Pass-Through of Exchange Rates and Import Prices to Domestic Inflation in Some Industrialized Economies[1]

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Abstract

This paper examines the impact of exchange rates and import prices on the domestic PPI and CPI in selected industrialized economies. The empirical model is a VAR incorporating a distribution chain of pricing. Estimating the model over the post-Bretton Woods era, impulse responses indicate that exchange rates have a modest effect on domestic price inflation while import prices have a stronger effect. Pass-through is larger in countries with a larger import share and more persistent exchange rates and import prices. Over 1996-98, these external factors have had a sizable disinflationary effect in many of the countries, but not in the US. Estimating the model using post-1982 data has little effect on these conclusions.

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1 Introduction

In most industrialized economies, inflation rates in the 1990s were low compared to those of the 1970s and 1980s. Further underscoring the differences between the 1990s and the two previous decades, inflation remained low even in countries—in particular, the United States—that experienced lengthy economic expansions during the decade. In fact, the inflation rate in the US continued to decline even as the unemployment rate fell below levels generally associated with rising inflation during the previous two decades.

Because of the low inflation rates and because the relationship between inflation and economic activity in a number of countries during the past decade was contrary to the standard paradigm, many economists have searched for "special factors" to explain this phenomenon.[1] Among the more-cited special factors have been import prices and exchange rates. Many analysts have pointed to a general decline of import prices in industrialized economies, partly induced by the 1997-98 Asian crisis, to explain declining inflation during the late 1990s. More narrowly, many commentators have attributed a significant portion of the decline in inflation in the US and UK during the late 1990s to the disinflationary impact of exchange rate appreciation and import price deflation.[2] For the US, some analysts also have suggested that the greater openness of the economy has increased foreign competitive pressures on domestic firms, thus restraining domestic inflation to a greater extent than in previous episodes of dollar appreciation.

Clearly then, the extent to which exchange rates and import prices influence domestic inflation is of major concern for monetary policy.[3] If much of the good inflation performance of the late 1990s can be attributed to such special factors, then much of these recent gains could be fragile. Accordingly, many analysts have

[1] As one example articulating the view that special factors such as relative price shocks were a major contributor to declining inflation in the US during the late 1990s, see the speech of Federal Reserve Governor Laurence H. Meyer before the Boston Economic Club on June 6, 2000 ("The New Economy Meets Demand," *http://www.bog.frb.fed.us/boarddocs/speeches/2000/20000606.htm).*

[2] To give a couple of examples from official sources, Federal Reserve Governor Meyer in 1999 said, "Finally, international developments clearly are helping to restrain U.S. inflation. No doubt the appreciation of the dollar from the spring of 1995 through mid-1998 has played a powerful role." ("Start with a Paradigm, End with a Story: The Value of Model-Based Forecasting and Policy Analysis," speech before the Stern School of Business, New York, November 30, 1999. *http://www.bog.frb.fed.us/boarddocs/speeches/1999/19991130.htm.)*

In the UK, the Bank of England's May 2000 *Inflation Report* stated, "...manufacturers' output price inflation remains subdued, partly reflecting intense competition from imports. The sterling prices of imported manufactures have continued to decline, reflecting the appreciation of the exchange rate over the past year." (p. 33.)

[3] For example, in the Bank of England's *Inflation Report*, exchange rates and import prices are among the major considerations for the inflation forecasts underlying the deliberations of the Monetary Policy Committee.

expressed concern that as emerging market economies have recovered from the 1997-98 crisis, the resulting higher import prices have led to greater inflationary pressures in the industrialized economies. In fact, the European Central Bank has cited the possible inflationary effects of the weak euro as one factor behind its tightening of monetary policy in 2000.[4]

Beyond the policy implications of the subject, economists long have been interested in the influence of exchange rate and import price fluctuations on domestic inflation. Accordingly, this subject has spawned many studies through the years. Most have concentrated on the pass-through of a country's exchange rate fluctuations to its import prices, a literature that has been surveyed comprehensively by Goldberg and Knetter (1997).[5] There also have been a number of studies on the pass-through to domestic producer and consumer prices; some examples include Woo (1984), Feinberg (1986, 1989), and Parsley and Popper (1998).

Most recent work in this area has concentrated on pass-through at the firm or industry level, but several recent studies have examined the macroeconomic pass-through of exchange rates and import prices to domestic inflation. Kim (1998) uses a vector error correction model and finds that in the US, the exchange rate has the expected negative long-run effect on the producer price index (PPI) although his work does not address the relationship at shorter, policy-relevant horizons. In this regard, Dellmo (1996) finds that the effect of import prices on the consumer price index (CPI) in Swedish data is relatively weak, which may be surprising given that Sweden is a small open economy.

In the case of the large, relatively closed US economy, the recent evidence is mixed concerning the pass-through to domestic CPI inflation. Tootell (1998) finds that measures of foreign capacity do not enter significantly into estimates of the US Phillips curve, suggesting that domestic variables are sufficient to explain US inflation over the past thirty years. In contrast, Gordon (1998), Stock (1998), and Rich and Rissmiller (2000) find that import prices explain a substantial portion of the forecast error in the 1990s from a Phillips curve model. Similarly, Koenig (1998) and Boldin (1998) find that including import prices in a CPI inflation forecasting model improves forecasts during the 1990s.

This paper takes a somewhat more general approach to examine pass-through of external factors to domestic inflation. It uses a VAR model that permits one to track pass-through from exchange fluctuations to each stage of the distribution chain in a simple integrated framework. The model has a similar structure to that of Clark (1999), who studies responses of prices at different production stages to monetary policy shocks. However, his model does not explicitly include exchange rates and

[4]For example, see the May 2000 issue of the *ECB Monthly Bulletin*.

[5]In addition, much has been written concerning the related issue of the response of exporters' prices to exchange rate fluctuations. One such recent paper is Klitgaard (1999).

import prices.[6] In addition, I estimate the model for several industrialized economies and examine whether the factors affecting pass-through that have been identified in the industry-level studies also explain cross-country differences in pass-through. As a final step, I use the model to examine the effect of exchange rates and import prices on domestic inflation in these countries during the 1996-98 disinflation.

To preview the results, the impulse response functions indicate that exchange rate shocks have modest effects on domestic inflation in most of the countries in the sample, while import price shocks appear to have a larger effect. Pass-through appears to be larger in countries with a higher import share of domestic demand as well as in countries with more persistent exchange rates and import prices. Variance decompositions suggest that the role of exchange rate and import price shocks in explaining consumer price fluctuations is relatively modest. Concentrating on the period 1996-98 indicates that external factors have had a sizable disinflationary effect over this period in many countries, but not in the US. Finally, estimating the model for different sample periods does not suggest stronger pass-through in the latter 1980s and 1990s than previously.

The remainder of this paper proceeds as follows. The next section discusses some influences on pass-through that have been identified in previous studies and that may explain cross-country differences in pass-through. Section 3 describes the model and its empirical implementation, and Section 4 the data used in the study. Section 5 provides the results from the impulse responses and variance decompositions. Section 6 discusses the historical decomposition of the 1996-98 period and Section 7 the issue of possible changes in pass-through over time. Section 8 concludes.

2 Influences on Pass-Through

Even within a simple supply-demand model where the law of one price holds, there can be cross-country variation in the pass-through of exchange rate fluctuations to domestic prices. In a large country, the inflationary effect of a currency depreciation on domestic prices is counteracted by a decline in the world price (because of lower world demand), reducing the measured pass-through. For a small country, a currency depreciation would have no effect on world prices, and thus pass-through would be complete in the simple model. Therefore, even within the confines of this model, pass-through should be greater in smaller economies.

Still, pass-through appears to vary more—across countries and time as well as across industries within a country—than can be expected in the simple model. Consequently, recent studies have examined firms' adjustment of markups in response to exchange rate fluctuations. A theoretical basis for many of these studies is Dornbusch

[6] Theoretical antecedents of this model and Clark's (1999) include the production chain model of Blanchard (1983) and the limited participation model of Christiano, Eichenbaum, and Evans (1997).

(1987), who applied industrial organization models to explain pass-through in terms of market concentration, import penetration, and the substitutability of imported and domestic products. Utilizing these principles, Feinberg (1986, 1989) found exchange rate pass-through to domestic producer prices in the US and Germany to be greater in industries that were less concentrated and faced greater import penetration. More generally, Goldberg and Knetter (1997) concluded that the pass-through to import prices is smaller in more segmented industries—that is, industries where firms are able to engage in third degree price discrimination.

What do these results imply for cross-country differences in pass-through? If a country's import share can be assumed to be a good proxy for the import penetration faced by firms, then a country with a larger import share should have greater pass-through of exchange rate and import price fluctuations to domestic prices.[7] In addition, both because of a direct effect as well as through a greater pass-through, exchange rates and import prices should be more important in explaining domestic price fluctuations as the import share increases.

Relating the industrial organization characteristics of concentration and market segmentation to the country level is more difficult. Here, I will use a country's "competitiveness" as measured by the Global Competitiveness Report from the World Economic Forum (1999) as a proxy and examine how it correlates with the extent of pass-through and the importance of exchange rates and import prices in explaining domestic price fluctuations.

Recent studies investigating the "pricing-to-market" hypothesis of Krugman (1987) and Marston (1990) suggest additional influences on pass-through. Knetter (1993) finds that a firm's industry matters more than its nationality for pricing-to-market behavior. This suggests that cross-country differences in pass-through may reflect differences in industrial composition. Also, if firms pay less attention to pricing strategies in smaller markets, pricing-to-market may occur less and pass-through should be larger in smaller economies.

Using the pricing-to-market principles, Mann (1986) discusses some macroeconomic variables that may affect pass-through. One is exchange rate volatility. Greater exchange rate volatility may make importers more wary of changing prices and more willing to adjust profit margins, thus reducing pass-through. Wei and Parsley (1995) and Engel and Rogers (1998) have provided some empirical evidence confirming this hypothesis at the sectoral and product level. Thus pass-through should be less in countries where the exchange rate has been more volatile.

In a similar vein, if firms expect exchange rate or import price shocks to be persistent, they are more likely to change prices rather than adjust profit margins in response to changes in the exchange rate or import prices, which would increase

[7] In contrast, Yang (1997) presents a model where import share in an industry is negatively related to exchange rate pass-through. The empirical results, however, indicate a statistically insignificant relationship across US industries.

pass-through.[8] Thus pass-through should be greater in countries where fluctuations in exchange rates and import prices have displayed greater persistence.

Another macroeconomic variable discussed by Mann (1986) is aggregate demand uncertainty. Aggregate demand shifts in conjunction with exchange rate fluctuations will alter the profit margins of importers in an imperfectly competitive environment, thus reducing measured pass-through. If this hypothesis is true, pass-through should be less in countries where aggregate demand (which will be proxied by the output gap) is more volatile.

3 Model and Methodology

To examine the pass-through of exchange rate and import price fluctuations to domestic producer and consumer inflation across countries, I use a model of pricing along a distribution chain.[9] Inflation at each stage—import, producer, and consumer—in period t is assumed to be comprised of several components. The first component is the expected inflation at that stage based on the available information at the end of period $t-1$. The second and third are the effects of period t domestic "supply" and "demand" shocks on inflation at that stage. The fourth component is the effect of exchange rate shocks on inflation at a particular stage. Next are the effects of shocks at the previous stages of the chain. Finally, there is that stage's shock.

The shocks at each stage are that portion of a stage's inflation that cannot be explained using information from period $t-1$ plus contemporaneous information about domestic supply and demand variables, exchange rates, and inflation at previous stages of the distribution cycle. These shocks can be thought of as changes in the pricing power and markups of firms at these stages. Two other features of the model are worthy of note. First, the model allows import inflation shocks to affect domestic consumer inflation both directly and indirectly through their effects on producer inflation. Second, there is no contemporaneous feedback in the model: for example, consumer inflation shocks affect inflation at the import and producer stages only through their effect on expected inflation in future periods.

Under these assumptions, the inflation rates of country i in period t at each of the three stages—import, producer (PPI), and consumer (CPI)—can be written as:[10]

$$\pi_{it}^{m} = E_{t-1}(\pi_{it}^{m}) + \alpha_{1i}\varepsilon_{it}^{s} + \alpha_{2i}\varepsilon_{it}^{d} + \alpha_{3i}\varepsilon_{it}^{e} + \varepsilon_{it}^{m} \tag{1}$$

$$\pi_{it}^{w} = E_{t-1}(\pi_{it}^{w}) + \beta_{1i}\varepsilon_{it}^{s} + \beta_{2i}\varepsilon_{it}^{d} + \beta_{3i}\varepsilon_{it}^{e} + \beta_{4i}\varepsilon_{it}^{m} + \varepsilon_{it}^{w} \tag{2}$$

[8] For a short discussion of exchange rate persistence and pass-through, see Branson (1989), p.333.

[9] As discussed in the introduction, the chain structure of the model is similar to that of Blanchard (1983), Christiano, Eichenbaum, and Evans (1997), and Clark (1999).

[10] Even though the data have both cross-sectional and time-series aspects, the model will be estimated for each country separately because differing institutions in each country are likely to lead to different responses in each country (hence the i subscript for each coefficient in the equations).

$$\pi^c_{it} = E_{t-1}(\pi^c_{it}) + \gamma_{1i}\varepsilon^s_{it} + \gamma_{2i}\varepsilon^d_{it} + \gamma_{3i}\varepsilon^e_{it} + \gamma_{4i}\varepsilon^m_{it} + \gamma_{5i}\varepsilon^w_{it} + \varepsilon^c_{it} \tag{3}$$

where π^m_{it}, π^w_{it}, and π^c_{it} are import price, PPI, and CPI inflation respectively; ε^s_{it}, ε^d_{it}, and ε^e_{it} are the supply, demand, and exchange rate shocks respectively; ε^m_{it}, ε^w_{it}, and ε^c_{it} are the import price, PPI, and CPI inflation shocks; and $E_{t-1}(\cdot)$ is the expectation of a variable based on the information set at the end of period $t-1$. The shocks are assumed to be serially uncorrelated as well as uncorrelated with one another within a period.

