WHICH MONETARY REGIME FOR EUROPE?:
A Quantitative Evaluation.

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Which Monetary Regime for Europe?:
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There is a large and growing literature on the benefits and costs of moving to a single currency in Europe. Much of the literature is theoretical in nature with very little empirical evaluation of the magnitudes of effects. This paper places some quantitative magnitudes on the scale of some issues in European monetary integration. It uses the European version of the MSG2 multi-country model to evaluate the variance of a number of European variables in the face of shocks to money markets, fiscal policy and total factor productivity, under three alternative European monetary regimes: the current European monetary system; the impending European Monetary Union with a European central bank setting monetary policy; and a system of floating exchange rates within Europe. For each type of shock we consider the adjustment to global shocks, European wide shocks, shocks in Germany and shocks in Europe excluding Germany. Within the constraints of each monetary regime we allow any unconstrained monetary instruments to be set either cooperatively between European countries or non-cooperatively where each country is allowed to set their policy instruments to maximize an objective function. We find that no monetary regime consistently dominates for all shocks and regimes are ranked differently across European economies for the same shock. Abstracting from the serious question of policy credibility, this suggests that maintaining some flexibility in the setting of monetary policy in countries could potentially be invaluable to facilitate smooth adjustment to global, regional and country specific shocks.

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1. Introduction

The debate about the appropriate monetary regime for Europe has generated a large literature on the advantages and disadvantages of a single currency in Europe. The benefits of monetary union have been largely spelled out and widely examined[1]. The benefits include a reduction in transactions costs associated with use of multiple currencies, greater efficiency through the reduction of uncertainty related to fluctuations in currencies, and increased credibility of monetary policy within Europe. The major costs of a single currency are related to the ability of member countries to adjust to a variety of shocks. Eichengreen (1992) argues that the benefits appear to be quantitatively small, however less has been done in directly measuring the costs in terms of the implications for the variance of key variables in the face of a variety of shocks[2]. Monetary Union is to formally begin on 1 January 1999. Of the fourteen member countries of the European Union only Sweden, Britain, Denmark and Greece will not initially join. What types of shocks in Europe and in the world economy, will place strains on the new European Monetary Union? In this paper we extend the techniques used in McKibbin and Sachs (1991) and Henderson and McKibbin (1993) to focus on the consequences of a variety of shocks for three possible alternative monetary regimes for Europe.

The regimes considered are set out in greater detail in the following section. They are: a stylized representation of the current exchange rate mechanism (ERM) of the European Monetary System (EMS) in which the exchange rates are effectively pegged to the German mark; the

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[1] See for example Eichengreen (199: chapter 2) and De Grauwe (1992:chapter 3).

[2] Studies by the EEC (1990); Masson and Symansky (1993) and Minford, Rastogi and Hughes-Hallett (1992) have used large scale models in an attempt to quantify the costs of monetary union in terms of adjustment to a range of shocks. Other studies by Hughes-Hallett and Vines (1992) and Fratianni and von Hagen (1992) have used small theoretical models with calibrated parameters.

European Monetary Union (EMU) in which the currencies of individual countries are replaced by a single currency which is controlled by a single European central bank; and a system of floating exchanges rates within Europe where each country is able to credibly use domestic monetary policies to reach domestic policy goals. Each regime implies a set of restrictions on the monetary and fiscal policies of each country. In this paper we only focus on the restriction on monetary policy and leave the issues of fiscal policy to another paper.

For each regime, we evaluate the variance of a number of variables in response to 3 different types of shocks and 4 variants of these shocks. The 3 types of shocks are shocks to money demand, shocks to fiscal spending (or an aggregate demand shock); and shocks to total factor productivity. These shocks are presumed to be temporary, however, the techniques applied in this paper could also usefully be applied to permanent shocks. The 4 variants of each of these shocks are: shocks to all industrial economies (called global shocks); shocks to all countries currently members of the EMS; shocks to Germany alone; and shocks to all member countries of the EMS except Germany. These shocks are discussed in more detail in section 2.

The basic framework for this study is the McKibbin-Sachs Global Model[3] which has been used for studying a number of global issues. A number of important features make the MSG2 model useful for considering the consequences of alternative monetary regimes in Europe. First, the long run of the world economy is well determined, being driven by a Solow-Swan neoclassical growth model[4], with exogenous technical progress and population growth in different economies.

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[3] Complete documentation of the model including the theoretical derivation and evaluation of the tracking performance of the model can be found in McKibbin and Sachs (1991). The current specification of the model used in this study can be found in McKibbin (1993).

[4] See Solow (1970) and Swan (1956).

In the short run, however, the dynamics of the global economy towards this growth path are determined by a number of Keynesian style rigidities in the goods and labor markets. In addition, important stock-flow relations are observed in the model. Investment leads to physical capital accumulation, fiscal deficits lead to accumulation of government debt, current account deficits lead to the accumulation of foreign claims against domestic production. Intertemporal budget constraints are imposed so that all outstanding stocks of assets must be ultimately serviced.

Another important feature of the model is that asset markets are efficient in the sense that asset prices are determined by a combination of Intertemporal arbitrage conditions and rational expectations.[5] Asset prices are directly tied down by the imposition of intertemporal budget constraints in the model. The long run behavior of the model depends on stock equilibrium; asset prices stabilize in real terms, once desired ratios of asset stocks to GDP are reached.

Under the assumption of flexible exchange rates and high capital mobility, the short run of the model can be understood using the intuition provided by the basic Mundell-Fleming model.[6] The key difference is that the future paths of the global economy are important in the short run because of the forward-looking behavior in asset and goods markets.

As well as providing a well-defined theoretical framework, it is shown in McKibbin and Sachs (1991) that this model can reasonably account for the global experience of the 1980s. As already mentioned, one major advantage of using theoretical models to analyze problems is that a model provides insights into how to think about certain issues. If a model can be both theoretically constrained and empirically based then there is greater likelihood that the insight gained from the

[5] The assumption of wage stickiness and perfectly flexible asset prices gives exchange rate overshooting as in Dornbusch (1976).

[6] See Mundell (1963) and Fleming (1962).

analysis will also be of relevance.

It is clear that the results from a study such as this, will be sensitive to the assumptions of the model, as well as the parameter values of the model and the way in which the scenarios are interpreted. We have undertaken a number of sensitivity tests of the model and as would be expected, the magnitude of results depend on the values of parameter. Despite this sensitivity, the qualitative results are relatively robust and highlight key channels that are potentially relevant. A richly specified simulation model allows important channels of adjustment to be incorporated that analytical models preclude. In addition to the qualitative insights, the quantitative results are also relevant in that they are the outcome of many years of econometric research, as well as a large number of tracking exercises using the model. Because of these considerations, no sensitivity analysis is undertaken in this paper.

This paper is set out as follows. Section 2 outlines the regimes that are evaluated in the paper. Section 3 presents an outline of the model that forms the basis of this study. The techniques used to evaluate the regimes are discussed in section 4. The results are presented in section 5. The primary focus of the paper is the variance of key variables given a postulated variance in the shocks. However, we also examine a number of impulse response functions to illustrate how the adjustment of economies are importantly affected by the assumption of the monetary regime in Europe. Finally, a summary and conclusion are presented in section 6.

2. The Regimes

A range of regimes are set out in table 1. If fiscal and monetary policies are set strategically by countries then each regime implies a different set of restrictions on the monetary and fiscal

policies of each country. A stylized representation of the restrictions is presented in table 1. In reading this table note that there is a column for the regime, a column for the rules when only monetary policy is

Table 1: Policy Assignment Under Each Monetary Regime

Regime	*Monetary Policy Only*	*Monetary and Fiscal Policy*
EMS:		
noncooperative	$\{M^i\}$ *targets* $\{E^i\}$	$\{M^i\}$ *targets* $\{E^i\}$, $\{G^i\}$ *targets* $\{W^i\}$
	$\{M^G\}$ *targets* $\{W^G\}$	$\{M^G, G^G$ *targets* $\{W^G\}$
cooperative	$\{M^i\}$ *targets* $\{E^i\}$	$\{M^i\}$ *targets* $\{E^i\}$
	$\{M^G\}$ *targets* $\{W^E\}$	$\{M^G, G^i, G^G\}$ *targets* $\{W^E\}$
EMU:		
noncooperative	$\{M^i\}$ *exactly targets* $\{E^i\}$	$\{M^i\}$ *exactly targets* $\{E^i\}$,$\{G^i\}$ *targets* $\{W^i\}$
	$\{M^G\}$ *targets* $\{W^E\}$	$\{M^G\}$ *targets* $\{W^E\}$,$\{G^G\}$ *targets* $\{W^G\}$
cooperative	$\{M^i\}$ *exactly targets* $\{E^i\}$	$\{M^i\}$ *exactly targets* $\{E^i\}$
	$\{M^G\}$ *targets* $\{W^E\}$	$\{M^G, G^i, G^G\}$ *targets* $\{W^E\}$
Float:		
noncooperative	$\{M^i\}$ *targets* $\{W^i\}$	$\{M^i, G^i\}$ *targets* $\{W^i\}$
	$\{M^G\}$ *targets* $\{W^G\}$	$\{M^G, G^G\}$ *targets* $\{W^G\}$
cooperative	$\{M^i, M^G\}$ *targets* $\{W^E\}$	$\{M^i, M^G, G^i, G^G\}$ *targets* $\{W^E\}$

M^i = *country i monetary instrument*

M^G = *German monetary instrument*

W^i = *country i targets*

W^G = *German targets*

W^E = *European targets* $= \sum_{j=1}^{i} a^j W^j + a^g W^G$

chosen by optimizing policymakers and a column for the rules for when both monetary and fiscal policy are chosen by optimizing policymakers. Under each of the three regimes in column 1, there are two assumptions about how policymakers interact when choosing policy. One is the assumption that policymakers set policy in a non-cooperative fashion, taking as given the rules of the other policymakers and then doing the best they can given these rules. The alternative assumption is that policymakers cooperate in setting policies. Note that if only monetary policy is set strategically by policymakers in each country then some of the policy rules are equivalent and strategic play can be ruled out by the nature of the regime. For example consider the EMS which is the first regime listed in the table. When only monetary policy is chosen strategically, the non-German EMS countries are constrained in that their instruments ($\{M^i\}$ in the table) are constrained to target the bilateral exchange rate with the German mark. In a non-cooperative equilibrium, Germany uses its monetary instruments $\{M^G\}$ to target the German objective function (given by $\{W^G\}$). Cooperation implies the same rule for the non-German EMS countries but in this case it is assumed that the German monetary instruments $\{M^G\}$ target the European objective function $\{W^E\}$ which is defined as a weighted average of each country's objective function.

Similarly we can stylize fiscal and monetary policy interactions under noncooperative and cooperative assumptions. Under the EMS regime, again each non-German EMS member uses the monetary instrument to target the bilateral German mark exchange rate. However there is no restriction on fiscal policy, therefore these countries can use fiscal instruments to target their objective function, given the setting of the monetary instrument to maintaining the EMS exchange rate system. Germany now can use both monetary and fiscal instruments to target the German objective function. A cooperative regime for policy given the EMS regime, could be stylized as

Germany and the other EMS countries pooling their instruments (other EMS fiscal policies and German monetary and fiscal policies) to target a European objective function.

With more targets than instruments in each economy, the possibility of a Nash equilibrium is raised and can usefully be explored using the approach in this paper. However, to start with a manageable problem that restricts the number of possible regimes and policy reactions, a number of simplifying assumptions are made for this paper.

