992 ERM crisis. Figure II-4 gives an illustration of a series of risk premium shocks under the assumption of calm and turbulent financial markets.

Figure II-4. Denmark: Shocks to Risk Premium



Source: Staff calculations.

72. Column 2 of Table II-10 reports the simulation results. While financial market turbulence increases the variability of both output and inflation in comparison with the baseline under the "outsider" regime, it has a larger effect on output variability. The intuition is that a more volatile risk premium directly influences real interest rates, and thus output, but

[41] Another crucial assumption is no difference in domestic and foreign trend inflation. This assumption is not relaxed. Although it would be formally possible, it would not fit the logic of the argument applied in building and calibrating the model in Section B.

[42] In particular, the shock is assumed to be uniformly distributed over the [-0.5, 4.5] interval.

it has no direct impact on inflation under a fixed exchange rate regime. The variability of inflation increases only as a result of higher output variability.

73. Next, *loss of credibility in the outsider country's exchange rate peg* is examined. This is modeled as an increase in the "cost" of real appreciation. In particular, the risk premium is assumed to rise by 20 basis points (instead of the baseline 5 basis points) in case the real exchange rate is 1 percentage point more appreciated than its equilibrium value, and by 80 basis points (instead of the baseline 20 basis points) in case of a 2 percentage point appreciation.

74. Column 2 of Table II-10 shows that the less credible peg increases the average risk premium by about 30 basis points from its baseline level, and makes (via the channel of more variable real interest rate) the "outsider's" output and inflation substantially more variable than under the baseline or under the "insider" arrangement. Similarly to the case of financial market turbulence, this adverse development is more pronounced in the case of output than in the case of inflation.

Table II-10. Variance of Output and Inflation Under the "Outsider" and "Insider" Regimes

	Baseline	Financial market turbulence	Lower credibility of peg
Var(y), outsider	3.87	7.31	5.60
Var(y), insider	3.50	3.49	3.49
Var(π), outsider	1.14	1.70	1.40
Var(π), insider	1.09	1.10	1.10
Average risk premium	0.63	3.38	0.94

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III. Sovereign Asset and Liability Management in Denmark[43]

A. Introduction and Summary

75. The Kingdom of Denmark maintains one of the most sophisticated sovereign debt management offices in the world. Changes instituted in the 1990s have lowered costs and improved the management of the DKr 745 billion of government debt outstanding at the end of 1998. Such changes include: (1) the transfer of debt management from Ministry of Finance to the independent Danmarks Nationalbank in order to conduct a more active policy in which exchange rate risk can be managed in coordination with the reserves; (2) the establishment of a benchmark for the risk and return characteristics of foreign debt; and (3) general limitations and other policies with regard to debt management. These changes have allowed the debt management office to better accomplish its stated goals of achieving the lowest possible costs for the debt in the long run.

76. Some of the impetus for the recent changes in debt management policy has arisen from the desire to lower the level of outstanding government debt and reduce the burden of interest payments within the central government budget. This goal is a laudable one, particularly so because demographic trends in Denmark, like in many industrial countries, show that the costs of maintaining the existing level of government-provided social services and transfer payments are expected to increase as the population ages and there will be fewer entrants to the labor force from younger cohorts to support these fiscal expenditures through tax revenues. The authorities in Denmark are attempting to ready themselves by reducing the interest rate burden by lowering the level of outstanding government debt well in advance of the expected pressures on fiscal accounts. As currently stated in the Medium-Term Economic Survey,[44] the goal is to lower public debt to approximately 35 percent of GDP by 2005. Although the eventual elimination of all government debt may be desirable to completely remove the interest rate burden imposed upon the fiscal accounts, government debt often takes on an auxiliary goal of providing a benchmark yield curve for pricing other domestic securities. Indeed, the Danish authorities have stated that "in the long term government debt policy must be planned to take account of the overall requirement to build up a well-functioning, effective Danish capital market."[45] Thus, it is not presently planned to completely eliminate all government debt.

77. The amount of net foreign debt in the Danish economy also has been the subject of concern in the past. During the mid-1980s, net foreign debt increased to more than 40 percent

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[43] Prepared by Laura Kodres.

[44] The Danish Economy: Medium-Term Economic Survey, March 1999, p. 54.

[45] From the Act, passed December 22, 1993, setting out the legislative basis for government borrowing.

of GDP, one of the highest rates in the OECD, following more than a quarter century of current account deficits. The financing of the debt required annual interest payments abroad of about 4 percent of GDP.[46] For several years now, the government has attached high priority to lowering the net external debt of the economy. As can be seen in Table III-1, the recent sequence of years with current account and central government surpluses have permitted the reduction of net foreign debt (final column) to 24 percent of GDP in 1998. This process slowed with the current account deficit incurred in 1998, but the government has maintained its longer-term goal for a reduction. While the initial goal called for elimination of the net foreign-denominated debt by 2005, this goal has been scaled down in view of the recent and projected current account deficits over the next two years, to a level of net foreign debt amounting to 15 percent of GDP by 2005, with total elimination to take place sometime in the future.

78. While taking the goal of lowering the burden of interest payments as a well-reasoned one, and acknowledging that the management of Danish sovereign debt is done in an efficient manner, this paper attempts to step back and ask a very basic question: are there sound economic reasons for maintaining some positive amount of external net foreign debt? As is well-known, the need to finance continuous current account deficits by providing claims on domestic capital to foreigners can become onerous if such deficits appear unsustainably large or the terms on which they are financed make countries vulnerable to monetary or exchange rate instability. Despite the maintenance of a fixed exchange rate regime and the recent dip of the current account into negative territory, it does not appear that the current account deficit is unsustainable nor does the current level of the net foreign debt appear overly burdensome. Denmark does not appear to be in a situation which would call for the immediate decline in foreign debt to maintain the safety or soundness of the monetary and financial system. The decision regarding the level of foreign indebtedness is thus a voluntary one and a potentially positive role for external foreign debt remains.

79. The rationale for government issued foreign-denominated debt is usually expressed as either (1) an inability of the private sector to tap financial markets to finance the current account (or a desire to lower the cost of such borrowing to the economy by having the government be the intermediary) or (2) provide the central bank with borrowed reserves or a combination of the two. According to the Nationalbank's publication, Danish Government Borrowing and Debt, the primary purpose of the central government's borrowing in foreign currencies is to maintain an adequate foreign-exchange reserve.[47] An additional reason relies on the interaction between hedging and incentive considerations. This role for foreign-denominated debt, though not completely divorced from the above considerations, is seldom cited in official documents and does not feature in the Nationalbank's publications.

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[46] OECD Economic Surveys, Denmark, 1990/1991, (p. 25-26.)

[47] Danmarks Nationalbank, "Danish Government Borrowing and Debt" 1998, p. 57.

Table III-1. Denmark: External Assets and Liabilities

(In DKr billion)

	Public Sector		Private Sector		Reserve Assets	Total
	Central government	Other public sector	Banks	Other private sector		
Assets						
1991	16	1	291	271	49	628
1992	17	4	290	292	73	676
1993	16	4	392	298	76	786
1994	17	6	310	310	56	698
1995	14	9	318	311	66	717
1996	13	15	377	399	87	890
1997	13	22	451	481	131	1,098
1998	13	28	497	587	103	1,228
Liabilities						
1991	223	18	289	426	4	960
1992	290	18	236	416	28	988
1993	442	14	192	428	1	1,077
1994	299	19	193	444	2	957
1995	331	16	195	440	2	983
1996	368	16	260	498	2	1,143
1997	398	14	383	570	1	1,366
1998	384	14	433	675	1	1,508
Net liabilities						
1991	207	17	-2	155	-45	332
1992	273	14	-54	124	-45	312
1993	426	10	-200	130	-75	291
1994	282	13	-117	134	-54	259
1995	317	7	-123	129	-64	266
1996	355	1	-117	99	-85	253
1997	385	-8	-68	89	-130	268
1998	371	-14	-64	88	-101	280

Source: Danmarks Nationalbank.