The structure of equations (1)-(3) suggests they are part of a recursive VAR framework. Thus to complete the empirical model, I include two additional portions. The first portion identifies aggregate demand and supply shocks and exchange rate shocks through the following assumptions. (1) Supply shocks are identified from the dynamics of oil price inflation denominated in the local currency.[11] (2) Demand shocks are identified from the dynamics of the output gap in the country after taking into account the contemporaneous effect of the supply shock. (3) Exchange rate shocks are identified from the dynamics of exchange rate appreciation after taking into account the contemporaneous effects of the supply and demand shocks.[12] The equations of this portion of the model then are the following.

$$\pi^{oil}_{it} = E_{t-1}(\pi^{oil}_{it}) + \varepsilon^s_{it} \tag{4}$$

$$\tilde{y}_{it} = E_{t-1}(\tilde{y}_{it}) + a_{1i}\varepsilon^s_{it} + \varepsilon^d_{it} \tag{5}$$

$$\Delta e_{it} = E_{t-1}(\Delta e_{it}) + b_{1i}\varepsilon^s_{it} + b_{2i}\varepsilon^d_{it} + \varepsilon^e_{it} \tag{6}$$

Because monetary policy may react to exchange rate fluctuations and because policy also eventually affects exchange rates and domestic inflation, the last portion of the model consists of a central bank reaction function and a money demand equation in the spirit of the Christiano, Eichenbaum, and Evans (1996) model.[13] The reaction function relates short-term interest rates to the previously cited variables in the model as central banks use the short-term rate as their monetary policy instrument. The money demand function relates money growth to the other variables in the model.

$$i_t = E_{t-1}(i_t) + c_{1i}\varepsilon^s_{it} + c_{2i}\varepsilon^d_{it} + c_{3i}\varepsilon^e_{it} + c_{4i}\varepsilon^m_{it} + c_{5i}\varepsilon^w_{it} + c_{6i}\varepsilon^c_{it} + \varepsilon^{MP}_{it} \tag{7}$$

$$\Delta m_t = E_{t-1}(\Delta m_t) + d_{1i}\varepsilon^s_{it} + d_{2i}\varepsilon^d_{it} + d_{3i}\varepsilon^e_{it} + d_{4i}\varepsilon^m_{it} + d_{5i}\varepsilon^w_{it} + d_{6i}\varepsilon^c_{it} + d_{7i}\varepsilon^{MP}_{it} + \varepsilon^{MD}_{it} \tag{8}$$

[11] Casual observation suggests that the effect of oil prices on domestic inflation is more symmetric than their effect on GDP. Therefore, I will use the simpler oil price inflation rather than the net oil price increase variable of Hamilton (1996).

[12] Empirical research on exchange rates, at least since Meese and Rogoff (1983), suggests that most short-term fluctuations cannot be explained by macroeconomic fundamentals; see, for example, the survey by Taylor (1995). This simple model thus should be sufficient to identify exchange rate shocks.

[13] For discussion of the effect of monetary policy on estimates of pass-through, see Pigott, Rutledge, and Willett (1985) and Parsley and Popper (1998).

Finally, I assume that the conditional expectations in equations (1)-(8) can be replaced by linear projections of the lags of the eight variables in the system. Under these assumptions, the model can be estimated as a VAR using a Cholesky decomposition.[14] The impulse responses of PPI and CPI inflation to the orthogonalized shocks of exchange rate appreciation and import price inflation then provide estimates of the effect of these variables on domestic inflation. In addition, variance decompositions of PPI and CPI inflation enable one to determine the importance of these "external" variables for domestic inflation.

4 Data

Data from nine developed countries—the United States, Japan, Germany, France, the United Kingdom, Belgium, the Netherlands, Sweden, and Switzerland—are used in this study.[15] The data are quarterly and limited to the floating exchange rate period, and mostly come from national sources as compiled by the BIS data bank.[16] To account for lags in the construction of some variables and in the model specifications, the estimation period runs from 1976:1 through 1998:4 for most countries.[17]

As far as the variables used in this study, the exchange rate is the quarterly average of the nominal effective exchange rate as computed by the BIS. Depending upon data availability, import prices are either a general import price index or an index of import unit values. The PPI is the most general producer or wholesale price index that excludes imports. Imports were excluded because the broadest available PPI in some countries—in particular, the United States—do not include imports.[18] The CPI is the overall consumer price index to provide the broadest measure of inflation at the consumer level. Because of the numerous methodological changes in the US CPI in recent years, I use the current methods CPI research series.[19] The output gap is

[14] Although the Cholesky decomposition identifies aggregate supply and demand shocks under the assumptions of this model, oil price inflation may be affected contemporaneously by both aggregate supply and demand shocks. If so, each of the shocks in the first two equations of the VAR would be a combination of aggregate supply and demand shocks (Blanchard and Quah (1989)). Even if this is so, this should have little effect on the measurement of exchange rate and import prices shocks and their effect on domestic inflation.

[15] The German analysis uses all-German data where possible; using only West German data has little effect on the results.

[16] Although a monthly frequency would be desirable in examining these issues, key variables in some countries are available only quarterly. For example, a lengthy import price series for the United States is available only quarterly.

[17] Because of data availability, the estimation period is 1981:2-1998:4 for Belgium and 1978:1-1998:4 for the Netherlands.

[18] Using the general PPI irrespective of whether imports were included had little substantive effect on the results outside of the correlation between import share and pass-through to the PPI.

[19] See Stewart and Reed (1999) for details in the construction of this series.

created by taking the deviations of the log of real GDP from a linear and quadratic trend. The interest rate variable is an overnight interest rate, comparable to the US Federal funds rate, as such interest rates have been shown to be good indicators of monetary policy actions.[20] For the money variable, I use a broad monetary aggregate, primarily because such aggregates are generally available on a consistent basis. The appendix provides country-specific details about the variables.

Annualized percentage changes of the price indices and average output gaps and interest rates over five-year periods as well as the last three years of the sample are presented in Table 1. This summary provides some insight into the questions and problems of measuring the pass-through of exchange rates and import prices to domestic prices. In particular, the table shows that many declines in domestic inflation have been associated with exchange rate appreciation and import price disinflation/deflation (and *vice versa*), and suggests that these external factors may have played a role in the disinflation of the 1990s.

Nonetheless, there also have been cases where countries have experienced sizable swings in exchange rates and import prices with little effect on domestic prices. For example, the exchange rate depreciated over 1996-98 in Japan, Germany, and France, but the depreciations were associated with only a moderate increase in inflation (Japan) or disinflation (Germany, France). Other factors obviously have been important in the disinflation experienced by these countries, the most prominent probably being the decline in oil prices. Therefore, econometric analysis using the model presented in Section 3 is required to determine the role of exchange rates and import prices in domestic inflation.

5 Results

As discussed in Section 3, the model is estimated as a VAR consisting of eight variables: oil price inflation, the output gap, exchange rate change, import price inflation, PPI inflation, CPI inflation, short-term interest rate, and money growth.[21] The reduced form residuals from the VAR are orthogonalized using a Cholesky decomposition to identify the structural shocks, where the variables are in the order given above.

For each country, the number of lags in the VAR is set at four (a constant is the only other variable included in the regressions), and the model is estimated over the period 1976:1-1998:4 (92 quarters). Two sets of statistics are used to assess the

[20]For evidence on this in the US, see Bernanke and Blinder (1992).

[21]By estimating the model in this way, I am ignoring possible cointegration among the variables. Cointegration tests indicate several possible cointegrating vectors; however, the speed of convergence appears to be slow (similar to that toward PPP; see Rogoff (1996) and Higgins and Zakrajšek (1999)). Given the short horizons studied in this paper, using this simpler model should have little effect on the results.

pass-through from exchange rate fluctuations and import price inflation to domestic inflation. First, impulse responses to the exchange rate and import price shocks are estimated over a two-year (8-quarter) horizon.[22] These are standardized to correspond to the response to a one percent shock in the exchange rate or import price index to allow a comparison of the sensitivity to these factors across countries. Second, variance decompositions are used to measure the percentage of the forecast variance in domestic price indices that can be attributed to these factors, providing an assessment of their importance for domestic inflation.

5.1 Responses to exchange rate shocks

Figures 1-3 display the responses of the import price index, the PPI, and the CPI to an exchange rate shock in each of the countries of the sample. In this model, the exchange rate shock is estimated given past values of all variables plus current values of oil prices and the output gap. The solid line in each graph is the estimated response while the dashed lines denote a two standard error confidence band around the estimate.[23]

The initial impact of an exchange rate appreciation on import prices is negative as expected and remains so for at least a year in all of the countries (Figure 1). By the end of two years, the response is imprecisely estimated in many countries, and there are cases where it is positive. For the US, the pass-through is similar to previous estimates as well as common perceptions concerning exchange rate pass-through.[24] The pass-through is particularly large in Belgium and the Netherlands, with the eventual change in import prices exceeding 1 percent. On the other hand, the pass-through is surprisingly small in Sweden and Switzerland.

The response of the PPI appears to be fairly weak in most of the countries (Figure 2). Statistically, the estimates are not significantly different from zero, and for Japan the response has the wrong sign. The exceptions to this pattern are Belgium and the Netherlands. The estimates for the US are somewhat weaker than those in Feinberg (1989), but the estimates for Germany are similar to those in Feinberg (1986).

The response of the CPI to the exchange rate shock is smaller than that of the PPI, and is statistically insignificant in most cases (Figure 3). Furthermore, a number of responses have the wrong (positive) sign, particularly in Japan and France. Again, the exceptions to this pattern are Belgium and the Netherlands. The pass-through in the US is similar to the results of Woo (1984) for the pass-through to the consumption price deflator and of Parsley and Popper (1998) for the pass-through to the CPI.

[22] Although the model is estimated in first differences, it is then transformed into levels so that cumulative price level responses are examined.

[23] The error bands are estimated using the Bayesian Monte Carlo method employed by RATS with 1000 draws.

[24] See Kreinin (1977), Woo (1984), Hooper and Mann (1989), and Goldberg and Knetter (1997).

To judge further whether these responses are "large," I compare the estimated responses to the 1976-97 average of the ratio of imports to private final consumption expenditures.[25] Ignoring any effects on competing domestic goods, if exchange rate fluctuations were passed through completely down the distribution chain, the effect on the CPI would roughly be the imports-expenditure ratio since the CPI is weighted by expenditures. Therefore, this ratio can be considered to be a lower bound of a large pass-through to the CPI. In Figure 4, (the negative of) this ratio is pictured as the horizontal dashed line while the estimated response is the solid line. As can be seen in the figure, the responses are not nearly as large as this standard, suggesting that the pass-through to CPI is small in these countries.

Although the estimates of pass-through are small and imprecise, there are noticeable differences across countries. To assess explanations for these differences, I calculate the Spearman rank correlation statistic between the impulse responses at various horizons and some factors expected to influence pass-through. From the discussion in Section 2, the factors are: (1) mean import share (imports as a percentage of domestic demand) over 1985-1998;[26] (2) 1975 GDP in US dollars using purchasing power parities from the OECD;[27] (3) exchange rate persistence measured by the impulse response at the 8-quarter horizon of the exchange rate to its own standardized shock;[28] (4) exchange rate volatility measured by the variance of the residuals from the exchange rate equation; (5) aggregate demand volatility measured by the variance of the residuals from the output gap equation; (6) as a simple measure of industrial composition, the average manufacturing sector share of GDP by value added over 1980-94; and (7) "competitiveness" measured by the average ranking from 1996-99 global competitiveness surveys by the World Economic Forum (1999).

The rank correlations are mostly in accord with the hypotheses discussed in Section 2 (Table 2). Higher import shares, more persistent and less volatile exchange rates, and less volatile GDP are correlated with a greater import price response, although the relationship is statistically significant only for exchange rate persistence and volatility (panel a). Greater competitiveness is associated with a smaller response, an association statistically significant at short horizons. This suggests that importers to countries identified as more competitive adjust profit margins more to

[25] The data to compute these ratio come from *OECD National Accounts, Part I.*

[26] This is the longest period where there are complete data for each of the countries. Using a particular date or subperiod over this interval does not affect the ranking.

[27] 1975 was chosen as the year before the estimation period. Choosing a different year or average over the estimation period has minimal effects on the results since the ranking changes only for the two smallest economies in the sample (Sweden and Switzerland).

[28] Because the exchange rate shock is standardized to be one percent in all of the countries, so is the initial impulse response of the exchange rate to its own shock. Accordingly, the response of the exchange rate to its own shock at the 8-quarter horizon provides a measure of the persistence of exchange rate fluctuations across the countries. Using the 4-quarter horizon has little substantive effect on the results.

maintain market share. However, manufacturing share and 1975 GDP display no strong correlation with the import price response.

The results for the PPI response are similar to those for import prices, although the correlations for import share and exchange rate volatility are stronger while the correlations for exchange rate persistence are weaker (panel b). In addition, both GDP and manufacturing share are negatively correlated with this response. The latter correlation is consistent with pricing-to-market in the manufacturing sector. Finally, most of the correlations between these factors and the response of the CPI are weaker than those for the PPI (panel c). The exceptions are exchange rate persistence, which is strongly positively correlated with the response at all horizons, and manufacturing share, which remains negatively correlated with the response. Import share and exchange rate volatility have the expected correlations and these are statistically significant at some horizons.

To summarize, the impulse responses indicate considerable (although not complete) pass-through of exchange rate fluctuations to import prices in most of these countries. In contrast, pass-through to the PPI and CPI is economically modest for the most part. Therefore, "beachhead" behavior that has been a focus of many studies of import prices in the US appears to be pervasive when examining PPI and CPI pass-through in industrialized economies.[29] Higher import shares, more persistent and less volatile exchange rates, less volatile GDP, and lesser "competitiveness" are associated with larger pass-through.

5.2 Responses to import price shocks

Figures 5 and 6 display the responses of the PPI and the CPI to an import price shock. In the model, the import price shock is estimated given past values of all variables plus the current value of oil prices, the output gap, and the exchange rate. Therefore, these shocks are uncorrelated with exchange rate movements, but are likely to be related to movements in world commodity prices, changes in importers' profit margins, etc. These responses then should be informative about the pass-through from an import price decline like that induced by the 1997-98 Asian crisis.

The response of the PPI to an import price shock is positive as expected and usually statistically significant (Figure 5). The responses are particularly large in Belgium and Sweden, with the pass-through eventually exceeding 100 percent. In contrast, the pass-through is rather small in Japan.

The response of consumer prices to an import price shock is also positive and usually statistically significant, although smaller than the PPI response (Figure 6). In absolute terms, the pass-through is largest in Sweden, is quite large in the US, and is small in Japan. Comparing these responses to the import-private consumption

[29] For examples, see Baldwin (1988) and Baldwin and Krugman (1989).

expenditures ratio as was done for the exchange rate pass-through, they appear to be "large" after two years in most of these countries, with the exceptions being Japan, Belgium, and the Netherlands (Figure 7). Especially noteworthy the response in the US, which is about at its import-expenditures ratio on impact and rises well above this standard over the next two years.