We first rule out any strategic choice for fiscal policy. This will be the subject of a another paper. Thus the third column in table 1 is not considered further in this paper. In addition, if the objective function of each government has only one target for monetary policy then the differences between regimes collapse further. For example, the cooperative and non-cooperative policies under the floating exchange rate regime collapse to the same policy rules since each country exactly targets inflation and the assumption of policy being cooperative or non cooperative is irrelevant. However, if both inflation and unemployment were targets and there was only one instrument of monetary policy, then there would be some interesting differences between cooperation and noncooperation in the setting of monetary policy.

We therefore restrict our attention to the case of monetary policy chosen optimally to target the rate of inflation where not violating the regime restrictions. Even this significantly reduced set of possibilities provides some useful insights on regime choice in Europe.

In the remainder of this paper the goal is to choose as simple a setting as possible to limit the large number of cases of shocks, regimes and strategic reactions so as to focus on some key aspects of the question of monetary regime choice in Europe.

With these assumptions, table 1 collapses to three different regimes:

1) the current *European Monetary System* (EMS) in which we assume that monetary policy in each European economy outside Germany adjusts to approximately peg to the German mark exchange rate while Germany targets domestic inflation;

The exact form of the EMS regime for the non-German economies is written as a feedback rule for the stock of money of the following form

$$m_i - m_i^b = -10*(E_U^G - (E_U^G)^b)$$

where m_i is the log of the money supply in country i, E_U^G is the log of the US dollar-DM exchange rate and a superscript b indicates the baseline values of these variables. In this rule if the DM strengthens relative to the US dollar (i.e. E_U^G rises) then monetary policy is tightened in country i;

2) A *European Monetary Union* in which the currencies of individual countries are replaced by a single currency which is controlled by a single European central bank in order to target a weighted average of European inflation;

3) A system of *floating exchanges rates* within Europe with each country choosing monetary policy to target domestic inflation.

It is useful to point out that from the point of view of implementing the EMU in a model, the EMU as described above, is equivalent to having monetary policy in each European country exactly targeting the bilateral exchange rate relative to the German mark and the central bank of Europe choosing German monetary policy to target the weighted average of European inflation.

For diagnostic purposes, we assume that countries outside Europe target the baseline stock of money growth.

3. A Framework for Analyzing the Issues

The basis of this study is the MSG2 multi-country model. Full documentation of the model and an analysis of its properties and tracking performance can be found in McKibbin and Sachs (1991). A summary of its key features are presented in table 1 and the coverage of the model is listed in table 2. A more detailed overview of the model is presented in Appendix 1.

The MSG2 multi-country model is particularly well suited to analyzing the macroeconomic consequences of alternatives monetary regimes in Europe. It is a fully specified dynamic general equilibrium model with careful treatment of stock-flow relations such as the cumulation of investment into capital stocks and the cumulation of fiscal deficits into net asset stocks. Both the short run demand and supply sides of the major economies are incorporated. In the long run, supply is determined by neoclassical growth theory. Secondly, it incorporates a number of financial markets such as share markets and markets for short and long bonds in each of the industrial regions where prices are determined by intertemporal arbitrage relations as well as long run sustainability conditions on fiscal deficits and current account positions. In addition, the assumption of rational expectations in these financial markets as well as some forward looking behavior in real spending decisions means the effects of anticipated policy changes are well handled by this model. Finally the model incorporates separate country models for Germany, the United Kingdom, France, Italy and the rest of the EMS where the exchange rate arrangements of the EMS are explicitly modelled. The model version in this paper consists of The United States, Japan, Germany, United Kingdom, France,

Table 2: Main Features of the MSG2 Model

- both the demand and supply side of the major economies are explicitly modelled;

- demand equations are based on a combination of intertemporal optimizing behavior and liquidity constrained behavior;

- the supply side takes explicit account of imported intermediate goods especially the role of imported capital goods in investment in economies;

- major flows such as physical investment, fiscal deficits and current account imbalances cumulate into stocks of capital, government debt and net external debt which in turn change the composition and level of national wealth over time.

- Wealth adjustment determines stock equilibrium in the long run but also feeds back into short-run economic conditions through forward-looking share markets, bond markets and foreign exchange markets.

- Asset markets are linked globally through the high international mobility of capital.

Table 3: Regional Coverage of the MSG2 Model Used in this Paper

Regions (preceded by country code)

(U) United States
(J) Japan
(G) Germany
(K) United Kingdom
(F) France
(I) Italy
(E) Rest of the EMS (denoted REMS)
(C) Canada
(R) Rest of the OECD (denoted ROECD)
(O) oil exporting countries (denoted OPEC)
(L) non-oil developing countries (denoted LDCs)
(B) eastern European economies and the former Soviet Union (denoted EFSU).

Sectors

one good in each country/region

Italy, the Rest of the EMS (denoted REMS)[7], Canada, the Rest of the OECD (denoted ROECD)[8], non-oil developing countries (denoted LDCs)[9], oil exporting countries (denoted OPEC)[10], and eastern European economies including the former Soviet Union[11].

It is important to note that investment and consumption behavior is modelled as a weighted average of intertemporal optimizing behavior (with rational expectations of the future path of the global economy), and backward looking behavior based on current income. Thus expected increases in future productivity or wealth lead to an initial (although quite damped) response of households and firms. Investment is based on the cost of adjustment approach of Lucas (1967) and Treadway (1969) which yields a model with investment partially determined by Tobin's q, along the lines of the work of Hayashi (1982a). A full derivation of the model can be found in McKibbin and Sachs (1991).

Apart from the shocks and underlying model structure, the results also depend on the assumptions about fiscal and monetary reactions in the economies undergoing the shocks and outside these economies. In this paper plausible closures are chosen. For example fiscal policy is assumed to be implemented such that all economies maintain a fixed share of government spending to GDP and adjust taxes to service any changes in debt. The fiscal deficit adjusts endogenously to

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[7] This block consists of Belgium, Denmark, Ireland, and Luxembourg.

[8] This group of countries consists of Australia, Austria, Finland, Iceland, Norway, Portugal, Spain, Sweden, Switzerland and New Zealand.

[9] Non-Oil Developing countries are based on the grouping in the IMF Direction of Trade Statistics.

[10] Oil exporting countries are based on the grouping in the IMF Direction of Trade Statistics.

[11] These countries are Bulgaria, Czechoslovakia, Eastern Germany, Hungary, Poland, Romania, Yugoslavia, and the former USSR.

any changes in real activity or interest rates.

4. A Technique for Evaluating the Regimes

The technique used to evaluate the monetary regimes is based on chapter 9 of McKibbin and Sachs (1991) and the extension in Henderson and McKibbin (1993). The model is used to calculate the steady state variance of a range of variables given the variance of shocks. Rather than follow the approach of the modeling groups reported in Bryant et al (1993) where an historical variance-covariance matrix is used to evaluate regimes we are interested in how each regime handles shocks that are independently drawn and have a standardized variance. We therefore postulate individual shocks each with unit variance and calculate the steady state variance of variables under alternative regimes.

We choose three types of shocks to give a broad evaluation of the regimes. There are a number of papers, including papers by Blanchard and Quah (1992), Bayoumi and Taylor (1992), Bayoumi and Eichengreen (1993) and Weber ( ), that attempt to estimate the nature of shocks in the world and European economies. A similar exercise has been undertaken using the residuals of global econometric models as exploited by the papers in Bryant et. al. (1993). These studies show that aggregate demand, supply and monetary shocks are to a varying degree important. Rather than take a stand on the nature of disturbances historically our approach looks at the implications of individual shocks so that the types of shocks that affect the performance of the regimes can be clearly understood.

For each shock we present 4 variants. This follows from the approach in Henderson and McKibbin (1993) however in that paper we primarily focussed on symmetric versus asymmetric

shocks. This is problematic in a realistic model of the world because there are more than two countries and none of the countries are symmetric in terms of size or structure. To get an insight into whether the regimes perform differently under shocks that are symmetric versus asymmetric, we choose the 4 variants to capture many of the issues that are raised in the earlier work. We first examine shocks that are global in the sense of being the same in each industrial economy. Secondly we examine shocks that are particular to all countries in the EMS. Thirdly we examine shocks that only occur in Germany. An example of this of great relevance is the unification of German in 1989 that illustrates some important characteristics of the three regimes that are crucial for other countries in Europe. The fourth variant is a shock in all of the EMS countries except Germany. It is also important to stress that even symmetric shocks are not exactly symmetric in a realistic empirical model. The shocks are scaled in importantly different ways. The monetary shocks are drawn from a distribution with a variance equal to 1 percent of the demand for money. The demand shock in each country is a change in government spending on goods and services with a variance equal to one percent of each country's GDP. The shock to total factor productivity shock has a variance equal to 1 percent of each country's gross output.

In addition to calculating the variance of key variable we also present some results in the form of impulse response function that indicate the dynamic adjustment following a one period temporary shock.

5. Results

Results for the steady state variance of a number of variables, over a range of countries, for each regime, in response to each variant of each shock are presented in Tables 4 through 6. In these

tables we focus on the variance of GDP, employment, interest rates and inflation under each regime, *relative* to the variance under other regimes, over a range of shocks.

Each table contains results for variables in country order. We first list the variable, then the corresponding regime and the results for the four variants of shocks. The numbers contained in the table are the variance of each shock **relative** to the variance of the regime with the largest variance. Thus the largest variance for each regime for a given variant of shock will be shown by a number 1 in the table. The other two regimes will be less than or equal to 1. Because of the way these relative variances are calculated, comparisons can only be made between each vertical block of three regimes for a given variant of shock. Any regimes that perfectly insulate a variable will contain zeros in a cell.

To clarify how to read these table consider the results for Table 5 which are the results for fiscal shocks. The top left block of results show the relative variance of German GDP, employment, interest rates and inflation under each regime and for each variant of fiscal shock. Now focus on the results for German GDP. The results for GDP are divided into a row for the EMS, a row for the EMU and a row for the floating exchange rate regime. Now take the variant of a global demand shock which is the first column of numbers. These results indicate that the variance of German GDP for a global demand shock is largest under the EMU (i.e. it receives a relative result equal to 1). The variance of German GDP under the EMS is 95% of the variance under the EMU and the variance under the floating exchange rate regime is 92% of the variance for EMU.

a. Monetary Shocks

Now consider in detail the results given in Table 4 for monetary shocks. For each variant

of monetary shock, this table shows that the relative variance of German GDP is zero for each regime. That is, each regime is capable of insulating German GDP from the shock. Note that this is not true for interest rates in Germany although the absolute variance is very small it still shows up as a relative variance. The EMU has 76% of the variance in interest rates as the EMS and the float 90% of the variance of the EMS. Note again that comparisons cannot be made across the variants of shocks since absolute variances are not presented. These are available upon request. For the monetary shocks, the variances are small since each regime can approximately offset the shock. However, this is not the case for the United States and Japan when monetary shocks occur inside these economies, because we have assumed a fixed baseline monetary stock in these countries. Thus monetary shocks in the United States and Japan cause fluctuations in interest rates and real activity. The floating exchange rate regime between these economies and Europe effectively insulate both the United States and Japan from monetary shocks in Europe. Thus the global shocks rank a 1 for the U.S. and Japan whereas the European shocks rank zero across each variable, except of course for the exchange rate (not shown). The exchange rate will vary in order to offset the shock.

For the monetary shocks, it is clear that the type of fixed exchange rate regime in Europe does not matter for the ability of European countries to offset the effects of the shock.