80. The hedging rationale for foreign-denominated debt suggests that it may be desirable for an open economy that is subject to shocks to output to maintain a positive amount of foreign debt to act as a macroeconomic hedge. This argument basically derives from a basic portfolio analysis in a general equilibrium setting. The intuition is that uncertainty in net wealth and consumption can be reduced by the issuance of foreign or domestic currency debt to foreigners who take on some of the risk of fluctuations in the issuing countries' output. The degree to which domestic or foreign debt, or some combination of them, can act as a hedge depends on whether domestic output is negatively correlated with domestic and foreign inflation. When a negative correlation exists, low output growth is associated with high inflation which lowers the real value of nominal debt. Holders of nominal debt thus "share" in the states of nature in which there is low output. Alternatively, when output growth is high, inflation is low and holders of debt maintain high real values of their debt, "sharing" in good times as well. If domestic output is relatively more negatively correlated with foreign inflation, then foreign-denominated debt will be favored over domestic debt for the same reason.

81. A second argument often used in favor of foreign debt relates to the government's ability to "inflate away" the value of domestic liabilities through its ability to manipulate the domestic price level. When such an incentive exists, potential debt holders may insist on high nominal interest rates in the domestic currency and the government may "solve" the incentive problem by issuing foreign-denominated debt. The government is implicitly assumed to be unable to influence foreign inflation and thus cannot repudiate the debt in this way. Of course, some governments have explicitly defaulted on their foreign debt by not repaying either interest or principle on time. Their ability to borrow abroad is usually curtailed after such events, or the risk premiums investors insist upon often preclude borrowing. A risk premium on foreign debt may also arise if the government has difficulty committing to domestic price stability. This may influence the likelihood of nonpayment if it is viewed as a signal of other macroeconomic weaknesses. Since the credibility of the Danish authorities in maintaining the real value of assets is well established, this second argument is not applicable for a country like Denmark where the credit rating agencies have rated Denmark's foreign currency debt slightly below the AAA rating on the domestically-denominated debt and the authorities have never used rapid inflation as a method to repudiate the debt.

82. To examine whether the foreign debt can play a role in hedging output risk in Denmark, an examination of the characteristics of the Danish economy relative to its trading partners is performed. The use of foreign debt as a hedge for output risk has been analyzed theoretically, but little empirical evidence has been brought to bear on the issue. This paper represents an initial attempt to examine this potential role for foreign-denominated debt. Even though it has not been an explicit reason for the use of foreign-denominated debt, it fits into the Danish authorities' argumentation for a reduction of the net external debt in that it relates explicitly to the *macroeconomic* risks of excessive and costly foreign debt and is thus appealing in a macroeconomic context.

83. The major trading partners in this analysis are Germany, Sweden, and the United Kingdom and the 11 EMU countries. The conditions under which a positive amount of foreign currency debt would be optimal are taken from Bohn (1996). In this paper, a model of a small open economy is presented and the desirability of foreign currency debt depends on the structure of macroeconomic disturbances.

84. The results of the exercise presented in sections III and IV show that using foreign-denominated debt to hedge output risk is not advisable for Denmark. Although the results would marginally encourage the use of euro-denominated debt to hedge output fluctuations with the Euro-11 countries, the results appear to be statistically insignificant. The intuition behind the results is that shocks to Danish real output are not highly correlated with their trading partners relative to the shocks to their respective monetary sectors.

B. Facts about Danish Sovereign Assets and Liabilities

85. To provide a context for the discussion, consider some general characteristics regarding the external debt of Denmark and, more specifically, the government debt.[48] As shown in Table III-1, most of the net external debt (DKr 371 billion) is comprised of central government liabilities owned by foreigners,[49] both foreign-denominated debt and domestically-denominated debt. Less than a third (DKr 101 billion) of the net central government liability was offset by foreign exchange reserve assets held by the Danmarks Nationalbank in 1998. The private sector has much smaller net foreign debt, with banks holding more foreign assets than liabilities and other private sector entities holding the reverse, more liabilities than assets. On net, the private sector has a net liability position relative to foreigners of about DKr 24 billion. Thus, although the policy goal is to lower net foreign liabilities (final column in Table III-1) to 15 percent of GDP by 2005, the goal is likely to require the public sector to lower its net external liability position rather than rely exclusively on an alteration of the private sector asset and liability positions.

86. Examining the characteristics of the sovereign debt component of net foreign debt provides the background for a discussion of the usefullness of foreign-denominated debt. The nominal amounts outstanding of Danish government debt have grown substantially since the early 1980s, leveling off in the late eighties and again in the late nineties. There are various methods of measuring the level of public sector debt with some countries calculating it in gross terms and others netting the debt with other types of assets to arrive at net debt. Simply examining the central government's gross nominal debt, Figure III-1 shows the growth in

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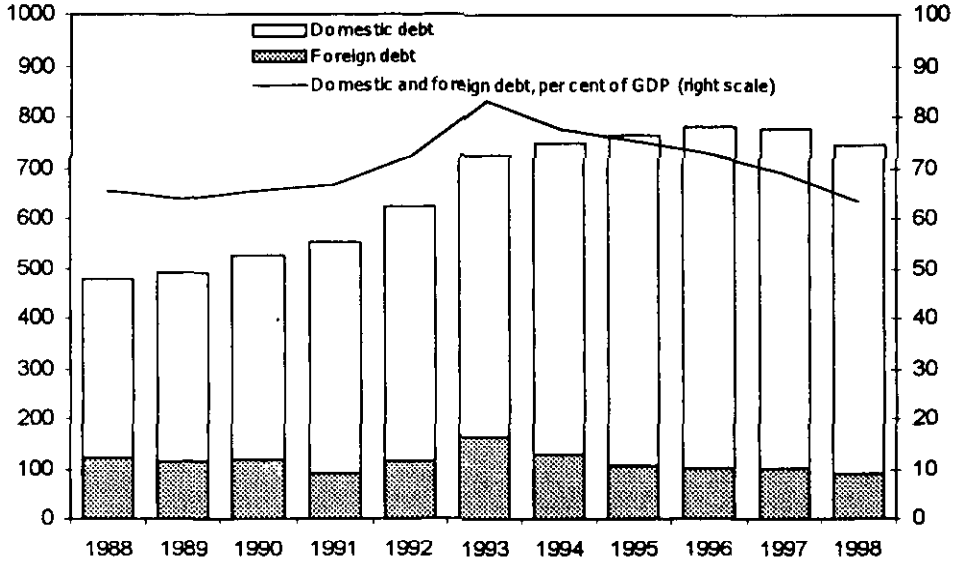
[48] The source of much of the information in this section comes from "Danish Government Borrowing and Debt" published by Danmarks Nationalbank, 1998, and other publications of the Nationalbank.

[49] Other public sector entities had net foreign assets of about DKr 14 billion at the end of 1998.

Danish gross debt since 1988 along with the amounts of government issued foreign debt. Although the amount of outstanding gross debt has leveled off close to 800 billion kroner in recent years, as a percentage of GDP gross debt has been falling. Since 1988, gross total debt (domestic and foreign) reached a high of just over 80 percent of GDP in 1993 and as of end-1998 was below 70 percent of GDP. Using the EMU definition of debt, the proportion of EMU debt to GDP has been reduced to less than 60 percent, below the cut-off level for entry into the EMU.[50]

Figure III-1. Real Domestic and Foreign Debt



87. The distribution between domestic and foreign sovereign debt is determined by the "central government borrowing norm" which is agreed between the government and Danmarks Nationalbank. The agreement is composed of two parts, one determining the domestic borrowing and another for the foreign borrowing. The domestic borrowing norm states that the issuance of domestic krone-denominated securities within a year shall match the gross central government borrowing requirements, including the redemption of domestic debt. The foreign borrowing norm states that the central government's redemption on foreign debt, *including securities bought back from the market and early redemptions, are normally* refinanced by foreign borrowing. These requirements provide a division between fiscal and monetary policy by ensuring that domestic liquidity is not affected by the government's

[50] The EMU debt includes the liabilities of both the central and local governments but also allows the public sector's claims on itself, i.e., holdings of government securities held by the Social Pension Fund and other social funds, to be deducted.

borrowing policies.[51] However, in situations in which foreign currency is needed for intervention purposes or there is excess foreign currency in the reserve account, the foreign borrowing norm may be waived (as long as the government account does not fall below zero). The government may issue foreign currency bonds to raise additional funds for reserve purposes or, alternatively, excess reserves can be used to redeem foreign borrowings lowering outstanding foreign debt.[52] As noted above, recent policy pronouncements have indicated a desire to lower net external debt over the next several years which could mean waivers from the foreign borrowing norm *if* the foreign-denominated portion of external government debt is to be reduced appreciably.