I next examine the cross-country rank correlations between these responses and the seven factors listed in the previous subsection (Table 3). For the PPI, a higher import share, a smaller economy, and a less volatile exchange rate are associated with a larger pass-through, although these relationships are statistically insignificant (panel a). In contrast, import price persistence is strongly correlated with a larger response at all horizons. Greater competitiveness is significantly correlated with a smaller response at short horizons, suggesting that profit margins at the producer level are adjusted more in those countries identified as more "competitive," but manufacturing share displays no strong relationship.

Turning to the CPI, the correlations between the responses and these factors are less clear cut than those for the other responses (panel b). For import share, exchange rate volatility, and GDP volatility, the correlations have the wrong sign although they are not statistically significant. Greater competitiveness is associated with a larger initial response, but there is little relationship thereafter. Only the correlation between import price persistence and the CPI response has the expected sign and is statistically significant at longer horizons. The weak correlations suggest that pass-through of import prices to consumer prices vary across countries more idiosyncratically than do other pass-throughs, possibly reflecting country-specific market structures and industrial composition not captured by these variables.

5.3 Variance decomposition

Although the impulse responses indicate the extent of pass-through to domestic prices, they do not indicate how important these shocks have been in domestic price fluctuations. If the exchange rate and import price shocks in a country are small, then pass-through could be large but exchange rates and import prices would have little influence on domestic inflation. Therefore, to investigate the importance of these external factors, I examine the variance decompositions of the price variables.

For import prices, exchange rate shocks are especially important in explaining import price variance in the UK, where their share ranges from over 25 to 40 percent (Table 4).[30] In the other countries, exchange rates explain from 5 to 30 percent (with most between 10 and 20 percent) of import price forecast variance initially. This percentage declines in all countries except the Netherlands as the forecast horizon

[30] The complete variance decomposition of import prices as well as the PPI and the CPI can be found in the Appendix in Tables A1-A3.

increases so that it ranges from 2 to 12 percent (with the exception of the UK) at the two-year horizon.

The lower part of Table 4 displays the rank correlations between the percentage of import price variance attributed to exchange rate shocks and the factors listed in Section 5.1. Import share is negatively associated with this percentage, although the relationship is strong only at impact. Exchange rate persistence is negatively correlated with this percentage at shorter horizons, but positively correlated at longer horizons. Exchange rate volatility is positively associated with this percentage at impact, suggesting the larger exchange rate fluctuations counteract the smaller import price response documented in Section 5.1. However, there is little relationship at longer horizons. Both economic size and manufacturing share are positively correlated with this percentage, significantly so for manufacturing share at shorter horizons. The positive correlation for manufacturing share may be surprising given that pricing-to-market is thought to be important in manufacturing.

For producer prices, the percentage of variance explained by exchange rates and import prices is quite large in many countries, which may be surprising since these PPIs exclude imported goods (Table 5). These factors explain one-third or more of variance of PPI (at least for some horizons) in five countries—Germany, France, Belgium, Sweden, and Switzerland. Although not negligible, their contribution in the other countries is more modest. The differences across countries are negatively related with economic size as expected, but are positively related with manufacturing share at short horizons, which is less expected. Interestingly, this percentage is positively correlated with import price persistence, but is negatively correlated (although insignificantly so) with exchange rate persistence.

The influence of exchange rates and import prices on CPI variance is less than it is for PPI, even though imported goods are included in CPI (Table 6). In most of the countries, these factors explain less than 25 percent of the variance of the CPI, although this percentage tends to increase as the forecast horizon increases. At longer horizons this percentage tends to be higher for countries with a larger import share, greater exchange rate and import price persistence, lower exchange rate volatility, and a smaller manufacturing sector.

The variance decompositions thus indicate that external factors explain a modest proportion of the variance of domestic consumer prices over the post-Bretton Woods era. As expected, the influence of these factors is greater in more open economies and in countries where exchange rates and import prices display persistence.

6 Recent Influence of External Factors

The analysis in the previous section suggests that external factors have had a modest effect on domestic price fluctuations during the post-Bretton Woods era. Nonetheless, these factors still could have been a significant contributor to the recent disinflation in the US and UK (as well as domestic price fluctuations in the other countries) if the shocks to these factors have been large and/or frequent.

To investigate the recent influence of these factors, I examine a historical decomposition of the VAR model for the period 1996:1-1998:4. In this decomposition, a base projection is made using the data through 1995:4 and assuming no subsequent shocks occur to any of the variables. Then using the estimated shocks to each of the variables, the projection error is decomposed into the contributions from each shock.

The decomposition of import price inflation provides some evidence concerning how unusual recent import price behavior has been in these countries. The first column of Table 7 displays the actual annualized percentage change of import prices over 1995:4–1998:4. The second column has the base projection, and the third has the projection error (projection – actual). The last four columns display the contributions of the shocks combined into four groups: demand and supply shocks (oil price and output gap), external factors (exchange rate and import price), domestic price shocks (PPI and CPI), and monetary shocks (interest rate and money). The contribution is defined as the difference between the base projection and the projection that includes the associated shocks.[31]

According to the model, import price inflation was below its projection in most of these countries—the exceptions being Japan and Switzerland. Shocks to external factors contributed to lower import price inflation in all countries except Japan and the Netherlands. Their contribution was especially large in the UK; still, in those countries outside of the US and the UK, the disinflationary effects of negative shocks to import prices stemming from the 1997-98 Asian crisis overwhelmed the inflationary effects of exchange rate depreciation. As far as the other variables, supply and demand shocks contributed to lower import price inflation in the US and the UK, but contributed to higher import price inflation in several other countries. In contrast, domestic price shocks lowered import price inflation in most countries. The effects of monetary variables were small except in the US and Japan where their contribution was positive.

Moving along the distribution chain, actual PPI inflation was less than projected except in Japan and the Netherlands (Table 8). Shocks to the external factors reduced PPI inflation in just over one-half of the countries—Germany, France, the UK, Belgium, and Sweden. Surprisingly, exchange rate and import price shocks were a slight positive contributor to US PPI inflation. The major disinflationary contributors in the US instead were aggregate demand and supply shocks (the oil price decline) and domestic price shocks. Price shocks also reduced PPI inflation in all of the other countries except the UK and the Netherlands, suggesting that changes in domestic

[31] Because the table displays the more familiar annualized percentage changes rather than the log differences in which the model was estimated, the contributions do not add up exactly to the projection error.

pricing behavior may have contributed to the disinflation. The contributions of monetary shocks were mixed: they were positive contributors in the US and Sweden and negative contributors in France, Belgium, and the Netherlands.

The story for consumer price inflation is similar to that of producer price inflation (Table 9). Except for Japan and the Netherlands, actual CPI inflation was below the model's base projection. Shocks to the external factors were negative contributors in two-thirds of the countries; however, these shocks were small positive contributors to CPI inflation in the US. As was the case for PPI inflation, aggregate demand and supply shocks—in particular, the decline in oil prices—as well as domestic price shocks are identified as the disinflationary forces in the US during this period. Domestic price shocks also were disinflationary factors during this period in the other countries except for Japan, the UK, and the Netherlands. Monetary shocks were small positive contributors in most countries, although the contribution was larger in Sweden. The exceptions were France and Belgium, suggesting that these countries may have been conducting a tighter monetary policy in anticipation of the introduction of the euro.

To summarize, external shocks have contributed to the disinflation of the late 1990s in many of these countries, suggesting that the import price decline stemming from the Asian crisis had a notable impact on inflation in the industrialized economies. However, despite the appreciation of the US dollar and the decline in import prices, these factors had little effect on the US disinflation once the oil price decline is taken into account.[32] Domestic price shocks also were a disinflationary factor in most of these countries, suggesting that there may have been changes in pricing behavior that have reduced inflation.

7 Has the Influence of External Factors Changed?

When discussing the influence of exchange rates and import prices on domestic inflation, pundits frequently point to greater global integration and competition as reasons for a greater pass-through of these factors. On the other hand, central banks have been more concerned with price stability during the last two decades. This would imply that monetary authorities may have counteracted the inflationary impact of these external shocks, reducing the measured pass-through over time.[33]

Therefore, the pass-through of external factors to domestic inflation may have changed over the years. To investigate this, I use a simple strategy of estimating the

[32] Of course, the Asian crisis probably was one factor behind the oil price decline.

[33] See Pigott, Rutledge, and Willett (1985) and Parsley and Popper (1998) concerning the question of central bank reactions to exchange rate fluctuations and estimating pass-through.

Some countries, most prominently Canada and New Zealand, began to use a monetary conditions index that includes the exchange rate to guide monetary policy during this period. The countries in this sample did not formally incorporate such an index in their monetary policy deliberations, but they may have informally incorporated exchange rates and import prices into their deliberations.

model over a sample period that does not include the 1970s. Balancing the concerns of using data from as late in the sample period as possible and of having sufficient observations for estimation, I decided to estimate the model from 1983:1 to 1998:4. In the subsequent analysis, I will concentrate on the pass-through to CPI for brevity.[34]

First examining the impulse response of the CPI to an import price shock, the differences between the responses estimated over the whole sample and those estimated over the shorter sample are small and probably statistically insignificant (Figure 8). Nevertheless, an import price shock appears to have a less inflationary effect during the later sample period in Japan, France, the Netherlands, and Sweden. Therefore, the impulse responses do not indicate a greater pass-through from import prices to the CPI during the 1980s and 1990s. In addition, the cross-country rank correlations between the responses and the factors listed in Section 5.1 retain the same signs, although they are weaker than they are in the full sample.

In contrast to the impulse responses, the variance decomposition indicates that external factors may have been more important contributors to CPI fluctuations in some countries during the later sample period (Table 10). In particular, the percentage of CPI forecast variance explained by external factors appears to be quite high for Germany, France, and the UK (upper panel). For the rest of the countries, the proportion of the CPI variance explained by these factors in the shorter sample period is similar to that in the full sample. Also, the correlations between the external factor contribution and the factors listed in Section 5.1 across countries are weaker in the later sample (lower panel).

Concentrating on the late 1990s, the historical decomposition using the model estimated over the later sample period paints a somewhat different picture of the disinflation (Table 11). Using the post-1982 data, the disinflation in the late 1990s is less surprising, with negative projection errors only for the US, the UK, Belgium, and Sweden. External factors have a sizable disinflationary effect only in the UK and Switzerland. For the US, excluding the 1970s data (and the oil price inflation of that era) wipes out the disinflationary impact of aggregate demand and supply shocks so that only domestic price shocks have a sizable disinflationary contribution. Monetary shocks have little impact in this case except possibly for Sweden and Switzerland.

These results suggest that exchange rates and import prices have not assumed a bigger role in domestic consumer price inflation in recent years, and may even have had a smaller role. In any case, the conclusion that the pass-through is modest still appears to hold in this later period.

[34] The conclusions in examining the effects on the PPI are substantially the same.

8 Conclusion

This paper has examined the pass-through of external factors—the exchange rate and import prices—to domestic inflation for several industrialized economies. Using a VAR model that incorporates a distribution chain, I find that the pass-through to aggregate consumer prices, which is the principal concern for monetary policy, appears to be modest in most of these countries. Still, these factors did have a disinflationary effect during the late 1990s in many of these countries, although not in the US.

This latter result for the US is probably the most surprising, as Gordon (1998), Stock (1998), Boldin (1998), and Koenig (1998) all find that external factors improve the forecast of US consumer price inflation in the mid- to late-1990s. I attribute these differences to two factors. First, the model in this paper includes a Fed reaction function and money demand function that are not part of the models in the previously cited studies. Second, unlike these other papers, I use a methodologically consistent version of the US CPI. This is important because the US Bureau of Labor Statistics made several methodological changes in the CPI during this period which had the effect of reducing published CPI inflation.

The overall results have a number of implications for monetary policy in the industrialized countries. One is that although external factors have contributed to the disinflation of the 1990s, their contribution mostly has been modest. Thus much of the decline in inflation during this decade has come from other, presumably more permanent factors, indicating that central banks may have been successful in reducing inflation expectations. Another implication is that continued fluctuations in exchange rates and import prices resulting from possible continued turmoil in emerging markets will have modest effects on domestic inflation in the industrialized world unless domestic policy mistakes are made.

Nevertheless, because of the recent financial and economic crises in several emerging markets and their effects on the global prices of some goods as well as increasing globalization, more research on the extent to which pass-through may have changed in recent years is necessary. A model that incorporates time variation in some of its parameters is desirable for such an examination. Furthermore, additional investigation into the 1990s disinflation is needed; in particular, the role and sources of the domestic "price shocks" in the historical decomposition. Such an investigation may provide more insight into the mechanisms behind the pass-through of exchange rates and import prices to domestic prices.

A Data Appendix

This appendix describes some of the details in the construction of the variables used in this study. As mentioned in the text, the data come from the BIS data bank. I first discuss variables whose construction is common for all the countries. I then discuss the construction of GDP, the import price index, the PPI, and the CPI for each country separately, as the details in their construction differs across countries.

A.1 Common variable construction

Local currency oil price index: This is constructed for each country using a crude oil US dollar-basis price index from the BIS data bank (1990=100, quarterly average of monthly data). This is converted into a local currency index using an index of the currency's exchange rate versus the US dollar (1990=1.00, quarterly average of monthly data).

Output gap: As discussed in the text of the paper, the output gap is calculated as the residual from a regression of the logarithm of GDP (details for each country are given below) on a constant plus linear and quadratic time trends.

Exchange rate: This is taken as the quarterly average of the BIS-calculated nominal effective exchange rate index versus 25 countries (1990=100).

Import share: This is imports as a percentage of domestic demand (GDP + imports – exports), where all variables are in the same units as GDP (see below for each country).

1975 GDP in US dollars: This is 1975 GDP in 1975 prices using 1975 PPP exchange rates as published by the OECD in *National Accounts, Part I.*

Manufacturing sector share of GDP: This is value added of the manufacturing sector as a percentage of GDP in current prices, averaged over 1980-94 as published by the OECD in *National Accounts, Part II.*

Competitiveness: This is the average ranking of global competitiveness from 1996-99 as compiled by the World Economic Forum (1999).

A.2 Nation-specific variable construction

A.2.1 United States

GDP: This is gross domestic product valued using billions of 1996 chained-weighted US dollars, seasonally adjusted at an annual rate.

Import price index: This is the national income and product account (NIPA) total import price index (1996 = 100), seasonally adjusted.

PPI: This is the quarterly average of the monthly finished goods index of the US PPI (1982=100), seasonally adjusted.