This is the standard theoretical point that fixed exchange rates effectively counteract monetary shocks. As the demand for money rises in a country or a region, the tendency for the exchange rate to appreciate leads to an increase in the supply of money which perfectly accommodates the shocks without secondary consequences. Note that for the EMS regime in the table, there is some more variance in variables relative to other regimes. This occurs because we have modelled the EMS as an inexact pegging of exchange rates to the German mark so there is less than complete adjustment to the monetary shocks. Also note that the floating exchange rate regime is also able to offset the monetary shock. This is less familiar from theoretical models in which a fixed exchange rate usually dominates a floating exchange rate. The difference here is that we have allowed policymakers to optimally adjust monetary policy given the regime constraints. Since they observe the shocks, they can adjust the money supply in the face of a monetary shock. In this case a fixed exchange rate has no advantage over a flexible exchange rate for offsetting monetary shocks.

b. Fiscal/Demand Shocks

We next consider the consequences of aggregate demand shocks that are implemented as a variance in government spending. The results for the steady state variance of a number of variables are contained in Table 5.

For each variant of fiscal shock, Germany is able to maintain an inflation target under both the EMS and floating exchange rate regimes but encounters variance in inflation under the EMU. This occurs because adjustment by the European central bank to changes in German inflation is traded off against changes in the inflation rate of other European economies. Thus variance in German inflation under a German fiscal shock is larger than the variance of German inflation under

a European fiscal shock because the European central bank reacts to the general variance in inflation in Europe implied by the latter shock, but reacts less so to the German shock. This result cannot easily be seen in the table because the results are scaled to be relative within a given variant of shock. Thus the difference in inflation variance between variants of shocks is not able to be calculated from the tables. It will be seen more clearly below where we present some impulse response results.

In terms of the variance of GDP, Germany should prefer a floating exchange rate for a global fiscal shock and a non-German European fiscal shock, whereas Germany should prefer an EMU regime when the variance of shocks are dominated by European-wide or German specific fiscal shocks. Yet in terms of inflation control, Germany should prefer the EMS or a floating exchange rate to an EMU regime because under the former regimes, Germany is able to maintain control over inflation.

This ranking of the regimes for Germany does not follow exactly for other European economies. For example, in terms of minimizing the variance of GDP and employment, the U.K. is better served by a floating exchange rate for each variant of fiscal shock. Similarly France is better off in terms of reduced variance of GDP and employment with a floating exchange rate. For Italy, the EMU dominates other regimes for global shocks but similar rankings to the U.K. and France apply for other fiscal shocks. For the other EMS countries, the ranking is even less clear with the EMU being the dominant region for minimizing the variance of GDP for global and European fiscal shocks.

It is worth focussing in particular on the ranking of each region for the German fiscal shock since this most closely corresponds to the unification of Germany in 1989. Kenen (1992) argues that

Europe would have been better served if the EMU was already in place when the German fiscal shock occurred relative to the costs of maintaining the EMS regime. This is supported by the results for Italy and the other EMS countries but not apparently in the results for the UK and France. To see the reason for this difference consider figure 1 which contains the impulse responses of GDP in Germany, the United Kingdom, France and Italy and figure 2 which contains the results for inflation for the same group of countries.

In each panel of figure 1, results are shown for the percentage deviation of GDP and in figure 2 results are shown for the percentage point deviation of inflation in response to a rise in German fiscal spending of 1 percent of GDP in period 1. Each panel contains results for the indicated country for the three regimes. For example, German GDP rises under each regime although by most in the case of a floating exchange rate. This can best be understood by comparing these results with the EMS regime. In the case of the EMS regime, as output and interest rates rise in Germany, the DM exchange rate tends to appreciate. To offset this inside Europe, countries contract monetary policy by raising interest rates in line with the rise in German interest rates. Thus output contracts in these countries and there is a negative spillover to German output. In each case of the United Kingdom, France and Italy, the rules of the EMS lead to a contraction in GDP. In the case of a more permanent shock in Germany, this would lead to a more severe contraction in these countries. Now compare this outcome with the responses under the EMU regime. Under the EMU, the German fiscal shock tends to initially lower inflation slightly in Germany through a strong DM feeding into consumer prices, but more importantly the shock leads to disinflation in the non-German European economies. This causes the European central bank to relax monetary policy to a degree that causes a rise in GDP in these economies. In comparing the results for GDP or

employment in the non-German economies illustrated, it is clear that output is much higher under an EMU regime that under an EMS regime. In this sense the EMS countries are better off under an EMU. The calculation of variances shown in table 5, gives negative weight to changes in a variable in either direction. In that sense the point made by Kenen (1992) is supported by these results when evaluated in terms of levels of output rather than variation in output.

The results for the floating exchange rate regime illustrate that this regime outperforms the other regimes for the countries apart from Germany in the face of a German fiscal shock. However, the insulation is not perfect as we know from other model based studies of fixed versus flexible exchange rates.

The results for the German specific shock can be contrasted with the results for the European wide fiscal shock. The results for GDP are shown in Figure 3 and for inflation in Figure 4. The results for German GDP are broadly similar to those for the German fiscal shock except that the ranking of regimes has changed because the rest of Europe no longer contracts monetary policy in response to the strong German exchange rate. Indeed the results for non-German inflation under the EMS is quite surprising given the debate about the preference of the EMS over a floating exchange rate for inflation targeting. The reason for the larger change in inflation under the European wide shock is because, given the parameters of the model, the fiscal shocks in non German Europe tend to appreciate these currencies relative the DM. These leads to an expansion of monetary policy which further adds to the demand stimulus from the fiscal shock. Thus although the exchange rate remains relative aligned with the DM, the inflation rate rises relative to the rate in Germany. Although this result is parameter dependent, it illustrates that the EMS does not necessarily imply low inflation variance in European economies relative to Germany. This depends on the nature of

the shock impinging on the economies.

c. Productivity Shocks

Table 6 contains results for the variance of each variable in the case of productivity variance. These results differ from the results for fiscal shocks presented above. For example, Germany should most prefer the EMU for minimizing GDP variance and least prefer the floating exchange rate regime when there are global productivity shocks. A similar ranking holds for European shocks but the EMU dominates for German specific shocks and the EMS for non-German European shocks. In contrast, the United Kingdom does better in the EMS for global and European productivity shocks but the floating exchange rate regime clearly dominates for German specific productivity shocks. This ranking of results is similar for France. A good result for the EMS regime for each productivity shock, except the German productivity shock, is also supported by results for Italy and the other EMS economies although the rankings of EMU and floating exchange rates are reversed in these economies.

In order to more clearly understand the level changes in variable as well as the variance of variable, Figures 5 and 6 present the impulse responses of GDP and inflation for Germany, the United Kingdom, France and Italy for German specific productivity shocks. Figures 7 and 8 present the impulse responses of GDP and inflation for Germany, the United Kingdom, France and Italy for European productivity shocks.

Figure 5 illustrates that a rise in German productivity leads to a rise in German GDP. The

pattern of response of GDP is similar to that of the fiscal shock although the ranking of regimes differ to that of the fiscal shock. The primary reason can be seen from the results for GDP in other European economies. In contrast to the fiscal shock, the rise in productivity in Germany leads to a rise in GDP across Europe. This occurs because the demand shock raises both output and domestic prices which raises short term interest rates. In contrast the productivity shocks raises output but lowers domestic prices. Thus real money balance rise and the interest rate falls. (It can indeed rise depending on parameter values). Thus with a weaker German exchange rate, the members of the EMS relax monetary policy and raise GDP. Therefore, although the level of GDP is higher under the EMS regime for the non-German economies shown, the variance of GDP is also higher under the EMS.

The EMU results are also different in an interesting way. In the case of a German productivity shock, non German inflation rises due to the demand rise in these economies. Thus the European central bank contracts monetary policy to dampen the inflation rise. This helps to dampen the volatility in GDP relative to that experienced in the EMS regime. Note again that outside of Germany, inflation and GDP are well stabilized by a regime of floating exchange rates.

Finally we present results for a European wide productivity shock in figures 7 and 8. As with the European wide fiscal shock, the choice of regime makes little difference to GDP since exchange rates change very little under this nearly symmetric shock. On the other hand, inflation does move in an interesting way under the different regimes. The flexible exchange rate is able to perfectly stabilize inflation because we assume that the policymakers can use monetary policy credibly to target inflation. The EMS regime leads to a larger fall and subsequent fluctuation in inflation outside Germany.

6. Conclusion

This paper has presented a range of results for the variance of variables under three monetary regimes for Europe in the case of 4 variants of three types of shocks. The desirability of each regime for a given country depends on the nature of the shock as well as whether outcomes for variables such as inflation and GDP are evaluated in terms of the levels of variables in the short term or the steady state variance of variables. It is clear from the results presented above that even from a reduced set of policy assumptions and variables, there is a rich variety of outcomes that can usefully be explored in a modelling framework.

It is also shown that the impact of German unification on European economies was importantly dominated by the monetary regime that existed in Europe at that time. As argued by Kenen (1992) an EMU in place would have reduced the negative impact of German unification on GDP and employment in the rest of Europe. In contrast, the effect of EMU is to accentuate the variability of GDP and employment in Europe and may therefore not be preferable to the existing EMS for random future fiscal shocks in Europe.

More work can usefully be undertaken in the framework of this paper. The approach could easily be extended to deal with strategic issues arising from tradeoffs between targets of countries within the monetary regimes. In addition the more complex issue of fiscal policy under alternative monetary regimes could usefully be explored.

References

Bayoumi T, and B. Eichengreen (1993) "Shocking Aspects of European Monetary Unification" in F. Giavazzi and F. Torres (eds) (1993) The Transition to Economic and Monetary Union in Europe, Cambridge University Press, Cambridge.

Bayoumi T. and M. Taylor (1992) "Macroeconomic Shocks, The ERM and Tri-Polarity", CEPR Discussion Paper No. 711, Centre for Economic Policy Research, London.

Blanchard O. and D. Quah (1992) "The Dynamic Effects of Aggregate Demand and Supply Disturbances" *The American Economic Review*, 79, no.4, pp1-161.

Bryant R., Hooper, P., and C. Mann (eds) (1993) *Evaluating Policy Regimes: New Research in Empirical Macroeconomics*, Brookings Institution.

Campbell J. And N.G. Mankiw (1987) "Permanent Income, Current Income and Consumption" NBER Working Paper 2436.

Commission of the European Communities (1990) "One Market, One Money", *European Economy*, No 44, October.

Congressional Budget Office (1990) *How the Economic Transformations in Europe Will Affect the United States*, December.

De Grauwe P. (1992) *The Economics of Monetary Integration*, Oxford University Press, Oxford.

Dornbusch R. (1976) "Expectations and Exchange Rate Dynamics" *Journal of Political Economy* 84, pp 1161-76.

Eichengreen B. (1992) *Should The Maastricht Treaty be Saved*, Princeton Studies in International Finance no. 74, December.

Fleming, J.M. (1962) "Domestic Financial Policies Under Fixed an Flexible Exchange Rates", *International Monetary Fund Staff Papers*, 9, No. 3, November.

Fratianni M. and J. von Hagen (1992) *The European Monetary System and European Monetary Union*, Westview Press , Oxford.

Giovannini A. and W. McKibbin (1992) "The Economic Implications of Maastricht" mimeo The Brookings Institution, June.

Gros D. and N. Thygesen (1992) European Monetary Integration: From the European Monetary System to European Monetary Union, Longmans: London.

Hayashi, F. (1982a) "Tobins Marginal q and Average q: A Neoclassical Interpretation." *Econometrica* 50, pp.213-224.

Hayashi, F. (1982b) "The Permanent Income Hypothesis: Estimation and Testing by Instrumental Variables. *Journal of Political Economy* 90(4) pp 895-916.