88. Table III-2 shows the components of the net and gross financing requirement over the last several years. Central government receipts less expenditures equal the net financing requirement as a result of the government's financial balance for the year. The redemptions of domestic and foreign debt within the year are then added to the financial balance to result in the gross financing requirement. Since 1994 there has been an improvement in the government's financial balance which has substantially reduced the gross financing requirements of the central government.

Table III-2. Central Government's Financing Requirement

(In billions of DKr)

	Total receipts	Total expenditure	Net financing requirement	Domestic debt	Foreign debt	Gross financing requirement
1994	366.0	408.9	42.9	76.9	14.9	134.7
1995	378.1	408.1	30.0	108.7	32.5	171.3
1996	394.0	412.9	18.9	75.8	33.2	127.9
1997	408.4	403.9	-4.5	78.3	25.2	99.0
1998	435.8	400.5	-35.3	78.3	37.4	80.4

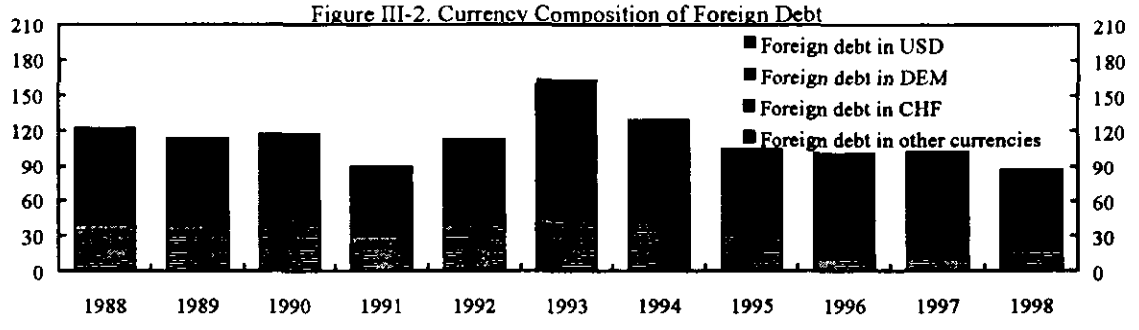
Sources: Finansiel Statistik, April 1999; Danmarks Nationalbank.

[51] When the central government issues foreign-denominated debt, the proceeds are added to foreign exchange reserves and the balance in the central government's account at the central bank increases. Article 104 of the Maastricht treaty, which prohibits monetary financing, imposes the constraint that the balance of the central government's account with the Nationalbank must be positive at all times.

[52] This occurred in 1998 when Tele Danmark, a partially government-owned entity, was fully privatized by a sale of stock to foreigners. The proceeds from the sale were used to reduce the central government's foreign liabilities.

89. The composition of the Danish sovereign foreign debt by the major currencies used for issuance is presented in Figure III-2. Since 1988 there has been a pronounced trend toward the use of core European currencies rather than the U.S. dollar or Japanese yen for issuance. As of 1998 over three-quarters of the debt was formally denominated in German mark with the next largest proportion denominated in what is now euro. Even this breakdown may be slightly deceiving since currency swaps are used to alter the currency composition of the foreign debt. As of end-1998 over 90 percent of the foreign debt was effectively denominated in euro. The stated purpose for denominating much of the portfolio in German marks (pre-1999) and euro (post-1998) is to lower nominal exchange rate risk. This is a result of the monetary policy objective of maintaining a stable krone rate against the major EMS currencies prior to 1999 and now relative to the euro.

Figure III-2. Currency Composition of Foreign Debt



90. The issuance maturities of the government debt range from nine months to 30 years. The maturities are generally divided into three categories: short term with initial maturities up to three years; medium term with initial maturities up to five years; and long term with initial maturities of as much as 30 years. Most issuance maturities, however, are chosen so as to provide relatively liquid series and to ensure the effective maturity (duration) remains around a desired four years for the domestic bonds and around a desired 2.5 years for the foreign bonds. The effective maturity, measured by the Macaulay duration[53] in Denmark, can also be managed using interest rate swaps, as well as strategically issuing securities of various maturities, and the Danish authorities actively use both techniques. Figures III-3a and III-3b provide the maturity structure of the domestic and foreign debt separately. Notice that the bulk of the debt has a term to maturity exceeding two years and that the foreign debt has a larger proportion of short-term securities than does the domestic debt component. This

[53] This measure of duration is a weighted discounted present value of the coupon payments and final par value where the weights are the time in years from the present for each of the cash flows. Duration provides a more precise measure of the potential interest rate risk of a portfolio of bonds than the average of stated maturities by accounting for the effect that the different timing of the cash flows has on the portfolio's price sensitivity to interest rate changes.

conforms to the stated durations which were 4.4 years for the domestic denominated debt and 2.0 for foreign-denominated debt in 1998.

Figure III-3a. Maturity Structure of Domestic Debt

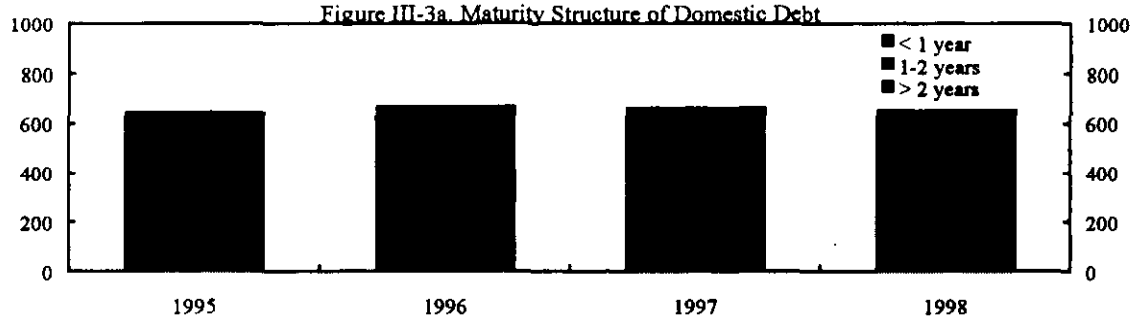
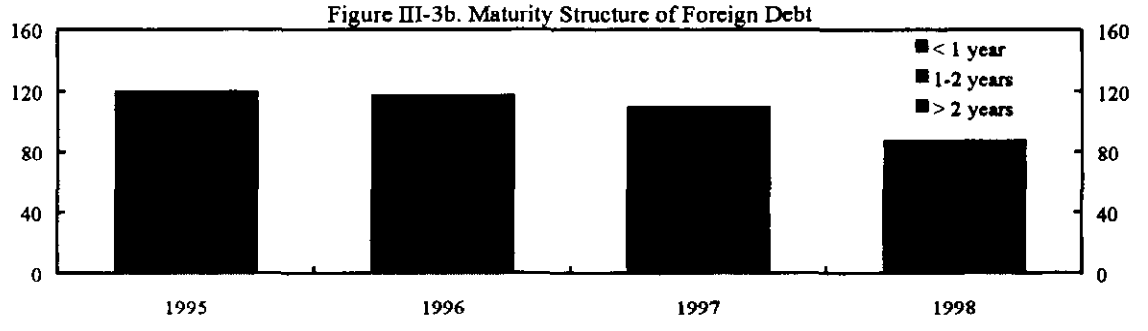
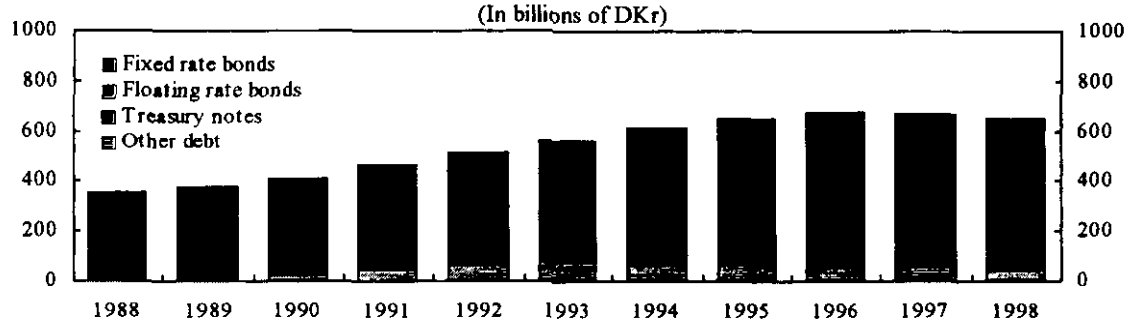


Figure III-3b. Maturity Structure of Foreign Debt



91. Another way of analyzing the government debt is to examine its terms by type of interest payment as this also has an implication for duration and interest rate risk management (Figure III-4). The vast majority of the domestic government debt is issued as fixed-rate debt. Fixed-rate issues are supplemented by short-term Treasury bills issued as zero-coupon securities with opening maturities of up to nine 9 months. These securities are kept open until 3 months before maturity. Floating-rate securities are no longer being issued although there remain some outstanding issues. Just as the currency risk of a foreign-denominated bond can be altered with a currency swap, so too can the interest rate risk be altered with an interest rate swap. Use of interest rate swaps, introduced in 1998, means that the target duration can be maintained without disturbing the issuance of a regular series of bonds. Thus, the goal of maintaining large liquid issues in order to lower outright borrowing costs and to support capital market development can be accomplished alongside better management of interest rate risk.