CPI: This is constructed by splicing two series. The first is the quarterly average of the monthly all items index of the CPI research series using current methods (CPI-U-RS, December 1977=100), not seasonally adjusted.[35] Prior to that, I use the quarterly average of the monthly CPI experimental series using the rental equivalence approach (CPI-U-X1, December 1982=97.6), not seasonally adjusted. The latter series is reindexed so that the 1978:1 values of the two series are equal. The resulting series is then seasonally adjusted using the US Census X-11 program.

Interest rate: This is the quarterly average of the effective Federal funds rate.

Monetary aggregate: This is the quarterly average of the monthly M2 monetary aggregate in billions of dollar, seasonally adjusted.

A.2.2 Japan

GDP: This is gross domestic product in billions of yen valued using 1990 prices, seasonally adjusted at an annual rate.

Import price index: This is the quarterly average of the monthly general index of import prices in Japan (1995=100), not seasonally adjusted. The series is seasonally adjusted by regressing the log difference of the series on quarterly dummy variables.

PPI: This is the quarterly average of the monthly general wholesale price index for domestic products for domestic use (1995=100), not seasonally adjusted. The series is seasonally adjusted in the same manner as the import price series.

CPI: This is the quarterly average of the monthly all-Japan general CPI (1995=100), not seasonally adjusted. The series is seasonally adjusted in the same manner as the import price series.

Interest rate: This is constructed by splicing two series. The first is the quarterly average of the interest rate on overnight uncollateralized call money, which begins in 1985:3. Prior to that, I use the quarterly average of the interest rate on overnight collateralized and uncollateralized call money, a series that was discontinued in February 1993. The latter series is reindexed so that the 1985:3 values of the two series are equal.

Monetary aggregate: This is quarterly average of the monthly M2 plus CDs monetary aggregate in billions of yen, seasonally adjusted.

A.2.3 Germany

GDP: This is constructed by splicing two series. The first is the all-German gross domestic product in billions of marks using 1991 prices, seasonally adjusted, which begins in 1991:1. Prior to that, I use West German gross domestic product in billions

[35] Stewart and Reed (1999) provide details of the adjustments made to the published CPI series to construct this methodologically consistent series.

of marks at 1991 prices, seasonally adjusted. This latter series is reindexed so that the 1991:1 values of the two series are equal.

Import price index: This is the quarterly average of the monthly general import price index (1991=100), seasonally adjusted, which is available for the combined West and East Germany over the entire sample period.

PPI: This is constructed by splicing two series. The first is the all-German PPI excluding the VAT for manufactures domestic sales (1991=100), not seasonally adjusted, which begins in 1991:1. Prior to that, I use the West German version of the same series. The latter series is reindexed so that the 1991:1 values of the two series are equal. The spliced series is seasonally adjusted by regressing the log difference of the series on quarterly dummy variables.

CPI: This is constructed in the same manner as the PPI. The two series that are spliced are the all-German all items cost of living index (1991=100), seasonally adjusted which begins in 1991:1; and the West German version of the same.

Interest rate: This is the quarterly average of the interest rate on day-to-day money.

Monetary aggregate: This is the quarterly average of the monthly M3 monetary aggregate in billions of marks, seasonally adjusted. The series is not adjusted for the increase in the aggregate following unification in 1990.

A.2.4 France

GDP: This is gross domestic product in millions of French francs valued using 1980 prices, seasonally adjusted.

Import price index: This is the implicit price deflator for import of goods and services in the GDP accounts (1980=100), seasonally adjusted.

PPI: This is the quarterly producer price index for industrial products (1980=100), seasonally adjusted.

CPI: This is constructed by splicing two series. The first is the quarterly average of the monthly retail consumer prices index, all items (1990=100), not seasonally adjusted, which begins in 1990:1. Prior to that, I use the retail prices index, total (1980=100), not seasonally adjusted. The latter series is reindexed so that the 1990:1 values of the two series are equal. The spliced series is seasonally adjusted by regressing the log difference of the series on quarterly dummy variables.

Interest rate: This is the quarterly average of the interest rate on day-to-day loans.

Monetary aggregate: This is constructed by splicing two series. The first is the quarterly average of the monthly M3 monetary aggregate in millions of French francs, seasonally adjusted, which begins in December 1977. Prior to that, I use the quarterly average of the monthly discontinued series of the monetary aggregate M3R (Total liquidity in the economy) in billions of French francs, seasonally adjusted. The latter series is reindexed so that the 1978:1 values of the two series are equal.

A.2.5 United Kingdom

GDP: This is gross domestic product (expenditure-based) in millions of British pounds using 1990 prices, seasonally adjusted.

Import price index: This is the quarterly general index of import prices (1990=100), not seasonally adjusted. It is seasonally adjusted by regressing the log difference of the series on quarterly dummy variables.

PPI: This is the quarterly average of the monthly producer price index of home market sales of all manufactured products based on the 1992 SIC classification (1990=100), not seasonally adjusted. It is seasonally adjusted in the same manner as the import price index.

CPI: This is the quarterly average of the monthly retail price index, all items (January 1987 = 100), not seasonally adjusted. It is seasonally adjusted in the same manner as the import price index.

Interest rate: This is constructed by splicing two series. The first is the quarterly average of the interest rate on overnight sterling interbank deposits, which begins in January 1978. Prior to that, I use the quarterly average of the interest rate on three-month sterling interbank deposits. The latter series is reindexed so that the 1978:1 values of the two series are equal.

Monetary aggregate: This is the quarterly average of the M4 monetary aggregate in millions of British pounds, seasonally adjusted.

A.2.6 Belgium

GDP: This is constructed by splicing two series. The first is gross domestic product in billions of Belgian francs using 1990 prices, seasonally adjusted, which begins in 1984:1. For 1980:1–1983:4, I use a discontinued gross domestic product series in billions of Belgian francs using 1985 prices, seasonally adjusted. The latter series is reindexed so that the 1984:1 values of the two series are equal.

Import price index: This is the quarterly average of the monthly imported goods producer price index (1990=100), not seasonally adjusted. It is available beginning in 1980, which matches the period GDP is available. The series is seasonally adjusted by regressing the log difference of the series on quarterly dummy variables.

PPI: This is constructed by splicing two series. The first is the quarterly average of the monthly index of producer prices for domestic sales of finished manufactures (1990=100), not seasonally adjusted, which begins in 1980:1. Prior to that, I use a discontinued quarterly average of the monthly index of producer prices for finished manufactures (1980=100), not seasonally adjusted. The latter series is reindexed so that the 1980:1 values of the two series are equal. The spliced series is seasonally adjusted in the same manner as the import price index series.

CPI: This is constructed by splicing three series. The first is the quarterly average of the monthly general consumer price index (1996=100), seasonally adjusted, which begins in 1991:1. The second is the quarterly average of a discontinued monthly general consumer price index (1980=100), seasonally adjusted, which begins in 1980:1. The second series is reindexed to the 1991:1 value of the first series. The third series is the quarterly average of another discontinued monthly general consumer price index (1980=100), seasonally adjusted, which begins in 1970:1. The third series is reindexed to the 1980:1 value of the reindexed second series.

Interest rate: This is constructed by splicing two series. The first is the quarterly average of the interest rate on overnight interbank deposits, which begins in January 1989. Prior to that, I use the quarterly average of the interest rate on day-to-day money, which was discontinued after December 1990. The latter series is reindexed so that the 1989:1 values of the two series are equal.

Monetary aggregate: This is the quarterly average of the M3H monetary aggregate in billions of Belgian francs, not seasonally adjusted. The series is seasonally adjusted by regressing the log difference of the series on quarterly dummy variables.

A.2.7 Netherlands

GDP: This is gross domestic product in millions of Dutch guilders using 1990 prices at purchasers' values, seasonally adjusted.

Import price index: This is constructed by splicing two series. The first is the quarterly average of the monthly general import price index (1990=100), not seasonally adjusted, which begins in 1981:1. Prior to that, I use the unit value of total imports (1990=100), not seasonally adjusted. The latter series is reindexed so that the 1981:1 values of the two series are equal. The spliced series is seasonally adjusted by regressing the log difference of the series on quarterly dummy variables.

PPI: This is the quarterly average of the monthly producer price index excluding exports and imports (1990=100), not seasonally adjusted. The series is seasonally adjusted in the same manner as the import price series.

CPI: This is the quarterly average of the monthly all items consumer price index for all households (1995=100), seasonally adjusted.

Interest rate: This is the quarterly average of the interest rate on call money.

Monetary aggregate: This is constructed by splicing two series. The first is the quarterly average of the monthly M3H (corrected for breaks) in millions of Dutch guilders, not seasonally adjusted, which begins in December 1982. This series is seasonally adjusted by regressing the log difference of the series on quarterly dummy variables. Prior to that, I use the quarterly average of the monthly M3 (national concept) monetary aggregate in millions of Dutch guilders, seasonally adjusted. The latter series is reindexed so that the 1983:1 values of the two series are equal.

A.2.8 Sweden

GDP: This is constructed by splicing two series. The first is gross domestic product in millions of Swedish kroner using 1991 prices, not seasonally adjusted, which begins in 1980:1. Prior to that, I use a discontinued gross domestic product series in millions of Swedish kroner using 1980 prices, not seasonally adjusted. The latter series is reindexed so that the 1980:1 value of the two series are equal to the 1980:1 values of the 1991-price series. The resulting series is seasonally adjusted using the US Census X-11 program.[36]

Import price index: This is constructed by splicing two series. The first is the quarterly average of the monthly general import price index (1990=100), not seasonally adjusted, which begins in 1990:1. Prior to that, I use the quarterly average of a discontinued monthly index of import prices (ISIC 1-3, 1968=100), not seasonally adjusted. The latter series is reindexed so that the 1990:1 values of the two series are equal. The spliced series is seasonally adjusted by regressing the log difference of the series on quarterly dummy variables.

PPI: This is constructed by splicing two series. The first is the quarterly average of the monthly producer price index for home sales (1990=100), not seasonally adjusted, which begins in 1990:1. Prior to that, I use the quarterly average of the monthly general domestic supply price index (1968=100), not seasonally adjusted. The latter series is reindexed so that the 1990:1 values of the two series are equal. The spliced series is seasonally adjusted in the same manner as the import price series.

CPI: This is the quarterly average of the monthly all items consumer price index (1980=100), not seasonally adjusted. The series is seasonally adjusted in the same manner as the import price series.

Interest rate: This is the quarterly average of the interest rate on day-to-day money.

Monetary aggregate: This is the quarterly average of the monthly M3 monetary aggregate in millions of Swedish kroner, not seasonally adjusted. The series is seasonally adjusted in the same manner as the import price series.

A.2.9 Switzerland

GDP: The construction of this series is similar to that of the Swedish GDP series. The primary series is gross domestic product in millions of Swiss francs using 1990 prices, not seasonally adjusted, which begins in 1980:1. Prior to that, I use a discontinued gross domestic product series in millions of Swiss francs using 1980 prices, not seasonally adjusted. The series are spliced in the same manner as the Swedish GDP series were spliced, and the resulting series is seasonally adjusted using the US

[36] Seasonally adjusting by regressing the log difference of the not seasonally adjusted series on quarterly dummy variables had no substantive effect on the results.

Census X-11 program.[37]

Import price index: This is the quarterly average of the monthly general import price index (May 1993=100), not seasonally adjusted. The series is seasonally adjusted by regressing the log difference of the series on quarterly dummy variables.

PPI: This is the quarterly average of the monthly producer price index excluding imports (May 1993=100), not seasonally adjusted. The series is seasonally adjusted in the same manner as the import price series.

CPI: This is the quarterly average of the monthly all items consumer price index (May 1993=100), not seasonally adjusted. The series is seasonally adjusted in the same manner as the import price series.

Interest rate: This is the quarterly average of the interest rate on day-to-day money ("tomorrow-next").

Monetary aggregate: This is constructed by splicing two series. The first is the quarterly average of the monthly M3 monetary aggregate (M2 plus time deposits, including Liechtenstein) in millions of Swiss francs, not seasonally adjusted, which begins in December 1984. Prior to that, I use the quarterly average of the monthly M3 monetary aggregate (M2 plus saving deposits, excluding Liechtenstein) in millions of Swiss francs, not seasonally adjusted, which has been discontinued. The latter series is reindexed so that the 1985:1 values of the two series are equal. The spliced series is seasonally adjusted in the same manner as the import price series.

[37] Again, seasonally adjusting by regressing the log difference of the series on quarterly dummy variables had little impact on the results.

References

Baldwin, Richard E., "Hysteresis in Import Prices: The Beachhead Effect," *American Economic Review*, 1988, *78*, 773–85.

—— **and Paul R. Krugman**, "Persistent Trade Effects of Large Exchange Rate Shocks," *Quarterly Journal of Economics*, 1989, *104*, 635–54.

Bernanke, Ben and Alan S. Blinder, "The Federal Funds Rate and the Transmission of Monetary Policy," *American Economic Review*, 1992, *82*, 901–22.

Blanchard, Olivier J., "Price Asynchronization and Price Level Inertia," in Rudiger Dornbusch and Mario Henrique Simsonen, eds., *Inflation, Debt, and Indexation*, Cambridge, MA: MIT Press, 1983, pp. 3–24.

Blanchard, Olivier Jean and Danny Quah, "The Dynamic Effects of Aggregate Demand and Supply Disturbances," *American Economic Review*, 1989, *79*, 655–73.

Boldin, Michael D., "A New Era for Inflation or Will Inflation Pick Up Before This Expansion Ends?," 1998. Unpublished paper, Conference Board.

Branson, William H., "Comment on Hooper and Mann," *Brookings Papers on Economic Activity*, 1989, *1*, 330–333.

Christiano, Lawrence J., Martin Eichenbaum, and Charles L. Evans, "The Effects of Monetary Policy Shocks: Evidence from the Flow of Funds," *Review of Economics and Statistics*, 1996, *78*, 16–34.

—— **,** —— **, and** —— , "Sticky Price and Limited Participation Models of Money: A Comparison," *European Economic Review*, 1997, *41*, 1201–49.

Clark, Todd E., "The Responses of Prices at Different Stages of Production to Monetary Policy Shocks," *Review of Economics and Statistics*, 1999, *81*, 420–33.

Dellmo, Hans, "Relationships between Swedish Producer Prices and Import Prices and the CPI," 1996. Riksbank Working Paper No. 29.

Dornbusch, Rudiger, "Exchange Rates and Prices," *American Economic Review*, 1987, *77*, 93–106.

Engel, Charles and John H. Rogers, "Regional Patterns in the Law of One Price: The Roles of Geography versus Currencies," in Jeffrey A. Frankel, ed., *The Regionalization of the World Economy*, Chicago and London: The University of Chicago Press for the NBER, 1998, pp. 153–83.