D.W. Henderson and W. McKibbin (1993) "An Assessment of Some Basic Monetary Policy Regime Pairs: Analytical and Simulation Results from Simple Multi-Region Macroeconomic Models" in Bryant R., Hooper, P., and C. Mann (1993) *Evaluating Policy Regimes: New Research in Empirical Macroeconomics*, Brookings Institution.

Kenen P. (1992) *EMU after Maastricht*, Group of Thirty, Washington D.C.

Hughes-Hallett A. and D. Vines (1992) The Benefits and Costs of Currency Integration" CEPR Discussion Paper

Lucas, R. E.(1967) "Adjustment Costs and the Theory of Supply." *Journal of Political Economy* 75(4), pp.321-334

McKibbin W. (1992) "The New European Economy and its Economic Implications for the World Economy", *Economic and Financial Computing*, August 1992.

McKibbin W. (1993) *The MSG Multi-Country Model: European Version #36*, Computer Manual, McKibbin Software Group Inc, Arlington VA.

McKibbin W. (1993) "Stochastic Simulations of Alternative Monetary Regimes in the MSG2 Model" in Bryant R., Hooper P., and C. Mann (1993) *Evaluating Policy Regimes: New Research in Empirical Macroeconomics*, Brookings Institution.

McKibbin W. (1994) "Dynamic Adjustment to Regional Integration: Europe 1992 and NAFTA" paper prepared for the TCER-NBER-CEPR conference on Regionalism, held in Japan January 8 and 9, forthcoming in the *Journal of the Japanese and International Economies* (December).

McKibbin W.J. and J. Sachs (1991) *Global Linkages: Macroeconomic Interdependence and Co-operation in the World Economy*, Brookings Institution ,June.

McKinnon R. (1993) "The Rules of the Game", *Journal of Economic Literature*,

Melitz J. (1988) "Monetary Discipline an Cooperation in the European Monetary System: A Synthesis" in Giavazzi F., Micossi S. and M. Miller (1988) *The European Monetary System*, Cambridge University Press, Cambridge.

Minford P., A. Rastogi and A. Hughes-Hallett (1992) The Price of EMU Revisited, CEPR

Discussion Paper No. 656, Centre for Economic Policy Research, London.

Mundell, R. (1963) "Capital Mobility and Stabilization Policy Under Fixed and Flexible Exchange Rates", *The Canadian Journal of Economics* 29, November, pp 475-485.

Roubini N. (1989) :Leadership and Cooperation in the European Monetary Union: A Simulation Approach" NBER Working Paper no. 3044, National Bureau of Economic Research, Cambridge Mass.

Solow R. (1970) *Growth Theory: An Exposition*, Oxford University Press.

Swan T. (1956) Economic Growth and Capital Accumulation" *Economic Record*.

Treadway, A. (1969) "On Rational Entrepreneurial Behavior and the Demand for Investment." *Review of Economic Studies* 36(106), pp.227-239.

Table 4: Relative Variance of Variables For Monetary Shocks

COUNTRY/ VARIABLE	*REGIME*	*SHOCK*			
		Global	European	German	Non-German Europe
GERMANY					
GDP	EMS	0	0	0	0
	EMU	0	0	0	0
	Float	0	0	0	0
Employment	EMS	0	0	0	0
	EMU	0	0	0	0
	Float	0	0	0	0
Short Interest Rate	EMS	1	1	0	0
	EMU	0.76	1	0	1
	Float	0.9	1	0	0
Inflation	EMS	0	0	0	0
	EMU	0	0	0	0
	Float	0	0	0	0
UNITED KINGDOM					
GDP	EMS	0	0	0	0
	EMU	0	0	0	0
	Float	0	0	0	0
Employment	EMS	0	0	0	0
	EMU	0	0	0	0
	Float	0	0	0	0
Short Interest Rate	EMS	1	1	0	1
	EMU	0.68	0.25	0	0.33
	Float	0.92	0.25	0	0.33
Inflation	EMS	0	0	0	0
	EMU	0	0	0	0
	Float	0	0	0	0
FRANCE					
GDP	EMS	1	0	0	0
	EMU	0	0	0	0
	Float	0	0	0	0
Employment	EMS	1	0	0	0
	EMU	0.5	0	0	0
	Float	0	0	0	0
Short Interest Rate	EMS	1	1	0	0
	EMU	0.76	1	0	1
	Float	0.9	1	0	0
Inflation	EMS	0	0	0	0
	EMU	0	0	0	0
	Float	0	0	0	0
ITALY					
GDP	EMS	1	0	0	0
	EMU	0	0	0	0
	Float	0	0	0	0
Employment	EMS	1	0	0	0
	EMU	0.33	0	0	0
	Float	0	0	0	0
Short Interest Rate	EMS	1	1	0	1
	EMU	0.68	0.25	0	0.33
	Float	0.92	0.25	0	0.33
Inflation	EMS	0	0	0	0
	EMU	0	0	0	0
	Float	0	0	0	0

COUNTRY/ VARIABLE	*REGIME*	*SHOCK*			
		Global	European	German	Non-German Europe
OTHER EMS					
GDP	EMS	0	0	0	0
	EMU	0	0	0	0
	Float	0	0	0	0
Employment	EMS	1	0	0	0
	EMU	0	0	0	0
	Float	0	0	0	0
Short Interest Rate	EMS	1	1	0	1
	EMU	0.69	0.25	0	0.5
	Float	0.81	0.25	0	0.5
Inflation	EMS	0	0	0	0
	EMU	0	0	0	0
	Float	0	0	0	0
UNITED STATES					
GDP	EMS	1	0	0	0
	EMU	1	0	0	0
	Float	1	0	0	0
Employment	EMS	1	0	0	0
	EMU	1	0	0	0
	Float	1	0	0	0
Short Interest Rate	EMS	1	0	0	0
	EMU	1	0	0	0
	Float	1	0	0	0
Inflation	EMS	1	0	0	0
	EMU	1	0	0	0
	Float	1	0	0	0
JAPAN					
GDP	EMS	1	0	0	0
	EMU	1	0	0	0
	Float	1	0	0	0
Employment	EMS	1	0	0	0
	EMU	1	0	0	0
	Float	1	0	0	0
Short Interest Rate	EMS	1	0	0	0
	EMU	1	0	0	0
	Float	1	0	0	0
Inflation	EMS	1	0	0	0
	EMU	1	0	0	0
	Float	1	0	0	0
ROECD					
GDP	EMS	1	0	0	0
	EMU	1	0	0	0
	Float	1	0	0	0
Employment	EMS	1	0	0	0
	EMU	1	0	0	0
	Float	1	0	0	0
Short Interest Rate	EMS	0.99	0	0	0
	EMU	1	0	0	0
	Float	0.99	0	0	0
Inflation	EMS	1	0	0	0
	EMU	1	0	0	0
	Float	1	0	0	0

Table 5: Relative Variance of Variables For Fiscal Shocks

COUNTRY/ VARIABLE	*REGIME*	*SHOCK*			
		Global	European	German	Non-German Europe
GERMANY					
GDP	EMS	0.95	1	0.7	0.04
	EMU	1	0.76	0.69	1
	Float	0.92	0.93	1	0.03
Employment	EMS	0.92	1	0.68	0.03
	EMU	1	0.73	0.62	1
	Float	0.9	0.92	1	0.03
Short Interest Rate	EMS	0.99	0.86	0.36	0.19
	EMU	0.98	1	1	1
	Float	1	0.91	0.22	0.39
Inflation	EMS	0	0	0	0
	EMU	1	1	1	1
	Float	0	0	0	0
UNITED KINGDOM					
GDP	EMS	1	1	0.58	1
	EMU	0.87	0.76	1	0.44
	Float	0.71	0.71	0.01	0.32
Employment	EMS	1	1	0.62	1
	EMU	0.86	0.74	1	0.43
	Float	0.68	0.7	0.01	0.31
Short Interest Rate	EMS	0.89	0.81	0.3	0.17
	EMU	0.95	0.99	1	0.76
	Float	1	1	0.01	1
Inflation	EMS	1	1	1	1
	EMU	0.46	0.16	0.02	0.11
	Float	0	0	0	0
FRANCE					
GDP	EMS	1	1	0.76	1
	EMU	0.81	0.72	1	0.4
	Float	0.67	0.51	0.02	0.22
Employment	EMS	1	1	0.86	1
	EMU	0.77	0.7	1	0.38
	Float	0.6	0.47	0.02	0.2
Short Interest Rate	EMS	0.99	0.86	0.36	0.19
	EMU	0.98	1	1	1
	Float	1	0.91	0.22	0.39
Inflation	EMS	0	0	0	0
	EMU	1	1	1	1
	Float	0	0	0	0
ITALY					
GDP	EMS	1	1	1	1
	EMU	0.8	0.62	0.57	0.3
	Float	0.84	0.46	0.02	0.16
Employment	EMS	1	1	1	1
	EMU	0.69	0.58	0.46	0.28
	Float	0.73	0.4	0.02	0.13
Short Interest Rate	EMS	0.89	0.81	0.3	0.17
	EMU	0.95	0.99	1	0.76
	Float	1	1	0.01	1
Inflation	EMS	1	1	1	1
	EMU	0.46	0.16	0.02	0.11
	Float	0	0	0	0

COUNTRY/ VARIABLE	*REGIME*	*SHOCK*			
		Global	European	German	Non-German Europe
OTHER EMS					
GDP	EMS	0.83	0.84	1	1
	EMU	0.72	0.61	0.47	0.23
	Float	1	1	0	0.32
Employment	EMS	0.74	0.81	1	1
	EMU	0.58	0.53	0.37	0.2
	Float	1	1	0	0.29
Short Interest Rate	EMS	0.93	0.81	0.3	0.21
	EMU	1	1	1	1
	Float	0.87	0.76	0.02	0.93
Inflation	EMS	0.38	0.28	1	1
	EMU	1	1	0.15	0.07
	Float	0	0	0	0
UNITED STATES					
GDP	EMS	1	1	0.25	1
	EMU	1	1	1	0.67
	Float	1	1	0	0.67
Employment	EMS	1	0.94	0.12	0.9
	EMU	1	1	1	0.9
	Float	1	1	0.06	1
Short Interest Rate	EMS	1	1	0.07	1
	EMU	1	1	1	0.77
	Float	1	1	0	0.77
Inflation	EMS	0.99	0.91	0.18	0.63
	EMU	1	1	1	1
	Float	1	1	0.06	1
JAPAN					
GDP	EMS	1	1	0	1
	EMU	1	0.67	1	0.5
	Float	1	0.67	0	0.5
Employment	EMS	1	1	0	1
	EMU	1	0.89	1	0.67
	Float	1	0.89	0.12	0.67
Short Interest Rate	EMS	1	1	0.04	1
	EMU	1	0.93	1	0.62
	Float	1	0.93	0.08	0.67
Inflation	EMS	1	0.94	0.19	0.55
	EMU	1	1	1	1
	Float	1	1	0.06	1
ROECD					
GDP	EMS	1	0.99	0.16	1
	EMU	0.99	1	1	0.83
	Float	0.98	0.93	0.11	0.71
Employment	EMS	1	0.97	0.17	1
	EMU	0.99	1	1	0.94
	Float	0.98	0.94	0.11	0.81
Short Interest Rate	EMS	1	1	0.06	1
	EMU	1	0.98	1	0.79
	Float	0.98	0.93	0.1	0.66
Inflation	EMS	0.97	0.87	0.27	0.38
	EMU	0.99	1	1	1
	Float	1	0.98	0.09	0.87