Figure III-4. Debt by Type of Interest Payments
(In billions of DKr)



92. In terms of the subsequent discussion regarding the optimal amount of foreign debt, several observations can be usefully recalled. First, the domestic and foreign borrowing norms suggest that the need for domestic and foreign debt mechanically appears to arise from refinancing the existing debt and the central government yearly financial budget balance. While the amount of outstanding sovereign debt thus appears to be a residual outcome of other policy decisions, it is important to recognize that the budgetary process determining government receipts and expenditures takes as an input the desired level of government debt and its expected cost. The projected budget surpluses over the next five years, for instance, are intended to be used to reduce total government debt. Second, the amount and proportion of foreign debt compared to domestic debt is not such that questions of sustainability are relevant. However, the amount is large enough that its reduction would have a nontrivial budgetary effect from a reduction in interest payments. Also by lowering the deficit of the investment income account, debt repayment would also decrease the drag on the current account, allowing surpluses to be more easily accomplished. Lastly, the currency composition of the foreign debt is heavily influenced by the desire to minimize nominal exchange rate risk but does not appear to be related to hedging output risk.

C. The Underpinnings for a Positive Theory for Foreign Debt

93. The goal of the model is to show how the value of nominal domestic and foreign debt relate to output uncertainty and how debt policy can improve social welfare. The analysis begins with some standard macroeconomic modeling assumptions: a small economy with identical, infinitely-lived, risk-averse individuals. Each individual maximizes the utility of a stream of future (discounted) consumption and receives a stochastic endowment of output. The government acts on behalf of individuals to maximize social welfare, that is, the expected utility of the representative individual.[54] Individuals are thus assumed not to borrow directly, but only indirectly though the government as intermediary. In Denmark's open

[54] The model does not include the goal of maintaining a liquid government securities market for capital market development nor the notion that continual debt issuance may make it easier to access debt markets in times of distress.

capital markets, individuals and corporations are permitted to borrow abroad. The model should thus be interpreted broadly whereby the government represents all potential domestic borrowers. As noted above, public sector borrowing overwhelms the private sector borrowing that has maintained net liabilities of less than 10 percent of the total net investment position of Denmark.

94. The government decides how to interact with risk-neutral, foreign lenders who extend to the country nominal domestic or foreign currency-denominated debt.[55] Since the government is assumed not to be able to sell off output to the foreigners directly, non-indexed debt may provide an indirect way of hedging against output risk. The notion is that if nominal and/or foreign currency debt is outstanding, the country gains from unexpected inflation in the corresponding country. The value of real debt falls at the same time as consumption falls due to low output growth. Money is introduced in the model so as to study usefulness of nominal bonds. However, since the correlation of inflation and real growth is crucial for the results, Bohn introduces money in a way that does not guarantee a perfect negative correlation between these two variables. In particular, a basic cash-in-advance constraint with unit velocity would imply a perfect negative correlation and thus agents are assumed to experience a technical delay in clearing money balances forcing them to hold money into the next period. In this way, velocity will be less than one and the negative correlation between inflation and output growth is not assumed *a priori*. Money supply is determined before the shocks to output and velocity are realized so that the government cannot perfectly control inflation. Thus, for a given money supply, realizations of the shocks to output and velocity determine that period's price level and thus the real value of debt.

95. With regard to the foreign economy in the model, it is assumed to be identical to the domestic one except that the agents are risk-neutral.[56] The domestic government takes the foreign money supply as exogenous. The issue of changes in relative prices is ignored by assuming that one unit of the foreign goods is equivalent to one unit of domestic goods so that purchasing power parity holds. This also implies that the effects of real exchange rate changes on output are absent from the model.

96. Given this setup, the problem is one in which the government chooses foreign debt and domestic debt so as to maximize the utility of its citizens subject to a national budget

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[55] The term "nominal" debt will refer to domestically-denominated government debt that is not indexed.

[56] Actually, all that is necessary is that foreign investors are sufficiently less risk averse than the domestic ones that they are willing to provide the "insurance" represented by government debt. If foreigners are not risk neutral, then they would also want to hedge their own countries' output risk, complicating the solution of the model by requiring four types of debt. Bohn argues that international investors are likely to be more diversified and less risk averse than the typical taxpayer.

constraint which incorporates the notion that old government debt to foreigners is financed by new debt, taxes, or money balances. The optimal debt policy is then given by the first-order conditions of the constrained optimization problem. These conditions imply that optimal risk-sharing requires that bonds be issued (or purchased, if debt is negative) until the covariance of taxpayers' marginal utility with unexpected returns (represented by an inflation innovation) on the debt is zero. From this set of conditions, Bohn (1996) finds that the optimal supply of nominal, N, and foreign currency, F, debt satisfies the following system of linear equations.

$$\kappa \cdot Y_o \cdot \mathrm{cov}(y,\pi^*) - \mathrm{cov}(\pi,\pi^*) \cdot N_0 - \mathrm{var}(\pi^*) \cdot F_o = 0$$

$$\kappa \cdot Y_0 \cdot \mathrm{cov}(y,\pi) - \mathrm{var}(\pi) \cdot N_0 - \mathrm{cov}(\pi,\pi^*) \cdot F_0 = 0$$

where $\kappa = (1+r)/(r-\bar{y}) > 0$ and Y_0 is the initial level of output, y is the growth rate of output with $\bar{y}$ representing its mean, π and π^* are the domestic and foreign inflation rates, respectively, and r is the real return on both domestic and foreign bonds (also the rate of time preference of the risk-neutral lender).

97. Note that unless the inflation rates in both countries are perfectly correlated, in which case one of the securities is redundant, the system results in a unique solution for the amount of both domestic and foreign bonds that provide an optimal hedge against output fluctuations. Bohn (1996) goes further and assumes that shocks to output and inverse velocity,[57] the two stochastic components in the model, can be decomposed into a country-specific shock and a common shock. Output shocks, both country-specific and common, are assumed to move output growth away from $\bar{y}$ while inverse velocity shocks move inverse velocity growth away from zero.

$$y = \psi + \mu + \bar{y}, \qquad \alpha = \nu + \eta,$$

$$y^* = \psi^* + \mu + \bar{y}^*, \qquad \alpha^* = \nu^* + \eta.$$

Where ψ and ν represent the country-specific components and μ and η denote common worldwide components to the shocks to output and (inverse) velocity. These random variables, $\psi, \psi^*, \nu, \nu^*, \mu$, and η are independent and white-noise with mean zero and finite moments. With the imposition of these assumptions regarding the shocks to output and inverse velocity, the optimal quantities of nominal and foreign currency debt are as follows:

[57] The model is specified in terms of inverse velocity instead of velocity since the money balances are determined in the model as inverse velocity times the price level times output.

$$(1) \qquad N = \kappa \cdot Y_0 / a_0 \cdot [\text{var}(\pi^*) \cdot \text{var}(\psi) + \text{var}(\mu) \cdot \text{var}(\psi^* + \nu^*)] > 0$$

$$(2) \qquad F = \kappa \cdot Y_0 / a_0 \cdot [\text{var}(\mu) \cdot \text{var}(\nu) - \text{var}(\psi) \cdot \text{var}(\eta)]$$

where $a_0 = \text{var}(\pi^*) \cdot \text{var}(\psi + \nu) + \text{var}(\mu + \eta) \cdot \text{var}(\psi^* + \nu^*) > 0$.