Feinberg, Robert M., "The Interaction of Foreign Exchange and Market Power Effects on German Domestic Prices," *Journal of Industrial Economics*, 1986, *35*, 61–70.

—— , "The Effects of Foreign Exchange Movements on U.S. Domestic Prices," *Review of Economics and Statistics*, 1989, *71*, 505–11.

Goldberg, Pinelopi Koujianou and Michael M. Knetter, "Goods Prices and Exchange Rates: What Have We Learned?," *Journal of Economic Literature*, 1997, *35*, 1243–72.

Gordon, Robert J., "Foundations of the Goldilocks Economy: Supply Shocks and the Time-Varying NAIRU," *Brookings Papers on Economic Activity*, 1998, *2*, 297–333.

Hamilton, James D., "This is What Happened to the Oil Price-Macroeconomy Relationship," *Journal of Monetary Economics*, 1996, *38*, 215–20.

Higgins, Matthew and Egon Zakrajšek, "Purchasing Power Parity: Three Stakes Through the Heart of the Unit Root Null," 1999. Federal Reserve Bank of New York Staff Report No. 80.

Hooper, Peter and Catherine L. Mann, "Exchange Rate Pass-Through in the 1980s: The Case of U.S. Imports of Manufactures," *Brookings Papers on Economic Activity*, 1989, *1*, 297–337.

Kim, Ki-Ho, "US Inflation and the Dollar Exchange Rate: A Vector Error Correction Model," *Applied Economics*, 1998, *30*, 613–19.

Klitgaard, Thomas, "Exchange Rates and Profit Margins: The Case of Japanese Exporters," *Federal Reserve Bank of New York Economic Policy Review*, 1999, *5(1)*, 41–54.

Knetter, Michael M., "International Comparisons of Pricing-to-Market Behavior," *American Economic Review*, 1993, *83*, 473–86.

Koenig, Evan F., "What's New About the New Economy? Some Lessons from the Current Expansion," *Southwest Economy, Federal Reserve Bank of Dallas*, July/August 1998, pp. 7–11.

Kreinin, Mordechai E., "The Effect of Exchange Rate Changes on Prices and Volume of Foreign Trade," *International Monetary Fund Staff Papers*, 1977, *24*, 297–329.

Krugman, Paul R., "Pricing to Market When the Exchange Rate Changes," in Sven W. Arndt and J. David Richardson, eds., *Real-Financial Linkages Among Open Economies*, Cambridge, MA and London: MIT Press, 1987, pp. 49–70.

Mann, Catherine L., "Prices, Profits Margins, and Exchange Rates," *Federal Reserve Bulletin*, 1986, *72*, 366–79.

Marston, Richard C., "Pricing to Market in Japanese Manufacturing," *Journal of International Economics*, 1990, *29*, 217–36.

Meese, Richard A. and Kenneth Rogoff, "Empirical Exchange Rate Models of the Seventies: Do They Fit Out of Sample?," *Journal of International Economics*, 1983, *14*, 3–24.

Parsley, David C. and Helen A. Popper, "Exchange Rates, Domestic Prices, and Central Bank Actions: Recent U.S. Experience," *Southern Economic Journal*, 1998, *64*, 957–72.

Pigott, Charles, John Rutledge, and Thomas D. Willett, "Estimating the Inflationary Effects of Exchange Rate Changes," in Sven W. Arndt, Richard J. Sweeney, and Thomas D. Willett, eds., *Exchange Rates, Trade, and the U.S. Economy*, Cambridge, MA: Ballinger, 1985, pp. 245–65.

Rich, Robert W. and Donald Rissmiller, "Understanding the Recent Behavior of U.S. Inflation," *Federal Reserve Bank of New York Current Issues in Economics and Finance*, July 2000.

Rogoff, Kenneth, "The Purchasing Power Parity Puzzle," *Journal of Economic Literature*, 1996, *34*, 647–68.

Stewart, Kenneth J. and Stephen B. Reed, "Consumer Price Index Research Series Using Current Methods, 1978-98," *Monthly Labor Review*, June 1999, pp. 29–38.

Stock, James H., "Comment on Gordon," *Brookings Papers on Economic Activity*, 1998, *2*, 334–41.

Taylor, Mark P., "The Economics of Exchange Rates," *Journal of Economic Literature*, 1995, *33*, 13–47.

Tootell, Geoffrey M. B., "Globalization and U.S. Inflation," *New England Economic Review*, July/August 1998, pp. 21–33.

Wei, Shang-Jin and David C. Parsley, "Purchasing Power Disparity During the Floating Rate Period: Exchange Rate Volatility, Trade Barriers, and Other Culprits," 1995. NBER Working Paper No. 5032.

Woo, Wing T., "Exchange Rates and the Prices of Nonfood, Nonfuel Products," *Brookings Papers on Economic Activity*, 1984, *2*, 511–30.

World Economic Forum, *The Global Competitiveness Report 1999*, Geneva: World Economic Forum, 1999.

Yang, Jiawen, "Exchange Rate Pass-Through in U.S. Manufacturing Industries," *Review of Economics and Statistics*, 1997, *79*, 95–104.