Table 6: Relative Variance of Variables For Productivity Shocks

COUNTRY/ VARIABLE	*REGIME*	*SHOCK*			
		Global	European	German	Non-German Europe
GERMANY					
GDP	EMS	0.97	0.97	1	0.02
	EMU	0.94	0.97	0.41	1
	Float	1	1	0.79	0.1
Employment	EMS	0.95	0.93	1	0.02
	EMU	0.91	0.96	0.53	1
	Float	1	1	0.57	0.1
Short Interest Rate	EMS	0.95	0.93	1	0.03
	EMU	0.98	1	0.08	1
	Float	1	1	0.59	0.19
Inflation	EMS	0	0	0	0
	EMU	1	1	1	1
	Float	0	0	0	0
UNITED KINGDOM					
GDP	EMS	0.77	0.77	1	0.2
	EMU	0.86	0.88	0.11	0.69
	Float	1	1	0.03	1
Employment	EMS	0.62	0.61	1	0.38
	EMU	0.76	0.79	0.11	0.46
	Float	1	1	0.03	1
Short Interest Rate	EMS	0.72	0.68	1	0.01
	EMU	0.88	0.87	0.1	0.58
	Float	1	1	0.01	1
Inflation	EMS	1	1	1	1
	EMU	0.33	0.25	0.09	0.13
	Float	0	0	0	0
FRANCE					
GDP	EMS	0.8	0.74	1	0.17
	EMU	0.89	0.85	0.11	0.66
	Float	1	1	0.03	1
Employment	EMS	0.68	0.58	1	0.29
	EMU	0.82	0.75	0.11	0.45
	Float	1	1	0.03	1
Short Interest Rate	EMS	0.95	0.93	1	0.03
	EMU	0.98	1	0.08	1
	Float	1	1	0.59	0.19
Inflation	EMS	0	0	0	0
	EMU	1	1	1	1
	Float	0	0	0	0
ITALY					
GDP	EMS	0.88	0.85	1	0.21
	EMU	1	1	0.11	0.84
	Float	0.88	0.93	0.02	1
Employment	EMS	0.8	0.75	1	0.27
	EMU	1	1	0.11	0.71
	Float	0.81	0.88	0.02	1
Short Interest Rate	EMS	0.72	0.68	1	0.01
	EMU	0.88	0.87	0.1	0.58
	Float	1	1	0.01	1
Inflation	EMS	1	1	1	1
	EMU	0.33	0.25	0.09	0.13
	Float	0	0	0	0

COUNTRY/ VARIABLE	*REGIME*	*SHOCK*			
		Global	European	German	Non-German Europe
OTHER EMS					
GDP	EMS	0.9	0.86	1	0.34
	EMU	1	1	0.08	0.85
	Float	0.99	0.95	0.02	1
Employment	EMS	0.8	0.76	1	0.74
	EMU	0.99	1	0.08	0.71
	Float	1	0.94	0.02	1
Short Interest Rate	EMS	0.77	0.75	1	0.02
	EMU	0.94	0.97	0.1	0.63
	Float	1	1	0.01	1
Inflation	EMS	0.81	0.54	1	1
	EMU	1	1	0.07	0.04
	Float	0	0	0	0
UNITED STATES					
GDP	EMS	1	1	1	1
	EMU	1	1	0.33	1
	Float	1	1	0.33	1
Employment	EMS	1	0.95	1	0.7
	EMU	0.99	1	0.29	1
	Float	0.99	1	0.29	1
Short Interest Rate	EMS	1	1	1	1
	EMU	0.98	1	0.12	0.87
	Float	0.98	1	0.25	0.62
Inflation	EMS	0.99	0.89	1	0.35
	EMU	1	0.97	0.13	1
	Float	1	1	0.2	1
JAPAN					
GDP	EMS	0.97	0.86	1	0
	EMU	0.99	1	0	1
	Float	1	1	0.17	0.75
Employment	EMS	1	0.78	1	0
	EMU	0.98	0.89	0.12	1
	Float	0.97	1	0.25	0.75
Short Interest Rate	EMS	1	0.9	1	0.29
	EMU	0.98	0.94	0.08	1
	Float	0.97	1	0.23	0.59
Inflation	EMS	0.99	0.84	1	0.21
	EMU	1	0.97	0.18	0.84
	Float	1	1	0.18	1
ROECD					
GDP	EMS	0.95	0.82	1	0.31
	EMU	0.98	0.93	0.2	0.94
	Float	1	1	0.21	1
Employment	EMS	0.97	0.83	1	0.3
	EMU	0.97	0.93	0.19	0.95
	Float	1	1	0.23	1
Short Interest Rate	EMS	1	0.92	1	0.44
	EMU	0.94	1	0.12	1
	Float	0.91	0.92	0.12	0.97
Inflation	EMS	0.96	0.86	1	0.16
	EMU	0.98	0.97	0.15	1
	Float	1	1	0.24	0.83