98. These equations imply that a government should always issue nominal debt. However, the quantity depends on the variances. In this setup, if there were only real shocks in the domestic economy (i.e. no shocks to velocity) then inflation and output would be perfectly (negatively) correlated and nominal debt would provide a perfect hedge against output fluctuations.[58] If the variance of domestic money demand shocks is large relative to the variance of output shocks, nominal debt becomes less desirable.

99. With respect to foreign currency debt, the optimal amount may be positive or negative depending on the configuration of shocks. If the common component of the shock to output is large (that is, output growth between the domestic and foreign country is closely related) and domestic monetary disturbances have a relatively larger idiosyncratic component, then foreign currency debt has an advantage over domestic debt as a hedge. This corresponds to the case when foreign and domestic output are closely related and the common component of the two country's monetary shocks is small. Another way of interpreting this result is that foreign currency debt is most appropriate for a country with a relatively unstable monetary system and that is highly vulnerable to shocks from abroad. In fact, in the model, any time output is negatively correlated with foreign inflation, foreign currency debt can play a role in hedging domestic output fluctuations.

100. The results above rely on the negative correlation between output and inflation. However, recent data suggest that the correlation between Danish output and inflation is positive. Bohn anticipates this issue and, in an earlier version of the paper, shows that in a macroeconomic setting with a Phillips curve economy, the optimal nominal debt is reduced. With positively correlated inflation rates, nominal and foreign currency debt are substitutes so that the lower nominal debt is offset by higher foreign currency debt and the optimal foreign currency debt remain unchanged.[59]

101. Although some elements of Bohn's model are not realistic (e.g., the purchasing power parity assumption that sidesteps issues of real exchange rate changes), it is one of the few

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[58] Inflation is negatively correlated with output given a fixed money supply growth rate (that is, the government cannot manipulate inflation), exogenous output, and the equation determining inflation, $\pi_t = m_t - y_t - \alpha_t$, where α is the change in inverse velocity.

[59] See Bohn, p. 284.

papers to present a positive (risk-sharing) role for foreign-denominated debt based on hedging the real output of the economy. It considers a small, open economy operating within a global economy subject to worldwide shocks to output. The arguments favoring foreign debt do not rely on the lack of credibility of the government (although Bohn notes that this increases the optimal amount of foreign debt as long as actual default probabilities remain small)[60] nor are they related to the maintenance of reserves for intervention purposes. Since Denmark has maintained a credible monetary policy and has not attempted to repudiate its debt through inflation, the underlying structure of model accords fairly well with the circumstances of a small, open developed country considering its optimal debt policy. Danish debt policy is now considered in light of this model.

D. Empirical Analysis of a Positive Theory for Foreign Currency Debt

102. Before attempting to distinguish the relative variance of country specific and common shocks to output and inverse velocity and its implications for domestic and foreign debt, consider some basic information about the macroeconomic environment in which Denmark and its trading partners operate.

103. In Table III-3, first differenced logged real GDP and a first differenced logged velocity are evaluated for Denmark and three of its trading partners, Germany, Sweden, and the United Kingdom using quarterly data ranging from first quarter 1981 to fourth quarter 1998.

Table III-3. Standard Deviations and Correlations Between Selected Variables: Denmark, Germany, Sweden,United Kingdom, and the EU11

	Std. dev. of own output 1/	Corr. of Danish output with others	Std. dev. of own velocity 2/	Corr. of Denmark's velocity with others
Denmark	0.041	1.000	0.052	1.000
Germany	0.015	0.037	0.031	0.121
Sweden	0.115	0.195	0.056	-0.211
United Kingdom	0.006	-0.075	0.064	0.025
EU11	0.006	-0.131	0.01	-0.038

Sources: IFS and OECD quarterly data 1981Q1 to 1998Q4 for all except EU11. EU11 uses Eurostat data from 1990Q1 to 1998Q4.

1/ Standard deviations of first differences of logged output.

2/ Velocity = Nominal GDP/Broad Money. Standard deviations of first differences of logged inverse velocity.

[60] Bohn explicitly assumes actual default is not available only the "excusable" default of a decrease in the real value through inflation.

Data for the EU11 is also used, but is only available from first quarter 1991 to fourth quarter 1998. For Germany, the country to which Denmark has traditionally pegged its exchange rate and its largest trading partner, the results supporting the use of foreign debt denominated in deutsche marks is weak. First, note that correlation of output changes between the two countries is basically nil—only about 0.04 over this time period.

104. Low correlation between the output measures is also supported when examined relative to a larger sample of trading partners. Table III-4 shows that, except for Norway and Japan, Denmark has the lowest correlation between its output and its trading partners' output (weighted by their trade in goods with Denmark) of about 0.25 between 1984 and 1997. The 16 countries in Table III-4 together represent 95 percent of Denmark's trade. The average correlation of their own GDP with those of the trading partners is about 0.57 for the 1984-1997 period.

105. An examination of the movements in velocity, simply defined as nominal GDP divided by broad money, also suggests that foreign debt denominated in deutsche marks may not help hedge against output fluctuations. As noted above, foreign debt is useful when the domestic economy is characterized by a more unstable monetary system (higher variance of money demand shocks) than the foreign country and the two countries are hit by common output shocks. Yet, these velocity statistics suggest a weak relationship here as well. First, the standard deviation of the changes in the logarithm of velocity in Denmark is only marginally above that in Germany, 0.052 versus 0.031, and the correlation coefficient between the measures of velocity is 0.12, much higher than that for output growth. Again this suggests that the use of foreign debt to hedge output fluctuations is not likely to be successful.

106. Looking at the United Kingdom as the foreign country in the model shows that issuing debt denominated in British pounds would be even less helpful in hedging output shocks in Denmark if the correlation of output differences and velocity differences are any indication. Output measures between the United Kingdom and Denmark are negatively correlated and the standard deviation of velocity, instead of being higher in Denmark, is lower. Although these are admittedly crude estimates, it appears that there is likely to be more uncertainty in the monetary system in the United Kingdom than Denmark and shocks to output are not coincident.

107. Of the three trading partners, Sweden is the most promising country for which the issuance of foreign currency denominated debt might help counter Danish output fluctuations. The correlation of GDP growth rates, while not high, is about 0.2 and the standard deviation of the velocity measure is slightly higher in Denmark than in Sweden. This corresponds to a configuration of economic conditions that would marginally favor a positive amount of foreign debt denominated in Swedish krona.

Table III-4. Various Indicators of Output Correlation

	Standard deviation of own GDP			Standard deviation of trading partners' GDP			Correlation of own GDP with trading partners' GDP 1/			Correlation of own GDP with Germany's		
	1970-97	1970-83	1984-97	1970-97	1970-83	1984-97	1970-97	1970-83	1984-97	1970-97	1970-83	1984-97
USA	2.25	2.74	1.71	1.58	1.97	0.87	0.61	0.68	0.73	0.34	0.70	-0.01
United Kingdom	2.31	2.58	2.05	1.47	1.89	0.92	0.56	0.66	0.46	0.29	0.69	-0.06
Austria	1.96	2.46	1.21	1.59	1.96	1.08	0.79	0.83	0.61	0.51	0.76	0.49
Belgium	2.21	2.82	1.42	1.44	1.85	0.91	0.85	0.82	0.92	0.53	0.73	0.51
Denmark	1.88	2.28	1.45	1.43	1.77	0.98	0.54	0.67	0.25	0.37	0.73	0.03
France	1.68	1.79	1.43	1.51	1.95	0.93	0.85	0.89	0.87	0.48	0.80	0.38
Germany 1/	2.75	2.25	3.21	1.52	1.85	1.06	0.49	0.92	0.23	1.00	1.00	1.00
Italy	2.25	2.82	1.33	1.51	1.94	0.87	0.73	0.68	0.89	0.39	0.74	0.20
Netherlands	1.66	2.15	1.02	1.59	2.01	1.06	0.82	0.89	0.66	0.60	0.82	0.48
Norway	1.77	1.79	1.78	1.50	1.84	1.15	0.22	0.36	0.01	0.11	0.43	-0.08
Sweden	1.93	1.95	1.96	1.41	1.79	0.92	0.54	0.38	0.90	0.21	0.34	0.16
Japan	2.50	2.90	1.88	1.59	2.07	0.96	0.54	0.65	0.19	0.33	0.72	0.09
Finland	3.36	2.75	3.82	1.54	1.69	1.32	0.63	0.45	0.81	0.20	0.41	0.16
Greece	3.10	3.80	1.85	1.67	1.97	1.12	0.59	0.57	0.43	0.43	0.68	0.44
Ireland	3.12	3.37	2.53	1.55	1.93	1.10	0.42	0.57	0.27	0.43	0.50	0.36
Portugal	3.38	4.14	2.19	1.53	1.89	1.14	0.80	0.89	0.57	0.50	0.86	0.33
Spain	2.24	2.67	1.80	1.59	2.03	0.96	0.71	0.66	0.87	0.38	0.47	0.38
Average	2.37	2.66	1.92	1.53	1.90	1.02	0.63	0.68	0.57	0.42	0.67	0.29

Sources: OECD, Economic Outlook, December 1997; and IMF, World Economic Outlook databank.