Figure 1

Response of import prices to 1% increase in exchange rates

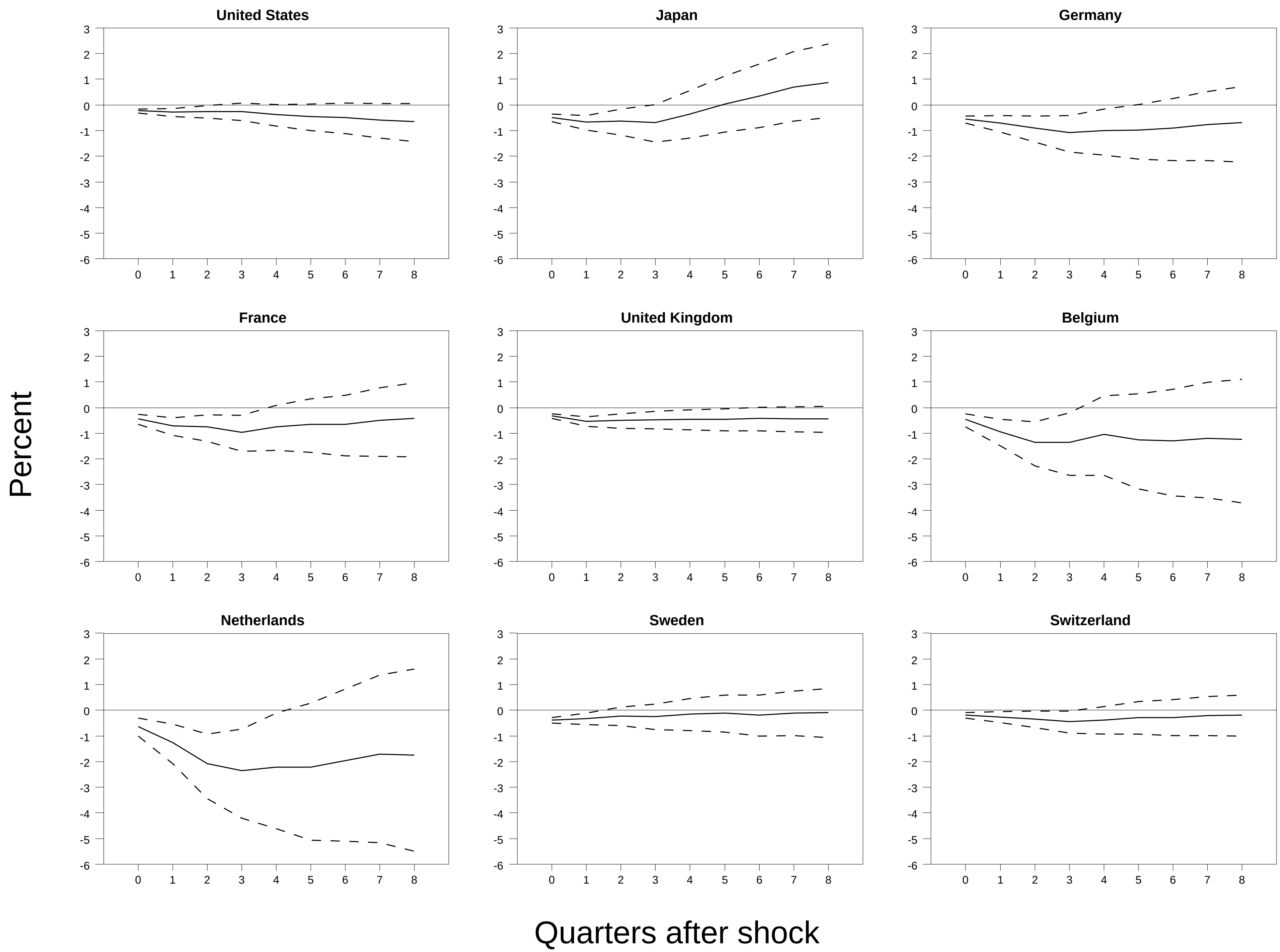


Figure 2

Response of PPI to 1% increase in exchange rates

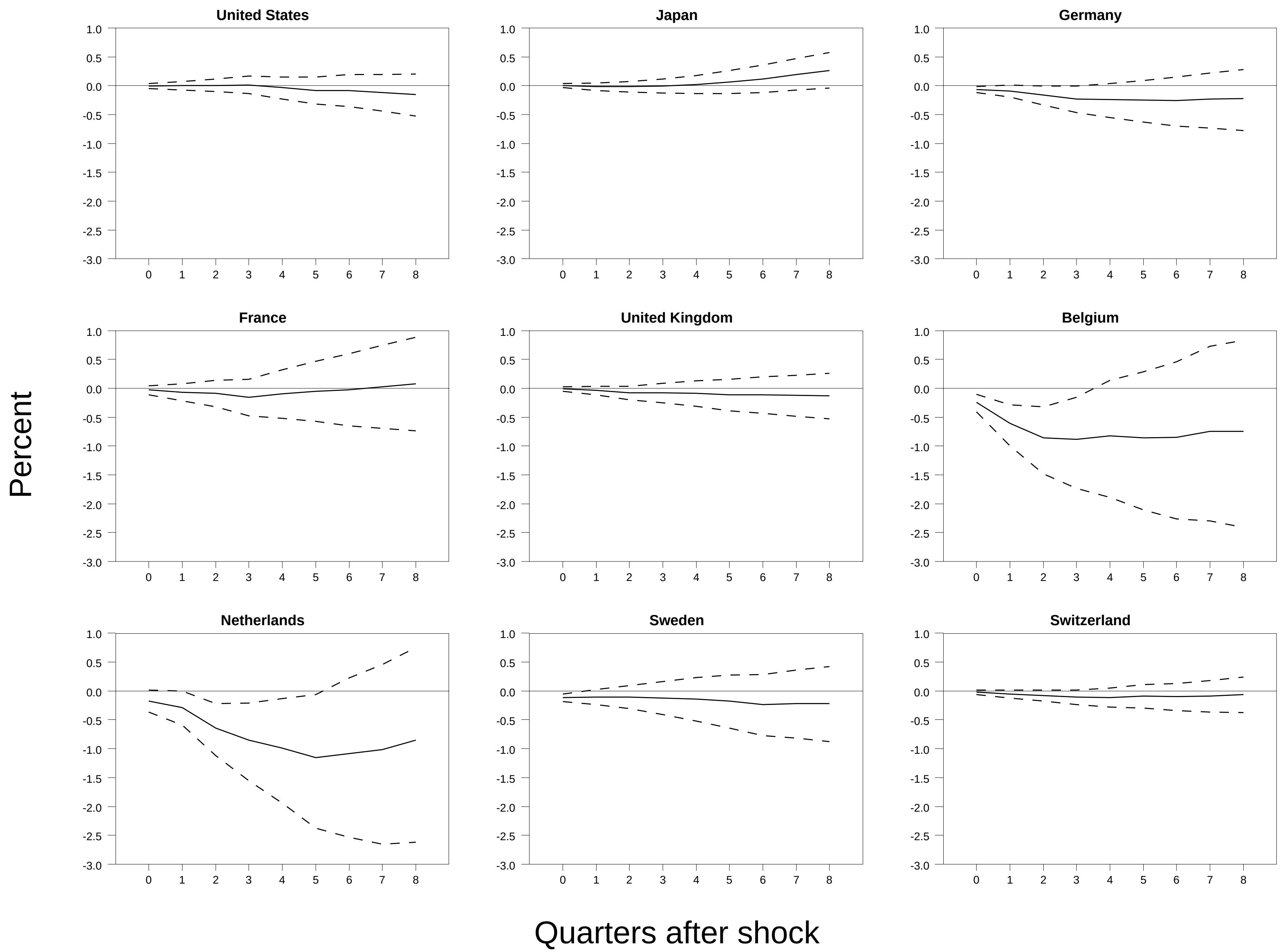


Figure 3

Response of CPI to 1% increase in exchange rates

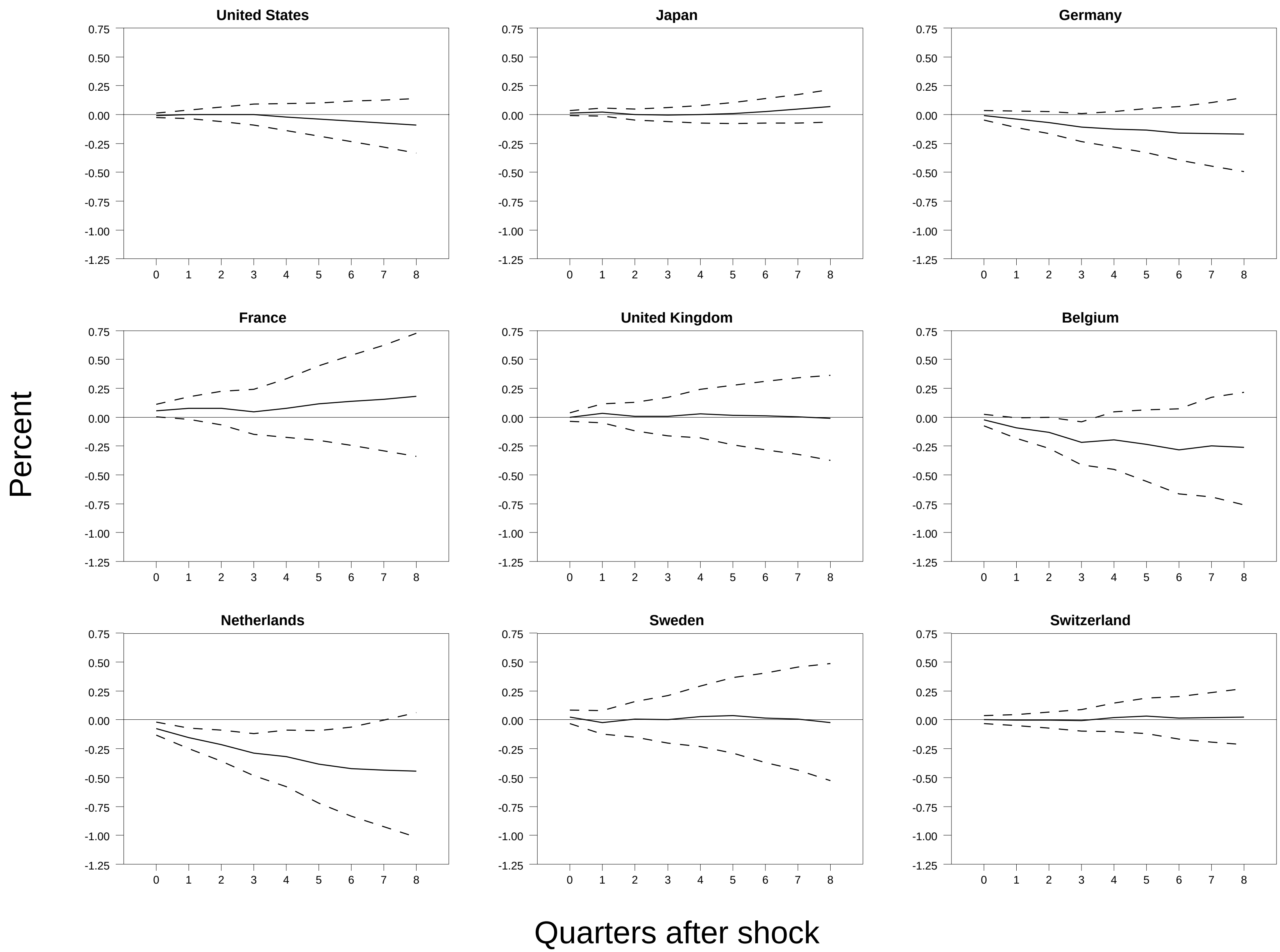


Figure 4

Imports/PCE ratio and exchange rate pass-through to CPI

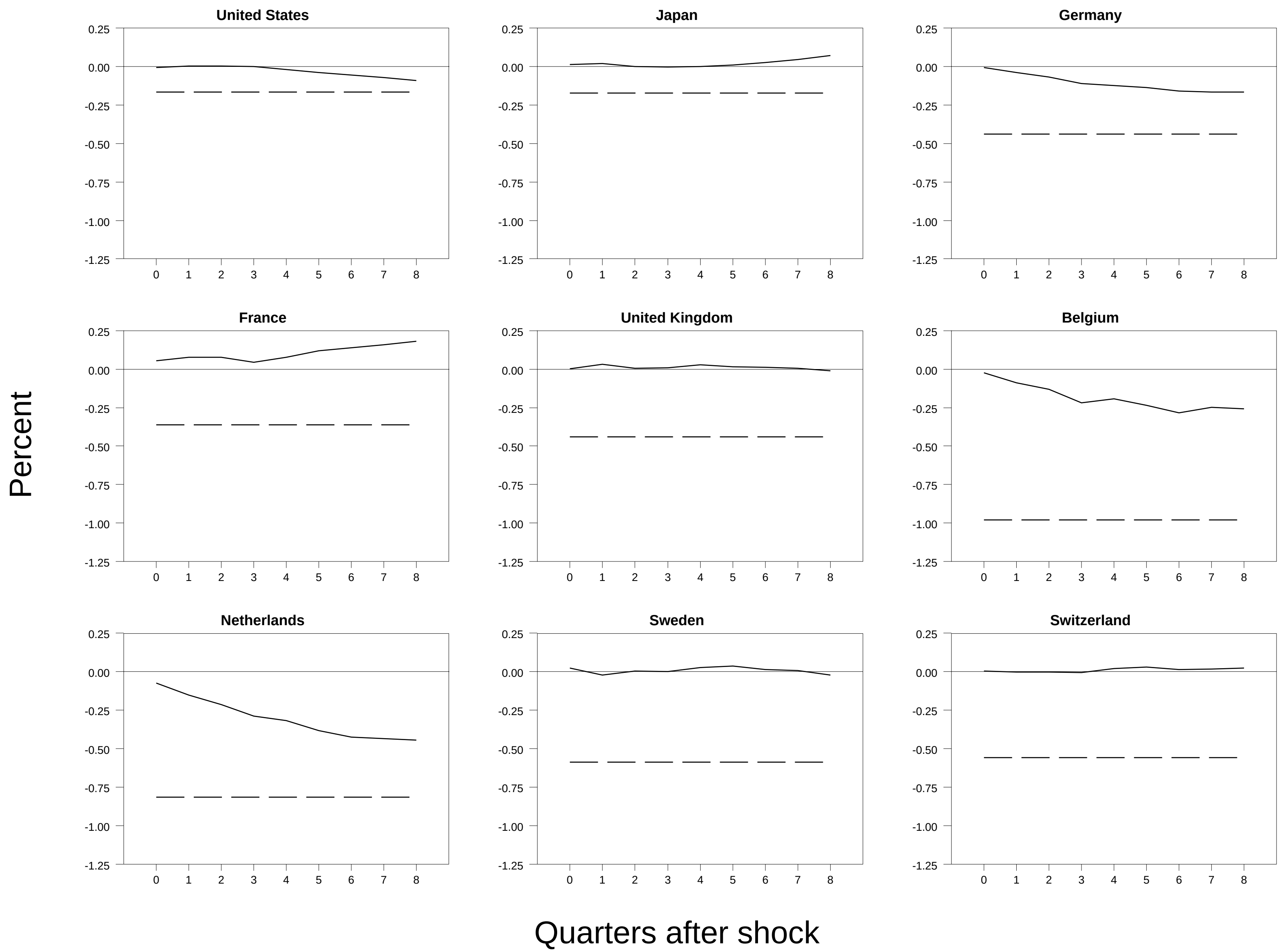


Figure 5

Response of PPI to 1% increase in import prices

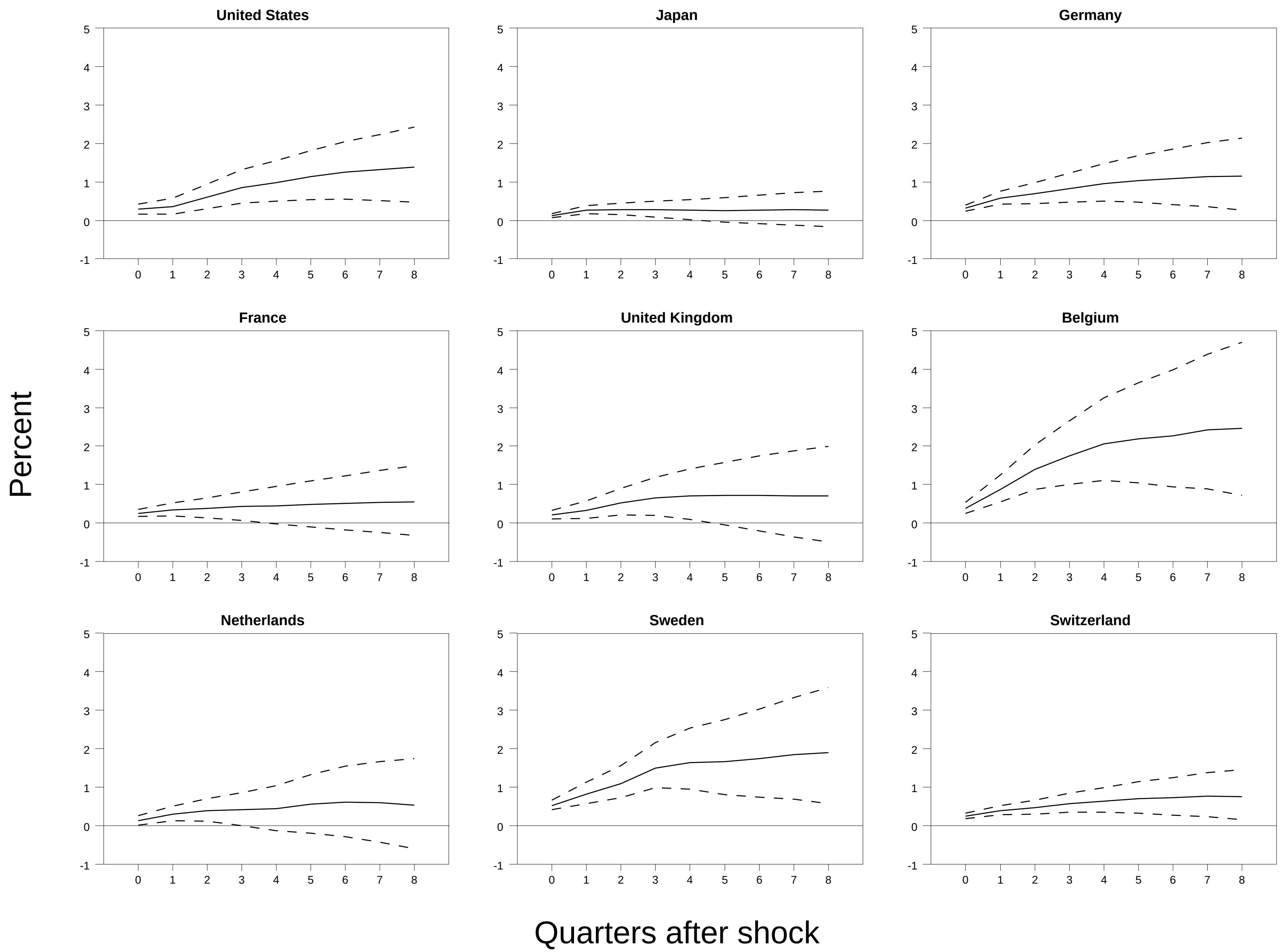


Figure 6
Response of CPI to 1% increase in import prices

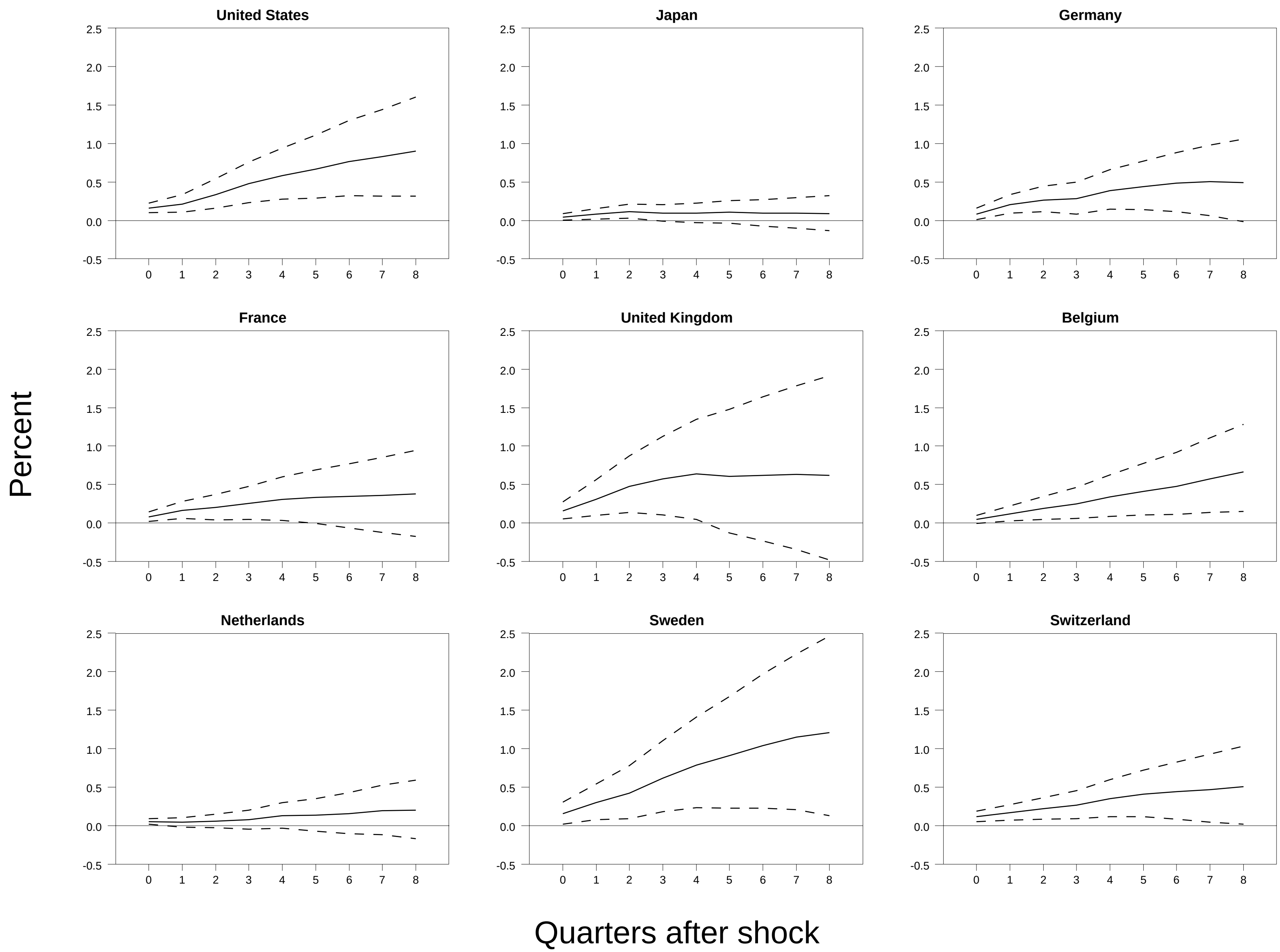


Figure 7
Imports/PCE ratio and import price pass-through to CPI

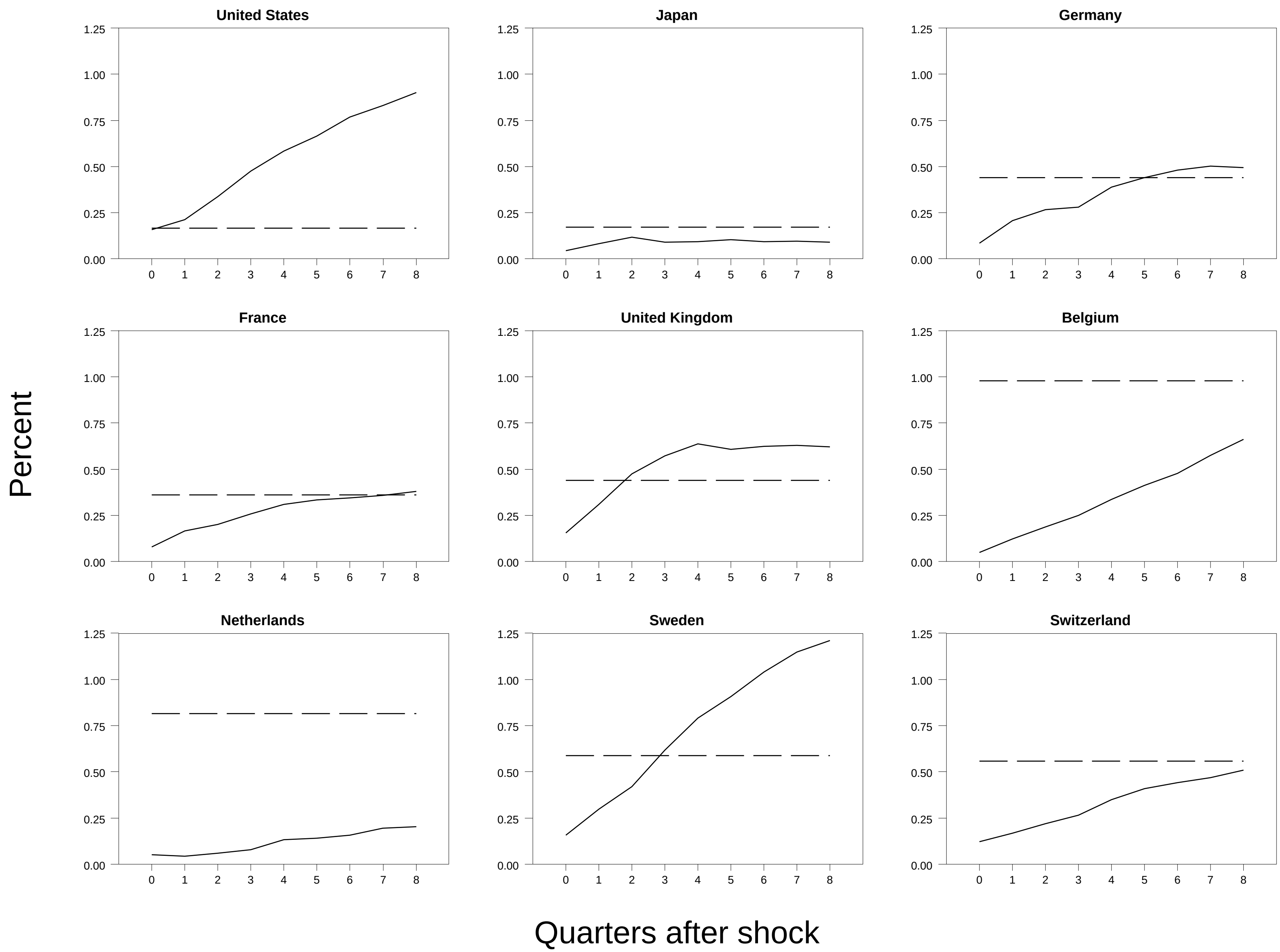
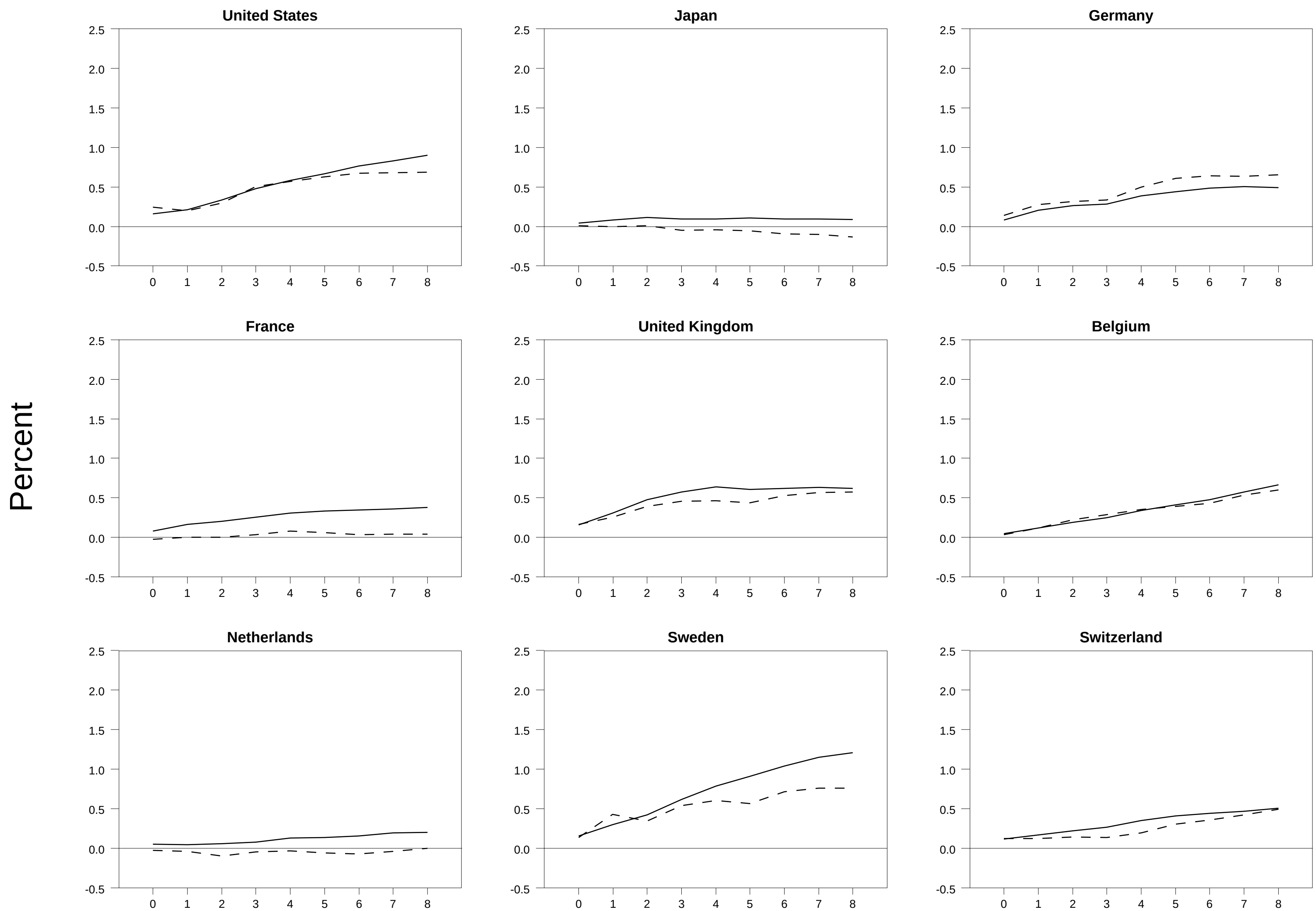


Figure 8
Response of CPI to 1% increase in import prices



________ 1976:1-1998:4 _ _ _ _ 1983:1-1998:4

Table 1

Summary statistics for various periods

Annualized percentage changes over the periods

Country	Oil prices	Output gap[a]	Exch. rate	Imp. prices	PPI	CPI	Int. rate[a]	Money
United States								
1976 - 80	26.3	1.5	-1.4	13.1	9.3	8.3	8.6	9.3
1981 - 85	-15.4	-1.8	3.4	-2.1	2.1	4.4	11.2	9.2
1986 - 90	2.4	2.0	-5.8	3.2	3.2	3.9	7.7	5.6
1991 - 95	-1.3	-1.5	0.0	-0.1	1.3	2.5	4.5	2.1
1996 - 98	-13.0	0.4	4.7	-3.9	0.3	1.9	5.4	6.3
Japan								
1976 - 80	16.9	0.3	8.1	7.2	5.2	6.1	6.9	10.8
1981 - 85	-16.9	-2.2	5.5	-4.4	-0.6	2.3	6.8	8.5
1986 - 90	-4.3	0.5	2.9	-4.7	-0.3	1.6	5.0	9.8
1991 - 95	-5.9	1.6	5.4	-4.2	-1.2	0.9	3.7	1.9
1996 - 98	-9.0	-0.8	-1.0	-0.8	-0.9	1.1	0.4	3.7
Germany								
1976 - 80	21.2	1.9	3.7	6.9	4.1	4.2	5.3	8.3
1981 - 85	-13.4	-1.9	3.1	0.7	2.5	3.2	7.2	6.1
1986 - 90	-6.0	-1.1	2.5	-1.8	1.2	1.7	5.4	8.7
1991 - 95	-2.1	2.6	1.7	-0.5	1.1	3.4	7.1	6.4
1996 - 98	-9.1	-1.5	-1.4	-0.7	0.0	1.3	3.3	5.9
France								
1976 - 80	28.1	0.9	-2.5	13.7	10.9	10.9	9.3	12.9
1981 - 85	-8.4	-1.0	-2.9	5.9	7.8	8.4	12.9	10.2
1986 - 90	-4.0	0.5	0.0	0.4	1.7	3.2	8.5	8.4
1991 - 95	-2.0	-0.1	1.7	-0.1	0.3	2.2	8.1	2.0
1996 - 98	-9.7	-0.1	-0.6	0.0	-1.1	0.9	3.4	0.4
United Kingdom								
1976 - 80	22.7	0.9	1.9	9.7	13.6	13.4	11.3	14.6
1981 - 85	-7.0	-3.4	-5.1	6.6	6.5	6.3	11.5	14.8
1986 - 90	-3.2	3.7	-0.4	1.5	4.4	6.3	11.6	15.6
1991 - 95	3.1	-1.3	-4.2	4.7	3.5	2.9	7.8	5.6
1996 - 98	-15.9	-0.3	7.3	-5.3	0.7	3.1	6.6	7.6
Belgium								
1976 - 80	22.6	3.4 [b]	1.6	14.3 [b]	4.4	8.0	9.0	7.6
1981 - 85	-9.2	-1.2	-2.1	6.0	4.9	6.3	11.1	7.1
1986 - 90	-5.8	0.3	1.7	-1.0	-0.1	2.2	7.9	9.6
1991 - 95	-2.2	0.6	1.4	0.4	0.7	2.3	7.4	4.3