Figure 1: Consequences for European GDP of a German Fiscal Shock

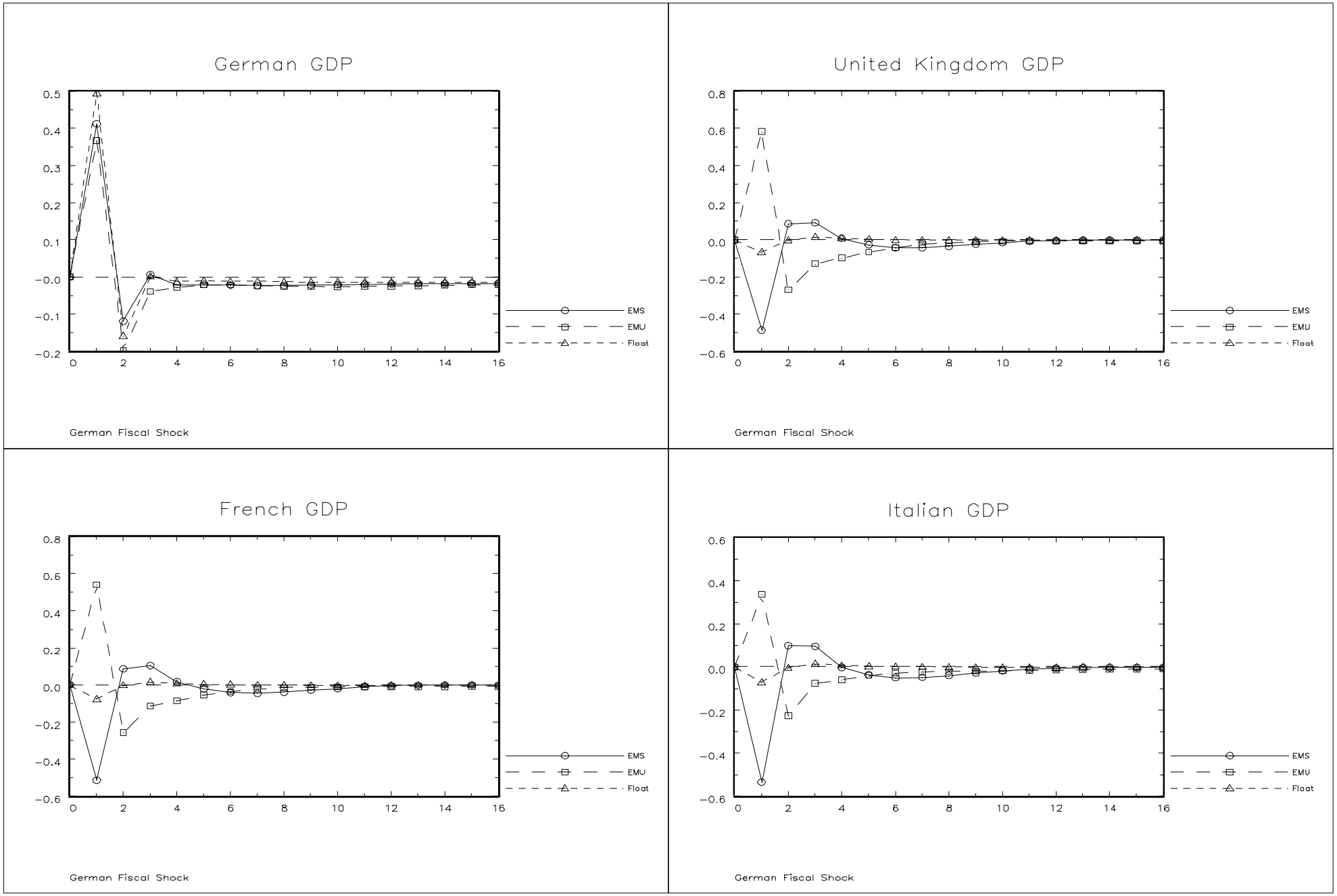


Figure 2: Consequences for European Inflation of a German Fiscal Shock

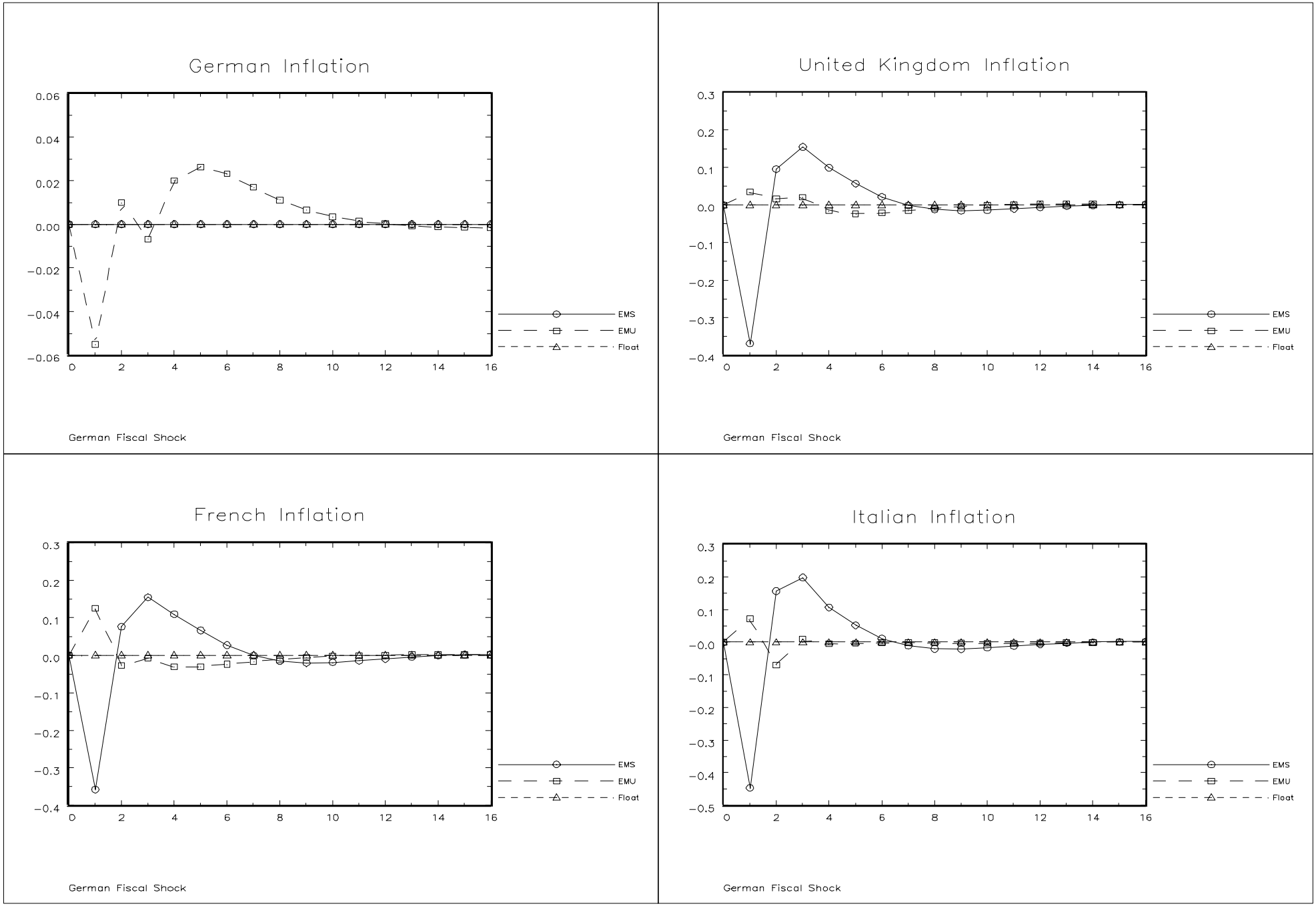


Figure 3: Consequences for European GDP of a European Fiscal Shock

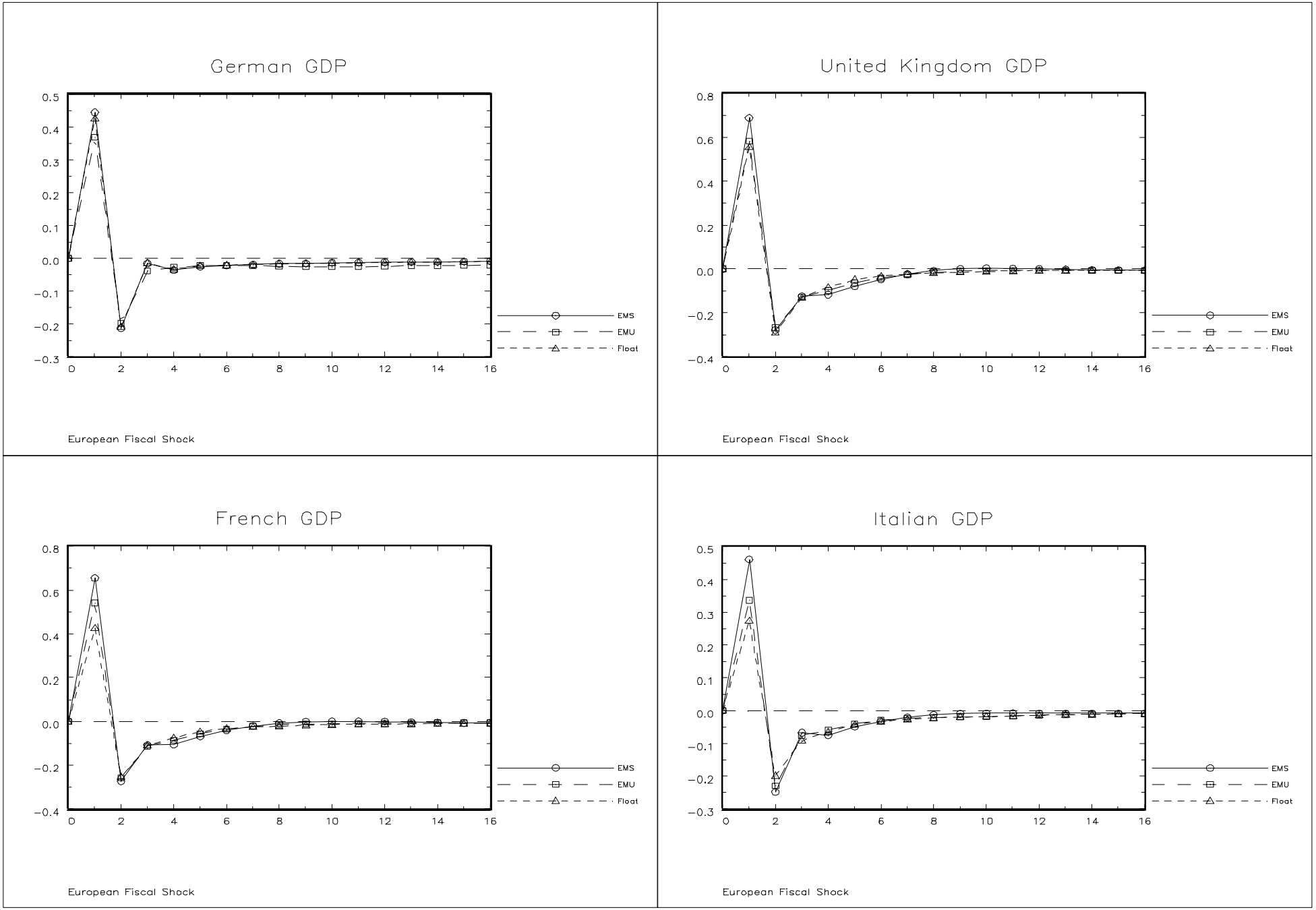


Figure 4: Consequences for European Inflation of a European Fiscal Shock

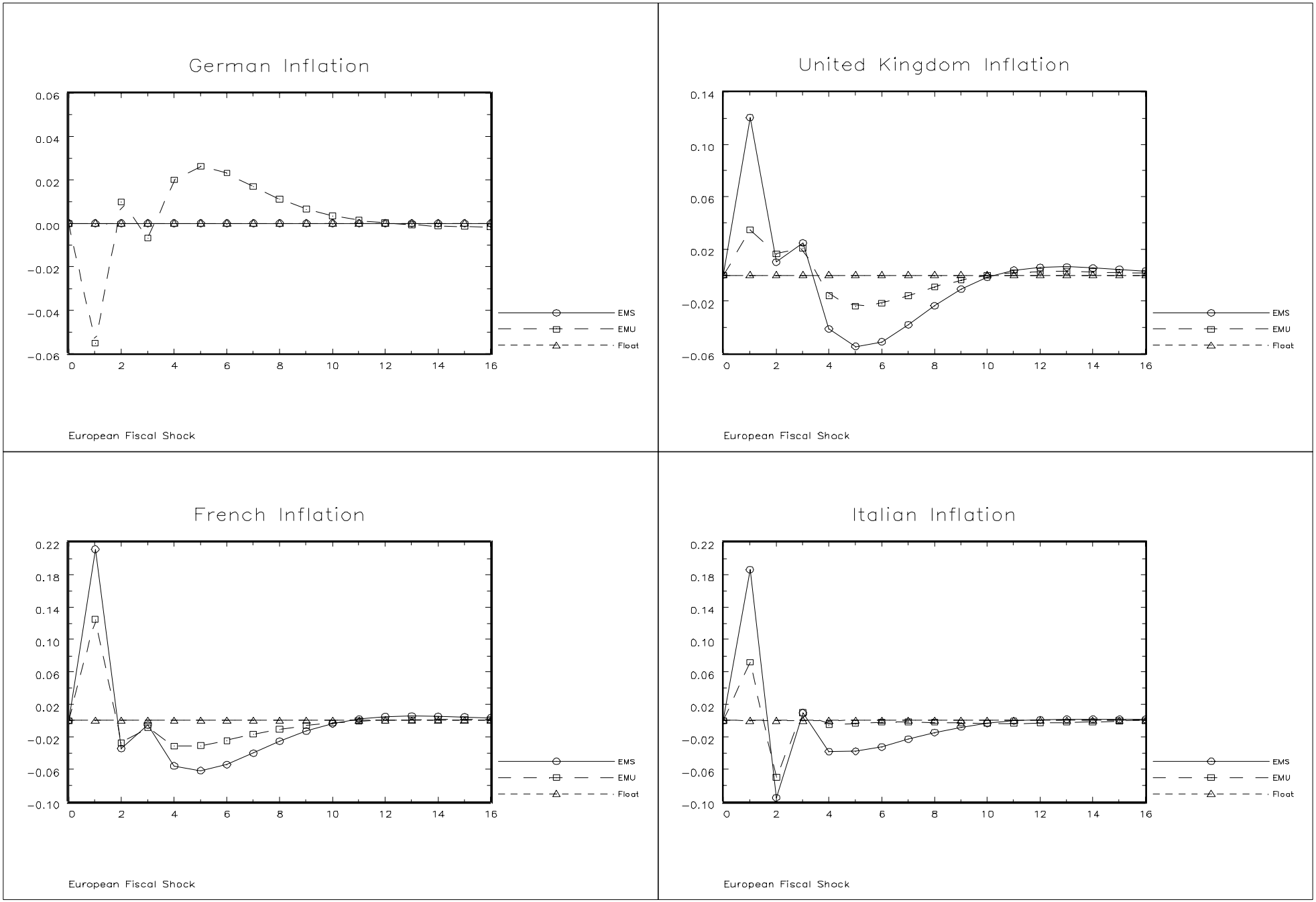


Figure 5: Consequences for European GDP of a German Productivity Shock

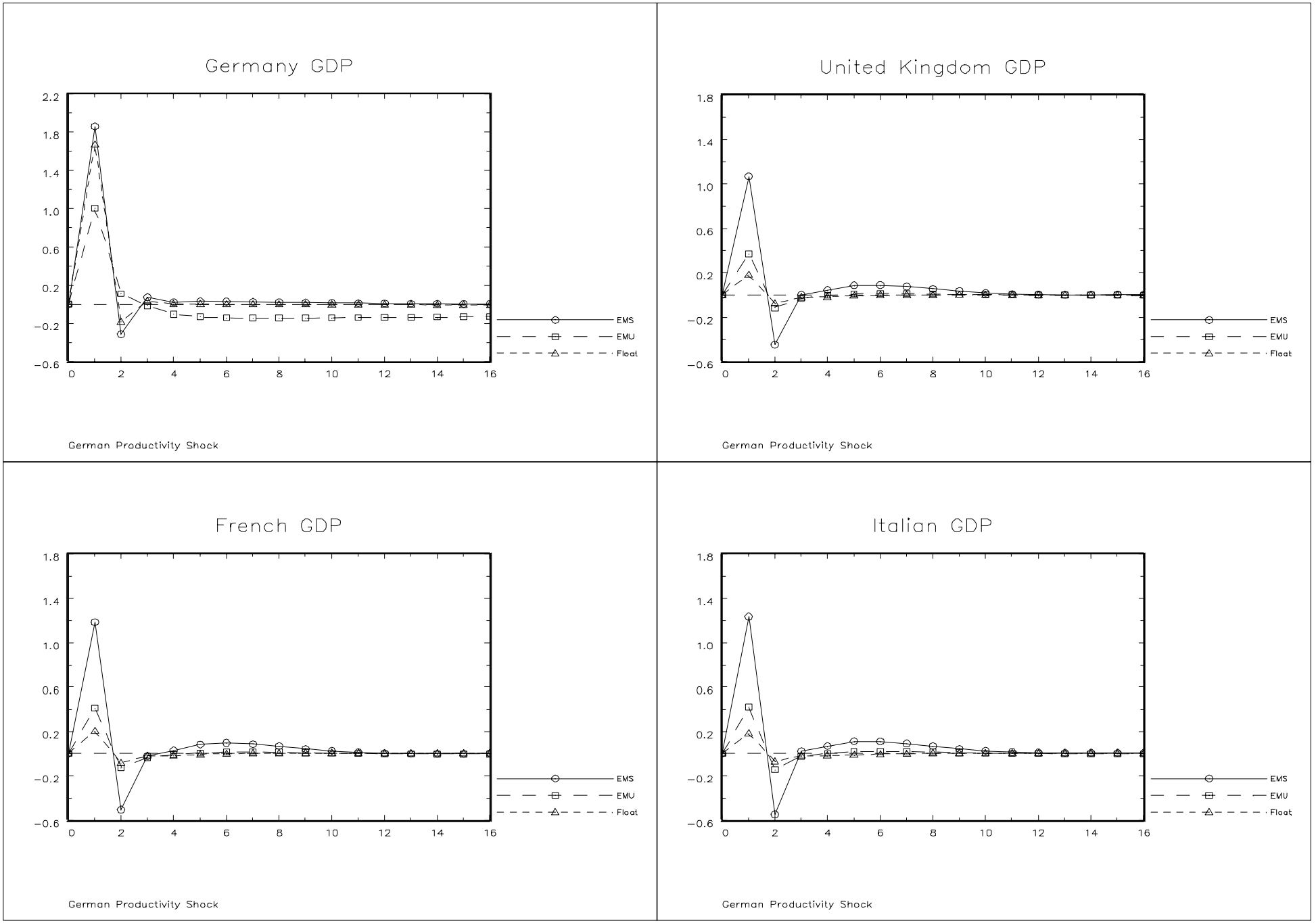