1/ Based on data for countries that together account for at least 95 percent of Denmark's trade. Their weights are based on trade in goods with Denmark
2/ West Germany.

108. The results for the EU11 show a negative correlation of output over the last nine years and slightly higher velocity variation: also not particularly promising.[61] However, given the possible positive outcome for Sweden and the fact that the foreign debt was denominated predominantly in deutsche mark and is now denominated almost exclusively in euro, these three sets of data will be used for the subsequent analysis.

109. Of course, the examination of correlations of these output and velocity measures does not truly correspond to the model which relates the relative size and sign of *shocks* to output and velocity. Thus, the next step is to get some notion as to the relation between the country specific and common shocks to output and velocity. This is done in a two-step process. First, for each trading partner, a vector autoregression (VAR) is fit using real output and velocity data from each of the two countries, Denmark and one of its trading partners. This VAR provides white noise residuals representing "shocks" to output and (inverse) velocity.[62] However, these residuals will represent *all* that is unpredictable about output and velocity dependent on lagged values of these variables from both countries. To obtain the country-specific and common components of these residuals, a simple factor model is assumed in which the residuals have one "common" factor and an orthogonal error term. The factor loading (or coefficient on the common factor) represents the weight of the common shock in the total shock and the error term represents the idiosyncratic portion, or the country specific component. This deconstruction will allow the calculation of the relative variances of the shocks included in the equation above.

110. Consider the country which is most favorable for the hypothesis—Sweden. Before beginning to specify the appropriate time-series Vector Autoregression, unit root tests are run on natural logarithms of the underlying data series of real output and inverse velocity for Denmark and Sweden to determine whether the data series, in levels, are stationary. Using a standard Dickey-Fuller test both series reject the hypothesis of no unit root at less than a 5 percent significance level. An augmented Dickey-Fuller test is then used to determine the number, s, of lagged differences of the series, Δy_t and $\Delta\alpha_t$, that make the error terms white noise. Even though these tests are run on each of the four series separately, the exercise provides an initial estimate of the number of lagged variables to be used in the vector autoregression. For each series, an ADF test shows that four lags of Δy_t and $\Delta\alpha_t$ for both Denmark and Sweden are jointly statistically significant and that the resulting residuals satisfy the characteristics of white noise. Thus, the VAR model estimated for Δy_t separately involves the joint estimation of the following two equations.

$$\Delta y_t^{Dk} = \delta_0 + \sum_{i=1}^{4} \delta_i \Delta y_{t-i}^{Dk} + u_t^{Dk}$$

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[61] The EU11 includes Germany so the results cannot be viewed as unrelated to those of Germany.

[62] Recall the model is in terms of inverse velocity as is the empirical work in this section.

$$\Delta y_t^{Sw} = \delta_0 + \sum_{i=1}^{4} \delta_i \Delta y_{t-i}^{Sw} + u_t^{Sw}$$

111. As well, a similar two equations are estimated for inverse velocity, $\Delta\alpha_t$, for Denmark and Sweden. Tables 5 and 6 show the parameter estimates and a set of test statistics, testing the adequacy of the VAR representation. For inverse velocity only the first and fourth lags in each equation are necessary to obtain white noise residuals. Recall that the purpose of the VAR is to obtain residuals which represent the (total) shocks to the two series so as to decompose the shocks into a common and idiosyncratic component. Thus, the focus is on tests that assure that the residuals are random, exhibit no autocorrelation, and that the variance of the residuals also exhibit no autocorrelation (i.e., there is no autoregressive conditional heteroscedasticity (ARCH) present). As can be seen from Tables III-5 and III-6, the residuals satisfy these criteria. The only potential issue is whether the residuals are normally distributed since the residuals from the Danish real GDP equation fail that test.[63] This could be an issue since both techniques used below to perform the factor analysis assume that each pair of data series are bivariate normally distributed (principal factors technique) or are multivariate normally distributed (maximum likelihood technique). Though the numerical results are somewhat sensitive to the technique, the two techniques give qualitatively similar results.

112. The next step is to use the residuals from the VAR and decompose them into a common and idiosyncratic component. This is done through factor analysis on the residuals of all four equations.

$$u_t^i = b_i \cdot F + e_t^i$$

where i represents the four residual series, Danish output, Swedish output, Danish inverse velocity, and Swedish inverse velocity. The factor "loading," b_i, in the equation above represents the correlation of the residual from the ith equation with the common (single) factor. From the estimates of b_i and the (random) factor, F, underlying the processes generating the residuals, the variance of the common component can be calculated as var(b_i F) and the variance of residuals from the factor equation, var(e_i), represent the idiosyncratic shocks. Table III-7, panel A, shows the variance of the common component and idiosyncratic component for the Danish and Swedish case.

113. Using these estimates representing the common and idiosyncratic shocks to output and inverse velocity, equation (2) above can be use to determine whether the use of foreign debt denominated in Swedish krona would provide an optimal hedge for output risk. From equation (2), the issuance of foreign debt would be optimal if the term in brackets is positive and lending in the foreign currency would be the appropriate policy if the term is negative.

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[63] The endogeneous variable, the difference of logged real Danish GDP, does not reject the normality test.

Table III-5. Denmark: VAR Results for Denmark and Sweden

Equation for Real Denmark GDP

Variable	Coefficient	Std.Error	t-value	t-prob
Constant	0.0121	0.0038	3.148	0.0026
Denmark:				
diff y(t-1)	-0.5423	0.1299	-4.175	0.0001
diff y(t-2)	-0.5885	0.1375	-4.280	0.0001
diff y(t-3)	-0.4054	0.1385	-2.928	0.0049
diff y(t-4)	0.2495	0.1284	1.944	0.0568
Sweden:				
diff y(t-1)	0.0908	0.1349	0.674	0.5033
diff y(t-2)	0.1263	0.1367	0.924	0.3595
diff y(t-3)	0.1294	0.1335	0.969	0.3363
diff y(t-4)	0.1653	0.1324	1.249	0.2167

Note: sigma = 0.02043; RSS = 0.02419.

Equation for Real Sweden GDP

Variable	Coefficient	Std.Error	t-value	t-prob
Constant	0.0036	0.0027	1.370	0.1760
Denmark:				
diff y(t-1)	0.0582	0.0898	0.648	0.5197
diff y(t-2)	0.0512	0.0951	0.539	0.5919
diff y(t-3)	0.0903	0.0957	0.943	0.3494
diff y(t-4)	-0.0293	0.0888	-0.331	0.7421
Sweden:				
diff y(t-1)	-0.2713	0.0932	-2.909	0.0051
diff y(t-2)	-0.2413	0.0945	-2.552	0.0134
diff y(t-3)	0.2433	0.0923	-2.636	0.0107
diff y(t-4)	0.7418	0.0915	8.104	0.0000

Note: sigma = 0.01412; RSS = 0.01157.