1996 - 98	-8.9	-0.7	-1.4	0.5	-0.7	1.3	3.4	6.0
Netherlands								
1976 - 80	22.3	1.2 [c]	1.6	8.2	4.0	5.7	7.3	10.0 [c]
1981 - 85	-12.8	-1.8	2.1	-0.8	2.5	3.4	7.3	7.3
1986 - 90	-5.9	0.6	1.9	-2.4	-1.1	1.0	6.1	7.6
1991 - 95	-2.4	0.7	1.5	-0.3	0.4	2.7	6.9	4.7
1996 - 98	-8.6	-0.7	-1.6	-1.9	0.1	2.0	3.1	8.2
Sweden								
1976 - 80	27.3	-0.4	-2.0	12.8	10.8	10.9	9.3	10.9
1981 - 85	-6.7	-1.6	-5.0	6.7	7.9	7.9	13.0	6.2
1986 - 90	-2.8	2.9	-0.8	2.3	4.3	7.0	10.9	8.3
1991 - 95	2.2	-1.6	-2.9	3.7	2.6	2.8	12.1	4.1
1996 - 98	-7.7	0.2	-2.6	0.2	0.0	0.2	4.8	3.5
Switzerland								
1976 - 80	18.8	-2.6	4.8	2.8	1.7	2.8	1.4	7.6
1981 - 85	-14.7	-0.6	3.7	0.3	2.3	3.7	3.9	4.9
1986 - 90	-5.7	1.7	1.8	-0.7	1.4	3.1	4.5	6.3
1991 - 95	-3.2	0.6	2.3	-0.9	0.0	2.5	5.4	4.0
1996 - 98	-8.7	-1.4	-1.5	-1.5	-1.3	0.3	1.5	2.4

Notes:

[a] Average over the period.

[b] 1980 only

[c] 1977 - 80

Table 2

Rank correlation between impulse responses to exchange rates and factors influencing pass-through

(a) Impulse response of import prices

	Response horizon			
Factor	**0**	**1**	**4**	**8**
Import share	0.067	0.333	0.450	0.433
1975 GDP (US$)	0.217	0.083	0.033	0.033
Ex. rate persistence	0.400	0.583**	0.867***	0.917***
Ex. rate volatility	-0.500*	-0.700**	-0.750**	-0.683**
GDP volatility	0.033	-0.217	-0.300	-0.150
Avg. mfg. share [a]	0.214	0.071	-0.119	-0.405
Competitiveness	-0.600**	-0.667**	-0.367	-0.183

(b) Impulse response of PPI

Import share	0.833***	0.817***	0.800***	0.567*
1975 GDP (US$)	-0.583**	-0.600**	-0.567*	-0.267
Ex. rate persistence	0.517*	0.450	0.650**	0.700**
Ex. rate volatility	-0.900***	-0.867***	-0.883***	-0.700**
GDP volatility	0.167	0.183	0.317	0.283
Avg. mfg. share [a]	-0.357	-0.238	-0.310	-0.500*
Competitiveness	-0.617**	-0.683**	-0.483*	-0.283

(c) Impulse response of CPI

Import share	0.333	0.583**	0.267	0.433
1975 GDP (US$)	0.017	-0.383	0.067	-0.117
Ex. rate persistence	0.867***	0.667**	0.800***	0.750**
Ex. rate volatility	-0.433	-0.633**	-0.450	-0.567*
GDP volatility	0.050	0.417	0.083	0.233
Avg. mfg. share [a]	-0.357	-0.429	-0.357	-0.500*
Competitiveness	-0.033	-0.283	-0.150	-0.167

* Significant at the 10 percent level (critical value=0.467)

** Significant at the 5 percent level (critical value = 0.583)

*** Significant at the 1 percent level (critical value = 0.767)

[a] Because of data limitations, Switzerland is excluded from the rankings for this category. The critical values thus are 0.500, 0.619, and 0.810 at the 10, 5, and 1 percent significance levels.