Figure 6: Consequences for European Inflation of a German Productivity Shock

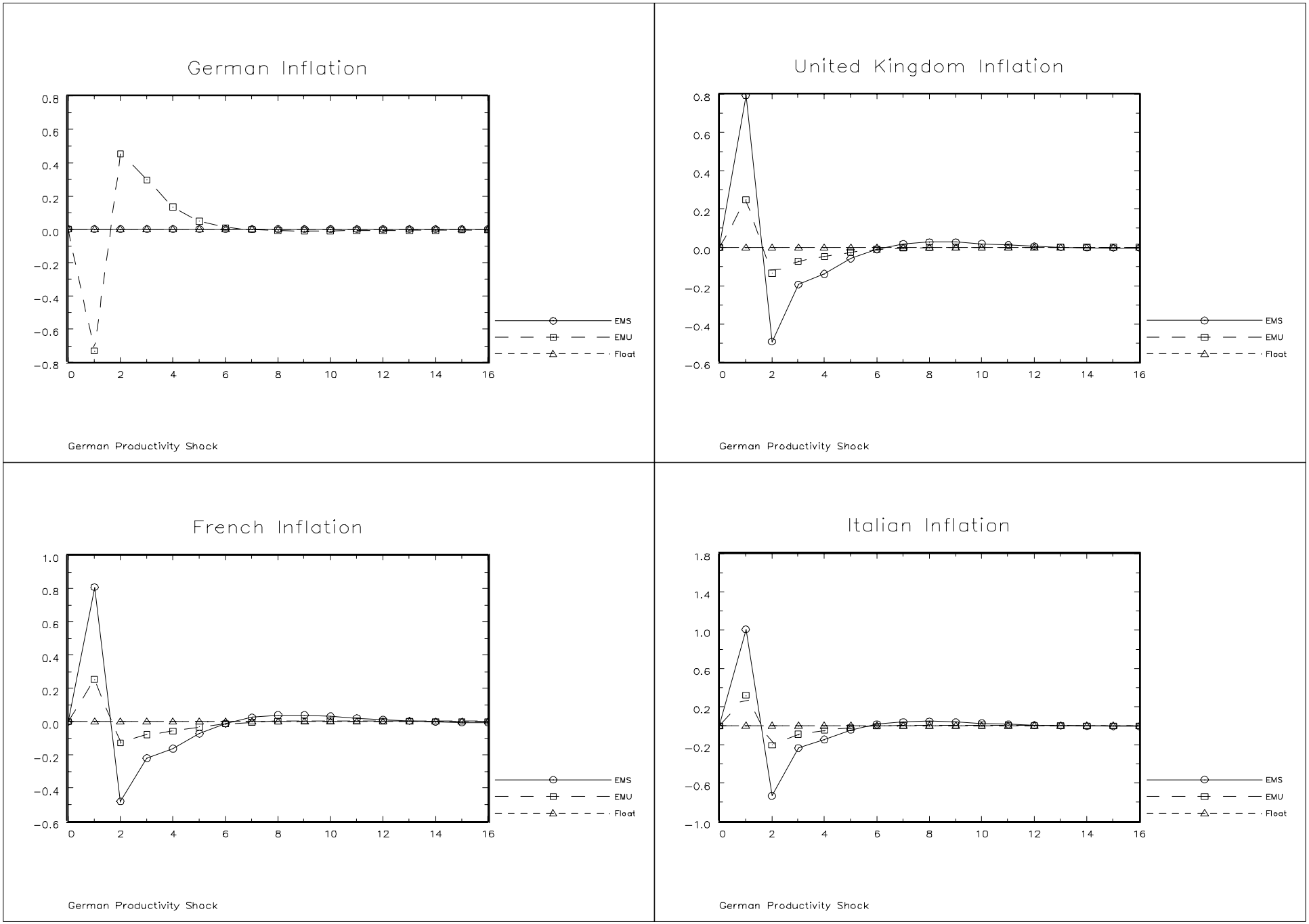


Figure 7: Consequences for European GDP of a European Productivity Shock

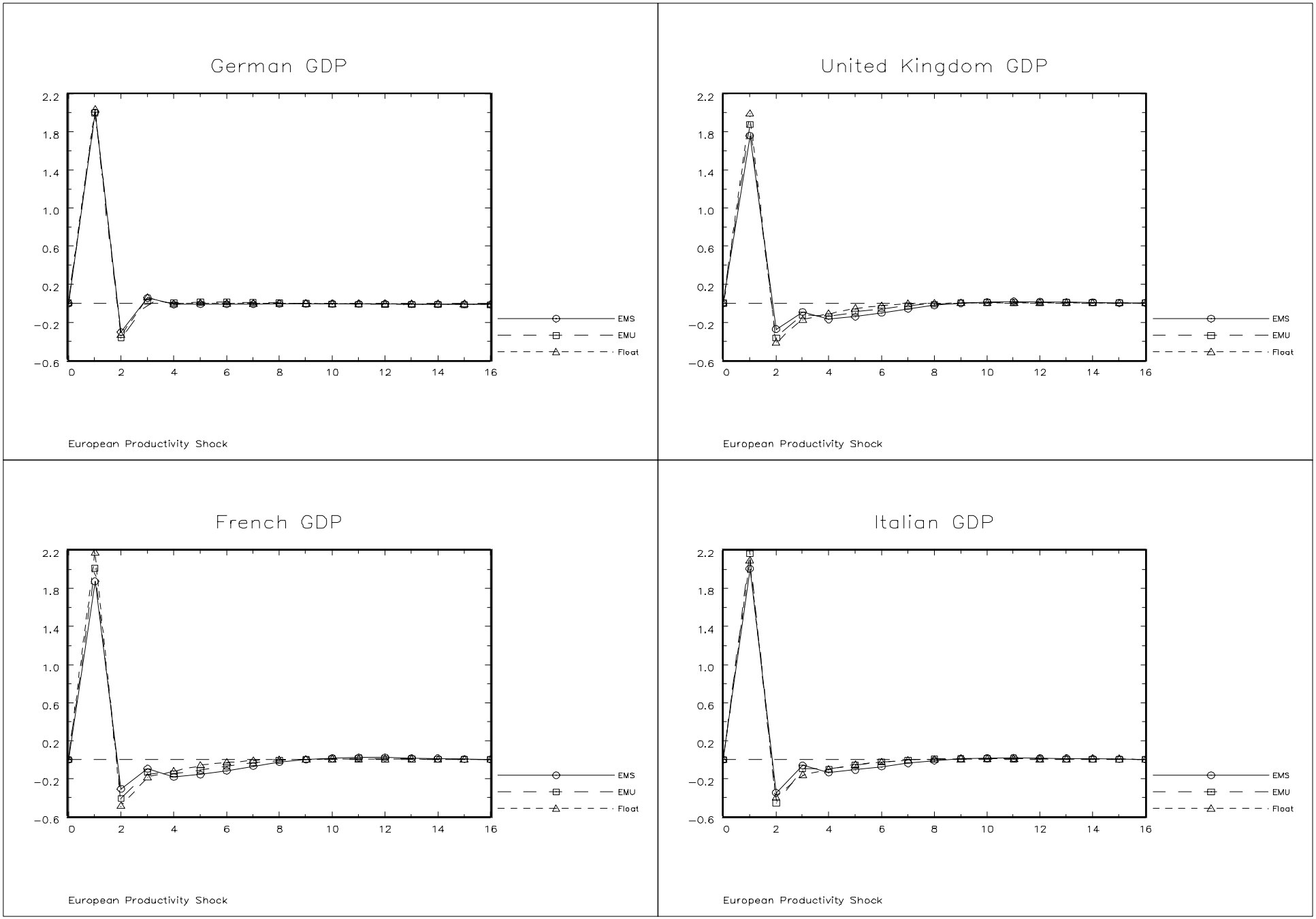
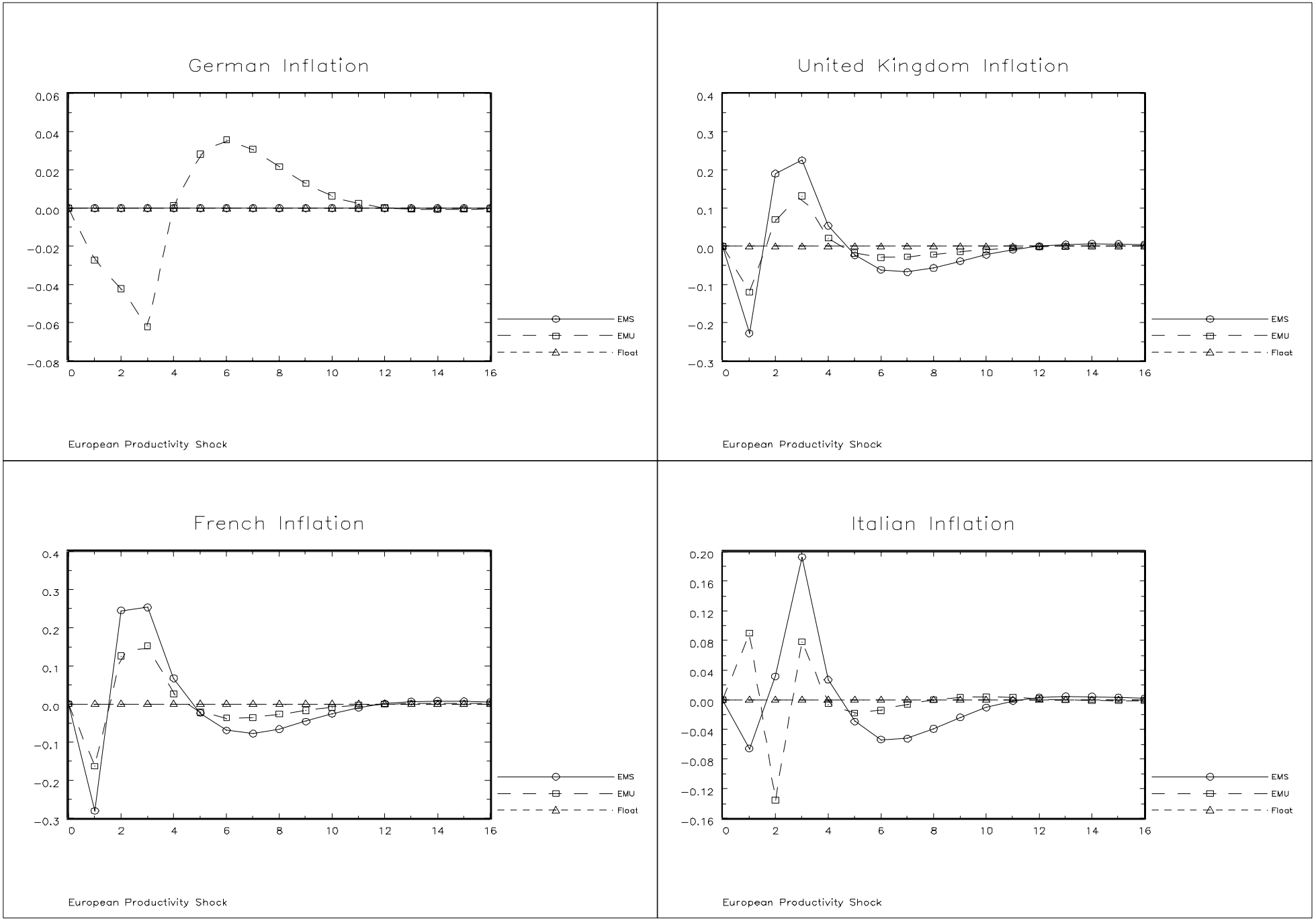


Figure 8: Consequences for European Inflation of a European Productivity Shock



Appendix 1: Stylized Representation of the MSG2 Model

This appendix provides a stylized summary of the structure of the MSG model. Full documentation can be found in McKibbin and Sachs (1991) and the current version of the model used in this paper is documented in McKibbin (1993).