Selected Tests

F-test on all regressors except constant: F(16,114) = 121.81 [0.0000] **
Denmark GDP AR(1-5): F(5,53)=0.6935 [0.6306]
Sweden GDP AR(1-5): F(5,53)=0..8835 [0.4987]
Denmark GDP ARCH(4): F(4,50)=0.3100 [0.8700]
Sweden GDP ARCH(4): F(4,50)=0.9814 [0.4262]
Denmark GDP Normality: Chi^2(2) = 27.755 [0.0000]**
Sweden GDP Normality: Chi^2(2)=0.59753 [0.7417]
Vector AR (1-5): F(20,94)=0.7536 [0.7604]
Vector normality: Chi^2(4)= 28.988 [0.0000]**

Table III-6. Denmark: VAR Results for Denmark and Sweden

Equation for Inverse Velocity Denmark

Variable	Coefficient	Std.Error	t-value	t-prob
Constant	0.0008	0.0045	0.181	0.8569
Denmark:				
diff v(t-1)	-0.1638	0.0970	-1.689	0.0963
diff v(t-4)	0.6160	0.0942	6.542	0.0000
Sweden				
diff v(t-1)	-0.0227	0.1065	-0.213	0.8322
diff v(t-4)	-0.0484	0.1043	-0.464	0.6443

Note: sigma = 0.03669; RSS= 0.08345.

Equation for Inverse Velocity Sweden

Variable	Coefficient	Std.Error	t-value	t-prob
Constant	-0.0029	0.0043	-0.662	0.5101
Denmark:				
diff v(t-1)	-0.0517	0.0932	-0.555	0.5807
diff v(t-4)	-0.0466	0.0905	-0.515	0.6085
Sweden:				
diff v(t-1)	-0.3079	0.1023	-3.010	0.0038
diff v(t-4)	-0.5795	0.1002	5.782	0.0000

Note: sigma = 0.03525; RSS = 0.07704.

Selected Tests

F-test on all regressors except constant: F(8,122) = 21.294 [0.0000] **
Denmark inverse velocity AR(1-5): F(5,57)=1.7751 [0.1326]
Swedish inverse velocity AR(1-5): F(5,57)=0.5657 [0.7258]
Denmark inverse velocity ARCH(4): F(4,54)=1.8537 [0.1320]
Swedish inverse velocity ARCH(4): F(4,54)=0.1.8182 [0.1387]
Denmark inverse velocity Normality: Chi^2(2) = 0.8285 [0.6608]
Swedish inverse velocity Normality: Chi^2(2)=0.4407 [0.8022]
Vector AR (1-5): F(20,102)=0.8811 [0.6106]
Vector normality: Chi^2(4)= 1.3081 [0.8600]

Table III-7. Denmark: Variances of Common and Idiosyncratic Shocks

Factor analysis method	Panel A Denmark and Sweden			Panel B Denmark and EU11			Panel C Denmark and Germany		
	Factor loading b(i)	Variance F*b(i)	Variance e(i)	Factor loading b(i)	Variance F*b(i)	Variance e(i)	Factor loading b(i)	Variance F*b(i)	Variance e(i)
Maximum Likelihood:									
Denmark: output	0.7708	0.41694	0.39456	0.6938	0.39847	0.38598	0.8555	0.56065	0.53168
Denmark: inverse velocity	-0.6540	0.30010	0.27094	-0.0386	0.00123	0.00178	-0.5759	0.25402	0.23264
Bracketed term (equation 2)		-0.00544			0.00023			-0.00463	
Principal Components:									
Denmark: output	0.5957	0.45061	0.43570	0.8194	0.51379	0.49672	-0.5970	0.19267	0.17877
Denmark: inverse velocity	-0.5596	0.42328	0.39769	-0.3438	0.09043	0.08400	0.5724	0.17713	0.15601
Bracketed term (equation 2)		-0.00521			0.00176			-0.00161	

Source: Staff estimates.

Using the estimates in Table III-6 results in a negative number for this term, -0.00544, indicating that issuing foreign debt in Swedish kroner would not be optimal and, in fact, lending Swedish kroner would be preferred. Using the principal factors technique, which does not impose a multinominal distributional assumption, results in the number –0.00521 for the term from equation (2). These results derive from the Danish economy being relatively more sensitive to common shocks in velocity and idiosyncratic shocks to output rather than the reverse.

114. A similar exercise is performed for the EU11. Quarterly data for real output and the components of velocity are available from first quarter 1990 from Eurostat. Using the Euro area data for the logarithm of output and inverse velocity shows that both series have unit roots. An augmented Dickey-Fuller test is used to detect an initial estimate of the number of lagged variables to include in the VAR analysis. Unlike the Swedish data, only one lag of output is found to be marginally significant in these tests and is used to estimate VARs of output. For the inverse velocity equation four lags were used although a more parsimonious model appears sufficient to generate white noise error terms. Estimates of the parameters of the VAR and standard test statistics are included in Tables III-8 and III-9.

115. The residuals from the estimated VAR are then used in the factor analysis to decompose the total shock into a common component and an idiosyncratic component. These results are included in Table III-7, panel B. The configuration of the variances of the shocks in equation (2) shows that foreign debt denominated in euro would aid in hedging output fluctuations vis-a-vis the euro area. That is, the term within brackets in equation (2) is positive, though very small (0.00023) implying that an outstanding foreign debt of about 1 percent of GDP would be optimal. It is interesting to note that the factor loading on the residuals from the VAR equation for Danish inverse velocity is close to zero suggesting that shocks to velocity are unrelated to the underlying factor driving the shock processes for the other variables. Using the principal components technique, the bracketed term is slightly larger and negative, -0.00176, suggesting that, as in the case of Sweden, issuing foreign debt would not be useful.

116. Lastly, the same exercise is complete for Germany, with the VAR results in Tables III-10 and III-11 and the construction of the relevant variables in Panel C of Table III-7. Again, the constructed variable of interest (the bracketed term in equation 2) is negative suggesting that using foreign debt as an output hedge relative to Germany is not advisable. The magnitude of the derived variable is smaller than for Sweden, as the initial analysis would have also suggested. The maximum likelihood technique and the principal factors technique give numbers that are both negative and the same order of magnitude, although they would imply that Denmark should lend in deutsche marks to Germany in an amount varying from 14 percent of GDP to 22 percent of GDP, i.e., have net assets denominated in deutsche mark to hedge output risk.

Table III-8. Denmark: VAR Results for Denmark and EU11

Equation for Real Denmark GDP

Variable	Coefficient	Std.Error	t-value	t-prob
Constant	0.0098	0.0046	2.108	0.0452
Denmark:				
diff y(t-1)	-0.4000	0.1639	-2.440	0.0221
diff y(t-2)	-0.3390	0.1795	-1.889	0.0706
diff y(t-3)	-0.3369	0.1819	-1.853	0.0758
diff y(t-4)	0.4831	0.1674	2.887	0.0079
EU11:				
diff y(t-1)	0.3350	0.4339	0.772	0.4473

Note: sigma =0.01427; RSS= 0.005093

Equation for Real EU11 GDP

Variable	Coefficient	Std.Error	t-value	t-prob
Constant	0.0014	0.0014	0.986	0.3335
Denmark:				
diff y(t-1)	0.0766	0.0503	1.523	0.1402
diff y(t-2)	0.1148	0.0550	2.086	0.0473
diff y(t-3)	0.0796	0.0558	1.427	0.1659
diff y(t-4)	0.0299	0.0513	0.582	0.5656
EU11:				
diff y(t-1)	0.1766	0.1331	1.327	0.1963

Note: sigma = 0.004377; RSS=0.0004788

Selected Tests

F-test on all regressors except constant: F(10,48) = 10.182 [0.0000] **
Denmark GDP AR(1-3): F(3,22)=0.3368 [0.7989]
EU11 GDP AR(1-3): F(3,22)=0.5263 [0.6688]
Denmark GDP ARCH(3): F(3,19)=0.3476 [0.7913]
EU11 GDP ARCH(3): F(3,19)=0.5286 [0.6680]
Denmark GDP Normality: Chi^2(2) = 1.5443 [0.4630]
EU11 GDP Normality: Chi^2(2)=5.0694 [0.0793]
Vector AR (1-3): F(30,35)=0.7468 [0.7910]
Vector normality: Chi^2(4)= 8.6359 [0.0709]