The MSG2 model consists of two types of country models: "Structural" and "Non-Structural".

Structural countries/regions have a full internal structure. In the version used in this paper the following countries are "structural": United States (U); Japan (J); Canada (C); Germany (G) France (F), Italy (I); United Kingdom (K); Rest of the EMS (E); and Rest of the OECD (R).

Non-Structural countries/regions only have their trade and asset flow linkages modeled so as to close the global model. The following regions are non-structural: Oil exporting developing countries (O); Eastern Europe and former Soviet Union (B); Rest of developing countries (L).

Each structural country/region is based on a generic structure which is modified for different parameter values and different institutional/policy regime characteristics of that country/region.

Each "non-structural" country is also based on a generic structure which is modified for different parameter values and different institutional/policy regime characteristics.

The following equations are the generic form of the structural and non-structural countries. The exact specifications are documented in McKibbin (1993). Parameter values differ across countries and can be found in McKibbin (1993).

In principle, each variable has a time dimension and a country dimension. Where no confusion will result, these two dimensions are not shown explicitly in this listing:

e.g. C^j_t (consumption of country j in period t) is written C;
$C^j_{i\,t}$ (consumption by country j of goods from country i in period t) is written C_i;

A subscript/superscript h refers to the set of structural countries or regions, h={U,J,G,K,F,I,C,E,R} whereas the subscript/superscript i refers to the set of structural countries or regions excluding the current generic country. e.g. for the United States, i={,J,G,K,F,I,C,E,R}.

A subscript/superscript j refers to the set of non-structural regions , j={O,B,L}, whereas the subscript/superscript k refers to the set of structural countries or regions excluding the current country. e.g. for non oil developing countries (LDC) k={O,B}.

Structural Countries:

HOUSEHOLDS

(i) **Utility**

$$U_t = \int_t^{\infty} \log C_s \, e^{(\beta_1 - n)s} \, ds$$

$$C = [\beta_3 (C^d)^{\gamma_1} + (1 - \beta_3) C^m)^{\gamma_1}]^{(1/\gamma_1)}$$

$$C^m = [\sum_i \theta_i (C_i)^{\gamma_2}]^{(1/\gamma_2)} \quad where \quad \sum_i \theta_i = 1$$

(ii) **Demand Functions**

$$C = \beta_4 \beta_1 (F + H) P/P^c + (1 - \beta_4) \beta_5 (INC)(P/P^c)$$

$$INC = WL(1 - \tau_1)/P + (r - n)F - TAX$$

$$C^d = \beta_3^{\sigma_1} (P^c/P)^{\sigma_1} (C + G) \quad where \quad \sigma_1 = 1/(1 - \gamma_1)$$

$$C^m = (1 - \beta_3)^{\sigma_1} (P^c/P^m)^{\sigma_1} (C + G)$$

$$C_i = \theta_i^{\sigma_3} (P^m/E^{*i} P^i)^{\sigma_3} C^m \quad where \sigma_3 = 1/(1 - \gamma_2)$$

$$P^{c\,1-\sigma_1} = \beta_3^{\sigma_1} P^{1-\sigma_1} + (1 - \beta_3)^{\sigma_1} P^{1-\sigma_1}$$

$$P^{m\,1-\sigma_2} = \sum_1^{N-1} \theta_i^{\sigma_2} (E^{*i} P^i)^{1-\sigma_2}$$

$$({}_{t}H_{t+1}) = (1+\psi_{1}+r-n)H_{t}-W(1-\tau_{1})L/P+TAX$$

FIRMS

(i) **Production Function**

$$Q = \beta_{14} V^{\beta_6} N^{(1-\beta_6)}$$

$$V = \beta_{12} K^{(1-\beta_7)} L^{\beta_7} K^{g\beta_8}$$

$$N = \prod_j N_j^{\eta_j}$$

(ii) **Factor demands**

$$L = \beta_6 \beta_7 PQ/W$$

$$N = (1-\beta_6) PQ/P^n$$

$$N_j = \eta_j P^n N/(E^j P^j)$$

$$K_{t+1} = (1-\beta_{16}-n) K_t + J_t$$

$$K^g_{t+1} = (1-\beta_{28}-n) K^g_t + I^g_t$$

$$I = [1 + 0.5\beta_{17}(J/K)] P^J J/P^I$$

$$J = \beta_{18}[(q-1)/\beta_{17}] K + (1-\beta_{18})(Q - (W/P)L - (P^n/P)N)$$

$$J_h = \theta_h P^J J/(E^h P^h)$$

$$({}_t q_{t+1}) = (1+\psi_2+r+\beta_{16}) q_t - (1-\tau_2)\beta_6(1-\beta_7)(Q/K) - (P^J/P)(0.5\beta_{17})(J/K$$

$$P^n = \prod_j (E^j P^j)^{\eta_j}$$

$$P^J = \prod_h (E^h P^h)^{\theta_h}$$

$$({}_tVOIL_{t+1}) = (1+ \psi_1 + r - n)VOIL_t - \beta_{24} N_P P^P E^P / P$$

$$({}_tVPE_{t+1}) = (1+ \psi_1 + r - n)VPE_t - \sum_i (C^i + I^i)(E^i / E^{i*})$$

ASSET MARKETS

$$M/P = i^{\beta_{10}} Q$$

$$F = B + M/P + qK + A + VPE + VOIL$$

$$A = \sum_i A^i + \sum_j A^j$$

$$\Lambda^h = P^h E^h / P$$

$$\Lambda^{*h} = P^h E^{*h} / P$$

$$\Lambda^j = P^j E^j / P$$

$$i_t = r_t + {}_t\Pi_{t+1}$$

$$r_t = R_t - ({}_tR_{t+1} - R_t)/R_t$$

$$r_t = r^i_t + ({}_t\Lambda^i_{t+1} - \Lambda^i_t)/\Lambda^i_t$$

$$({}_t\Pi_{t+1}) = ({}_tP_{t+1} - P_t)/P_t$$

$$({}_t\Pi^c_{t+1}) = ({}_tP^c_{t+1} - P^c_t)/P^c_t$$

$$E^{*i}_t / E^{*i}_{t-1} = (E^i_t / E^i_{t-1})^{\beta_{23}} \ (E^{*i}_{t-1} / E^{*i}_{t-2})^{(1-\beta_{23})} \ (E^i_{t-1} / E^{*i}_{t-1})^{0.05}$$

GOVERNMENT SECTOR

$$DEF = G + rB - T$$

$$T = TAX + \tau_1(W/P)L + \tau_2[Q - (W/P)L - (P^n/P)N]$$

$$TAX = rB + TAXE$$

$$B_{t+1} = (1 - n)B_t + DEF_t$$

WAGE SETTING

$$w_t = (W_{t+1} - W_t)/W_t$$

Each country differs according to institutional features for setting the nominal wage. For example, the equation for the United States is:

$$w_t = \beta_{25}({}_t\Pi^c_{t+1}) + (1 - \beta_{25})\Pi^c_t + \beta_{26}(L/L^f - 1)$$

BALANCE OF PAYMENTS

$$X = \sum_i (C^i + I^i) + \sum_j C^j$$

$$IM = \sum_i \mathbb{\Lambda}^{*i}(C_i + I_i) + \sum_j \mathbb{\Lambda}^j N_j$$

$$TB = EX - IM$$

$$CA = TB + rB$$

$$A_{t+1} = (1 - n)A_t + CA_t$$

MARKET EQUILIBRIUM

$$Q = (P^c/P)(C + G) + (P^J/P)(I + I^g) + TB + (P^n/P)N$$

$$M = M^s$$

Non Structural region equations

$$P = \prod_{(h,k)} (E^{(h,k)} P^{(h,k)})^{\mu_{1(h,k)}} (EX)^{\mu_2}$$

$$EX = \sum_h N^h + \sum_k C^k$$

$$IM = \sum_h \mathbb{\Lambda}^h C_h + \sum_k \mathbb{\Lambda}^k C_k$$

$$C^{(h,k)} = \mu_{1(h,k)} (IM)/\mathbb{\Lambda}^{(h,k)}$$

$$TB = EX - IM$$

$$CA = CA_0$$

$$A_{t+1} = (1 - n)A_t + CA_t$$

$$CA = TB + rB$$

Variable Definitions

A total real claims held by country i against other countries;
B real government debt;
C real consumption of total bundle of goods;
C^d real consumption of domestic bundle of goods;
C^m real consumption of imported bundle of goods;
C_j consumption by country i of country j good;
CA real current account balance ;
DEF real budget deficit;
E^i_j nominal exchange rate (units of currency j per unit of currency i; e.g. E^j_u is dollars per yen);
E^{*i}_j nominal exchange rate that enters the price of home country exports in foreign markets;
F real financial wealth;
G real government expenditure on goods;
H real human wealth;
i short nominal interest rate;
I private investment expenditure inclusive of adjustment costs ;
I^g government investment expenditure;
J gross fixed capital formation;
J_h us of country h good for investment in country i;
K private capital stock;
K^g stock of government infrastructure capital;
L demand for labor;
L^f full employment labour demand;
M nominal money supply;
N basket of intermediate inputs used in production;

N_j import of intermediate inputs from country j ;
n growth rate of population plus technical change;
P price of domestic goods;
P^m price of basket of imported goods;
P^c price of a consumption basket of imported and domestic goods;
P^I price of basket of investment goods;
P^n price of basket of intermediate goods;
π product price inflation;
π^c consumer price inflation;
Q real gross output;
q Tobin's q;
R long real interest rate;
r short real interest rate;
T total nominal tax receipts;
TAX lump sum tax on households;
TAXE exogenous tax;
TB trade balance in real domestic good units;
V Intermediate good produced with domestic factors;
VOIL Value of future stream of domestic oil production ;
VPE Value of net profit from slow pass through of exchange rate changes into foreign prices of export goods;
W nominal wage;
w rate of change of nominal wage ;
X real exports in domestic good units;
IM real imports in domestic good units;
τ_1 tax rate on household income;
τ_2 tax rate on corporate profits;
Λ^i relative price of country i to home good (real exchange rate) ;
Λ^{*i} relative price of country i to home good (real exchange rate) adjusted for short term pricing behavior of foreign firms in the home market;
σ_1 elasticity of substitution between domestic and imported goods;
σ_2 elasticity of substitution between capital and labor;
σ_3 elasticity of substitution between imported goods;
βi , γ, ϵ, η and θ are behavioral parameters.