Table III-9. Denmark: VAR Results for Denmark and EU11

Equation for Denmark Inverse Velocity

Variable	Coefficient	Std.Error	t-value	t-prob
Constant	-0.0099	0.0068	-1.449	0.1614
Denmark:				
diff v(t-1)	-0.2587	0.2023	-1.279	0.2143
diff v(t-2)	-0.1135	0.1897	-0.598	0.5559
diff v(t-3)	-0.2973	0.1813	-1.640	0.1153
diff v(t-4)	0.1859	0.1829	1.016	0.3207
EU11:				
diff v(1-1)	1.4166	0.5449	2.599	0.0164
diff v(t-2)	0.0077	0.6146	0.013	0.9901
diff v(t-3)	1.2243	0.5886	2.080	0.0494
diff v(t-4)	-0.9928	0.6185	-1.605	0.1227

Note: sigma=0.02905; RSS=0.01857

Equation for EU11 inverse velocity

Variable	Coefficient	Std.Error	t-value	t-prob
Constant	0.0014	0.0021	0.698	0.4925
Denmark:				
diff v(t-1)	-0.0362	0.0622	-0.581	0.5673
diff v(t-2)	0.0396	0.0584	0.679	0.5041
diff v(t-3)	-0.0005	0.0558	-0.010	0.9925
diff v(t-4)	-0.1153	0.0563	-2.048	0.0527
EU11:				
diff v(1-1)	0.3399	0.1677	2.027	0.0550
diff v(t-2)	-0.0343	0.1891	-0.181	0.8577
diff v(t-3)	-0.0231	0.1811	-0.128	0.8996
diff v(t-4)	0.2679	0.1903	1.408	0.1732

Note: sigma=0.008939; RSS=0.001758

Selected Tests

F-test on all regressors except constant: F(16,42) = 2.2786 [0.0167] **
Denmark inverse velocity AR(1-3): F(3,19)=2.7321 [0.0724]
EU11 inverse velocity AR(1-3): F(3,19)=2.0449 [0.1417]
Denmark inverse velocity ARCH(3): F(3,16)=0.7397 [0.5437]
EU11 inverse velocity ARCH(3): F(3,16)=0.1001 [0.9588]
Denmark inverse velocity Normality: Chi^2(2) = 1.5667 [0.4569]
EU11 inverse velocity Normality: Chi^2(2)=8.5357 [0.0140]*
Vector AR (1-3): F(12,30)=3.5604 [0.0023]**
Vector normality: Chi^2(4)= 10.042 [0.0397]*

Table III-10. Denmark: VAR Results for Denmark and Germany

Equation for Real Denmark GDP

Variable	Coefficient	Std.Error	t-value	t-prob
Constant	0.01504	0.004643	3.240	0.0020
Denmark:				
diff y(t-1)	-0.56816	0.1249	-4.550	0.0000
diff y(t-2)	-0.55452	0.1305	-4.250	0.0001
diff y(t-3)	-0.48790	0.1287	-3.791	0.0004
diff y(t-4)	0.30796	0.1242	2.479	0.0162
Germany:				
diff y(t-1)	-0.04542	0.1850	-0.245	0.8070
diff y(t-2)	-0.02600	0.1829	-0.142	0.8875
diff y(t-3)	0.05016	0.1813	0.277	0.7831
diff y(t-4)	-0.03459	0.1836	-0.188	0.8513

Note: sigma = 0.02161; RSS = 0.02616.

Equation for Real Germany GDP

Variable	Coefficient	Std.Error	t-value	t-prob
Constant	0.006543	0.002058	3.179	0.0024
Denmark:				
diff y(t-1)	-0.04371	0.05535	-0.790	0.4330
diff y(t-2)	-0.08242	0.05784	-1.425	0.1597
diff y(t-3)	-0.05697	0.05705	-0.999	0.3223
diff y(t-4)	-0.04083	0.05506	-0.742	0.4614
Germany:				
diff y(t-1)	-0.06152	0.08202	-0.750	0.4564
diff y(t-2)	-0.07875	0.08109	-0.971	0.3356
diff y(t-3)	0.07232	0.08036	0.900	0.3720
diff y(t-4)	0.14136	0.08139	1.737	0.0879

Note: sigma = 0.009580; RSS = 0.005140.

Selected Tests

F-test on all regressors except constant: F(16,110) = 7.6944 [0.0000] **
Denmark GDP AR(1-5): F(5,51) = 0.7154 [0.6148]
Germany GDP AR(1-5): F(5,51) = 0.5672 [0.7247]
Denmark GDP ARCH(4): F(4,48) = 0.2111 [0.9311]
Germany GDP ARCH(4): F(4,48) = 0.8581 [0.4959]
Denmark GDP Normality: Chi^2(2) = 25.47 [0.0000] **
Germany GDP Normality: Chi^2(2) = 6.6941 [0.0352]
Vector AR (1-5): F(20,90) = 0.8228 [0.6804]
Vector normality: Chi^2(4) = 32.641 [0.0000] **

Table III-11. Denmark: VAR Results for Denmark and Germany

Equation for Denmark Inverse Velocity

Variable	Coefficient	Std.Error	t-value	t-prob
Constant	0.002752	0.004428	0.621	0.5368
Denmark:				
diff v(t-1)	-0.1933	0.1072	-1.804	0.0764
diff v(t-2)	-0.0781	0.1076	-0.726	0.4710
diff v(t-3)	-0.1468	0.1031	-1.423	0.1599
diff v(t-4)	0.5482	0.1011	5.423	0.0000
Germany:				
diff v(1-1)	-0.1464	0.1451	-1.009	0.3170
diff v(t-2)	-0.1816	0.1454	-1.249	0.2165

Note: sigma = 0.03567; RSS = 0.07508.

Equation for Germany Inverse Velocity

Variable	Coefficient	Std.Error	t-value	t-prob
Constant	0.002259	0.003666	0.616	0.5401
Denmark:				
diff v(t-1)	0.01860	0.08872	0.210	0.8347
diff v(t-2)	-0.003529	0.08910	-0.040	0.9685
diff v(t-3)	0.02571	0.08539	0.301	0.7645
diff v(t-4)	-0.007444	0.08369	-0.089	0.9294
Germany:				
diff v(1-1)	-0.06476	0.12013	-0.539	0.5919
diff v(t-2)	-0.42761	0.12035	-3.553	0.0008

Note: sigma = 0.02953; RSS = 0.05146.

Selected Tests

F-test on all regressors except constant: F(12,116) = 6.3844 [0.0000] **
Denmark inverse velocity AR(1-5): F(5,54) = 1.8038 [0.1276]
Germany inverse velocity AR(1-5): F(5,54) = 0.8639 [0.5114]
Denmark inverse velocity ARCH(4): F(4,51) = 1.6591 [0.1739]
Germany inverse velocity ARCH(4): F(4,51) = 2.4951 [0.0543]
Denmark inverse velocity Normality: Chi^2(2) = 0.9633 [0.6178]
Germany inverse velocity Normality: Chi^2(2) = 21.301 [0.0000] **
Vector AR (1-5): F(20,96) = 0.9438 [0.5351]
Vector normality: Chi^2(4) = 22.613 [0.0002] **

117. Perhaps the best way of interpreting the results is to view them as circumstantial evidence against using foreign-denominated debt to hedge output fluctuations. Only in one case, for the euro, would one conclude that the use of foreign debt may be marginally useful for Denmark as a hedge to output fluctuations—and even then the use would be economically insignificant. The relative magnitudes of common and idiosyncratic components of output and inverse velocity shocks with respect to Sweden and Germany show that use of foreign debt denominated in either Swedish kroner or deutsche marks would not help to hedge output variations. However, it is important to exercise caution in interpreting these results because the magnitudes of the bracketed numbers are very close to zero and they are constructed using econometric estimates, which are themselves subject to estimation error (particularly given the relatively small samples). Thus, these numerical outcomes may not be statistically significantly different from zero.

118. Having examined the underlying correlations of output and velocity, however, one might have suspected, *a priori*, that using foreign-denominated debt may not be particularly useful for hedging output risk. Thus, the numerical results are not surprising since they embody the intuition that Denmark's output shocks are not correlated with those of its trading partners and its monetary system is relatively more stable than that of these same trading partners (the domestic money demand shocks are relatively smaller than those in the trading partner countries). These results lead to the conclusion that, from the perspective of hedging output risk with foreign debt, the elimination of foreign debt planned by the Danish government is a sensible goal. Thus, although the policy debate has centered on other reasons for the elimination of foreign debt, the analysis presented here adds yet another reason—one in which the potentially positive effects of foreign debt on the real economy are taken into consideration.

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