Table 3

Rank correlation between impulse responses to import prices and factors influencing pass-through

Factor	0	1	4	8
(a) Impulse response of PPI				
	Response horizon			
Import share	0.267	0.433	0.267	0.317
1975 GDP (US$)	-0.250	-0.450	-0.233	-0.300
Imp. price persistence	0.833***	0.933***	0.850***	0.900***
Ex. rate volatility	-0.333	-0.350	-0.167	-0.200
GDP volatility	0.167	0.217	0.100	0.133
Avg. mfg. share [a]	-0.095	-0.071	-0.238	-0.238
Competitiveness	-0.467*	-0.450	-0.267	-0.250
(b) Impulse response of CPI				
Import share	-0.183	-0.283	-0.067	0.183
1975 GDP (US$)	-0.033	-0.017	-0.183	-0.283
Imp. price persistence	0.250	0.233	0.483*	0.683**
Ex. rate volatility	0.300	0.450	0.250	0.067
GDP volatility	0.350	0.333	0.450	0.167
Avg. mfg. share [a]	-0.310	0.048	-0.190	-0.381
Competitiveness	0.533*	0.267	0.200	0.100

* Significant at the 10 percent level (critical value=0.467)

** Significant at the 5 percent level (critical value = 0.583)

*** Significant at the 1 percent level (critical value = 0.767)

[a] Because of data limitations, Switzerland is excluded from the rankings for this category. The critical values thus are 0.500, 0.619, and 0.810 at the 10, 5, and 1 percent significance levels.

Table 4

Percentage of import price forecast variance attributed to exchange rate shocks

	Forecast horizon			
Country	**0**	**1**	**4**	**8**
United States	20.4	14.9	8.3	12.2
Japan	21.3	15.0	7.3	6.1
Germany	29.5	21.1	17.8	13.1
France	17.0	19.0	15.4	9.4
United Kingdom	41.2	39.9	30.7	25.6
Belgium	12.5	18.7	15.4	12.1
Netherlands	5.8	9.1	15.3	12.4
Sweden	27.8	16.3	4.9	2.2
Switzerland	10.3	7.6	7.9	5.5
Spearman rank correlation coefficient with:				
Import share	-0.633**	-0.217	0.133	-0.150
1975 GDP (US$)	0.367	0.233	0.133	0.417
Ex. rate persistence	-0.567*	-0.200	0.533*	0.500*
Ex. rate volatility	0.567*	0.033	-0.283	-0.100
GDP volatility	0.267	-0.133	-0.183	-0.117
Avg. mfg. share [a]	0.524*	0.667**	0.238	0.024
Competitiveness	-0.100	-0.533*	-0.233	0.033

* Significant at the 10 percent level (critical value=0.467)

** Significant at the 5 percent level (critical value = 0.583)

*** Significant at the 1 percent level (critical value = 0.767)

[a] Because of data limitations, Switzerland is excluded from the rankings for this category. The critical values thus are 0.500, 0.619, and 0.810 at the 10, 5, and 1 percent significance levels.

Table 5

Percentage of PPI forecast variance attributed to exchange rate and import price shocks

	Forecast horizon			
Country	**0**	**1**	**4**	**8**
United States	13.3	11.0	21.5	25.4
Japan	18.3	26.9	14.5	14.9
Germany	44.2	39.4	39.1	38.5
France	34.8	30.5	19.4	15.3
United Kingdom	16.7	14.4	16.1	11.5
Belgium	23.9	39.5	61.0	64.9
Netherlands	7.7	13.0	17.3	17.7
Sweden	49.6	45.9	51.1	44.2
Switzerland	46.6	53.1	47.7	40.6

Spearman rank correlation coefficient with:				
Import share	0.150	0.367	0.600**	0.483*
1975 GDP (US$)	-0.500*	-0.683**	-0.617**	-0.533*
Ex. rate persistence	-0.417	-0.250	0.283	0.233
Imp. price persistence	0.467*	0.550*	0.983***	0.933***
Ex. rate volatility	-0.017	-0.050	-0.383	-0.267
GDP volatility	0.450	0.433	0.367	0.400
Avg. mfg. share [a]	0.524*	0.381	-0.310	-0.238
Competitiveness	-0.383	-0.383	-0.250	-0.250

* Significant at the 10 percent level (critical value=0.467)

** Significant at the 5 percent level (critical value = 0.583)

*** Significant at the 1 percent level (critical value = 0.767)

[a] Because of data limitations, Switzerland is excluded from the rankings for this category. The critical values thus are 0.500, 0.619, and 0.810 at the 10, 5, and 1 percent significance levels.

Table 6

Percentage of CPI forecast variance attributed
to exchange rate and import price shocks

	Forecast horizon			
Country	**0**	**1**	**4**	**8**
United States	19.1	13.2	19.9	23.4
Japan	5.7	10.2	9.0	6.8
Germany	5.8	13.0	21.3	19.6
France	12.3	17.5	17.5	15.8
United Kingdom	8.5	10.8	11.2	7.4
Belgium	3.7	11.4	28.4	39.1
Netherlands	15.9	20.2	23.3	20.6
Sweden	5.4	8.8	16.9	20.4
Switzerland	11.5	13.2	16.5	18.1

Spearman rank correlation coefficient with:				
Import share	-0.167	0.233	0.583**	0.517*
1975 GDP (US$)	0.333	0.133	-0.217	-0.183
Ex. rate persistence	0.300	0.683**	0.817***	0.650**
Imp. price persistence	-0.450	-0.200	0.733**	0.733***
Ex. rate volatility	-0.033	-0.533*	-0.767***	-0.600**
GDP volatility	-0.200	-0.333	0.083	-0.033
Avg. mfg. share [a]	-0.357	-0.286	-0.429	-0.667**
Competitiveness	0.667**	0.217	-0.333	-0.133

* Significant at the 10 percent level (critical value=0.467)

** Significant at the 5 percent level (critical value = 0.583)

*** Significant at the 1 percent level (critical value = 0.767)

[a] Because of data limitations, Switzerland is excluded from the rankings for this category. The critical values thus are 0.500, 0.619, and 0.810 at the 10, 5, and 1 percent significance levels.

Table 7

Historical decomposition of import prices: 1995:4-1998:4

Annualized percentage changes

Country	Actual	No subsequent shocks: Projection	Projection error	Contribution of shocks (percentage points):[a] Oil price and output gap	Ex. rate and import price	PPI and CPI	Int. rate and money
United States	-3.7	-0.4	-3.3	-1.8	-1.2	-0.9	0.6
Japan	0.2	-3.5	3.7	0.8	1.7	-0.1	1.3
Germany	-0.6	0.7	-1.3	0.0	-1.7	0.2	0.3
France	0.5	0.7	-0.2	0.9	-0.9	-0.3	0.2
United Kingdom	-4.6	1.6	-6.3	-0.9	-5.3	-0.3	0.2
Belgium	1.2	2.5	-1.3	1.1	-1.5	-0.7	-0.2
Netherlands	-1.0	-1.0	-0.1	-0.3	0.2	0.2	-0.3
Sweden	0.0	0.5	-0.4	1.4	-1.0	-0.6	-0.2
Switzerland	-1.8	-2.3	0.5	1.3	-1.5	0.7	0.1

Notes:

[a] Because the model is estimated in log differences while import price inflation in this table is expressed as an annualized precentage rate and because of rounding error, the contributions of the shocks do not add up exactly to the projection error.

Table 8

Historical decomposition of PPI: 1995:4-1998:4

Annualized percentage changes

		No subsequent shocks:		Contribution of shocks (percentage points):[a]			
Country	Actual	Projection	Projection error	Oil price and output gap	Ex. rate and import price	PPI and CPI	Int. rate and money
United States	0.6	1.6	-1.0	-0.8	0.2	-0.8	0.4
Japan	-0.9	-2.0	1.1	0.9	0.1	-0.1	0.2
Germany	-0.1	1.6	-1.7	-0.5	-1.0	-0.3	0.1
France	-1.2	0.3	-1.5	0.3	-0.9	-0.6	-0.3
United Kingdom	1.0	3.8	-2.8	-1.4	-1.7	0.2	0.1
Belgium	-0.4	1.4	-1.9	0.5	-1.0	-0.8	-0.6
Netherlands	0.5	-0.2	0.7	0.0	0.6	0.5	-0.4
Sweden	-0.4	0.7	-1.1	0.0	-1.3	-0.8	1.0
Switzerland	-1.4	-1.0	-0.4	-0.4	0.4	-0.7	-0.1

Notes:

[a] Because the model is estimated in log differences while PPI inflation in this table is expressed as an annualized precentage rate and because of rounding error, the contributions of the shocks do not add up exactly to the projection error.

Table 9

Historical decomposition of CPI: 1995:4-1998:4

Annualized percentage changes

		No subsequent shocks:		Contribution of shocks (percentage points):[a]			
Country	Actual	Projection	Projection error	Oil price and output gap	Ex. rate and import price	PPI and CPI	Int. rate and money
United States	2.0	2.7	-0.7	-0.5	0.1	-0.6	0.3
Japan	1.1	0.3	0.8	0.6	0.0	0.1	0.1
Germany	1.3	2.4	-1.1	-0.6	-0.3	-0.3	0.1
France	1.1	2.3	-1.2	0.2	-0.9	-0.1	-0.4
United Kingdom	3.1	4.6	-1.5	-1.4	-0.8	0.5	0.2
Belgium	1.5	2.1	-0.6	0.3	-0.2	-0.2	-0.4
Netherlands	2.2	1.6	0.5	-0.1	0.3	0.3	0.0
Sweden	0.0	2.4	-2.4	-1.2	-1.1	-0.8	0.8
Switzerland	0.3	0.9	-0.5	0.6	-0.6	-0.4	0.0

Notes:
[a] Because the model is estimated in log differences while CPI inflation in this table is expressed as an annualized precentage rate and because of rounding error, the contributions of the shocks do not add up exactly to the projection error.

Table 10

Percentage of CPI forecast variance attributed to exchange rate and import price shocks

Model estimated over 1983:1 - 1998:4

	Forecast horizon			
Country	**0**	**1**	**4**	**8**
United States	20.6	11.4	15.6	21.9
Japan	1.4	1.8	2.1	5.9
Germany	11.5	26.6	48.8	40.3
France	1.7	5.0	29.5	38.4
United Kingdom	14.2	17.7	43.1	50.0
Belgium	2.2	8.6	28.2	38.9
Netherlands	10.1	19.6	21.4	17.4
Sweden	3.0	10.6	10.1	9.0
Switzerland	19.5	15.1	11.0	24.4

Spearman rank correlation coefficient with:				
Import share	-0.050	0.133	0.083	0.133
1975 GDP (US$)	-0.033	-0.117	0.150	-0.033
Ex. rate persistence	-0.233	-0.050	0.467*	0.283
Imp. price persistence	-0.133	0.117	0.450	0.567*
Ex. rate volatility	0.267	-0.067	-0.283	-0.133
GDP volatility	-0.433	0.050	-0.133	-0.200
Avg. mfg. share [a]	-0.357	-0.190	0.381	0.286
Competitiveness	0.683**	0.217	-0.350	-0.233

[*] Significant at the 10 percent level (critical value=0.467)

[**] Significant at the 5 percent level (critical value = 0.583)

[***] Significant at the 1 percent level (critical value = 0.767)

[a] Because of data limitations, Switzerland is excluded from the rankings for this category. The critical values thus are 0.500, 0.619, and 0.810 at the 10, 5, and 1 percent significance levels.

Table 11

Historical decomposition of CPI: 1995:4-1998:4

Model estimated over 1983:1-1998:4

Annualized percentage changes

		No subsequent shocks:		Contribution of shocks (percentage points):[a]			
Country	Actual	Projection	Projection error	Oil price and output gap	Ex. rate and import price	PPI and CPI	Int. rate and money
United States	2.0	2.6	-0.6	0.0	-0.1	-0.5	0.0
Japan	1.1	0.9	0.2	0.1	0.0	0.2	-0.1
Germany	1.3	1.1	0.2	0.0	0.3	-0.1	0.1
France	1.1	0.9	0.2	0.3	0.2	-0.1	-0.2
United Kingdom	3.1	4.0	-0.9	-0.6	-0.7	0.4	-0.1
Belgium	1.5	2.0	-0.5	0.2	-0.2	-0.4	-0.2
Netherlands	2.2	1.5	0.7	0.3	0.1	0.3	0.0
Sweden	0.0	1.9	-1.9	-1.9	-0.1	0.5	-0.4
Switzerland	0.3	0.0	0.3	0.4	-0.4	0.0	0.4

Notes:

[a] Because the model is estimated in log differences while CPI inflation in this table is expressed as an annualized precentage rate and because of rounding error, the contributions of the shocks do not add up exactly to the projection error.

Table A1

Variance decomposition of import prices

Country	Forecast Horizon	Percentage of forecast variance attributed to:							
		oil prices	output gap	exch. rate	import pr.	PPI	CPI	int. rate	money
United States	0	36.8	4.9	20.4	37.8	0.0	0.0	0.0	0.0
	1	54.0	3.9	14.9	25.0	0.3	1.9	0.0	0.0
	4	46.0	6.8	8.3	21.5	0.3	10.7	3.2	3.2
	8	32.3	7.8	12.2	18.5	0.8	13.5	7.1	7.8
Japan	0	46.5	4.4	21.3	27.9	0.0	0.0	0.0	0.0
	1	70.9	2.7	15.0	9.9	0.0	1.2	0.3	0.0
	4	72.8	1.2	7.3	3.2	0.4	8.7	5.4	0.9
	8	64.8	1.1	6.1	4.1	1.1	9.5	8.7	4.7
Germany	0	43.9	0.0	29.5	26.5	0.0	0.0	0.0	0.0
	1	52.1	1.1	21.1	24.0	0.0	0.1	0.4	1.4
	4	52.2	2.7	17.8	21.1	1.0	1.4	0.2	3.5
	8	52.5	3.6	13.1	22.7	2.1	1.0	0.3	4.9
France	0	25.2	0.0	17.0	57.8	0.0	0.0	0.0	0.0
	1	32.5	0.6	19.0	44.2	2.0	0.0	0.5	1.1
	4	29.3	0.8	15.4	28.4	17.4	0.3	7.0	1.4
	8	24.9	0.5	9.4	23.0	24.5	2.7	14.0	1.0
United Kingdom	0	18.4	0.2	41.2	40.2	0.0	0.0	0.0	0.0
	1	23.8	0.7	39.9	26.5	4.0	2.2	2.8	0.0
	4	25.3	0.9	30.7	27.6	11.4	1.9	2.0	0.1
	8	26.9	1.1	25.6	26.7	16.5	1.4	1.0	0.7
Belgium	0	39.7	0.7	12.5	47.1	0.0	0.0	0.0	0.0
	1	40.4	0.3	18.7	36.2	3.2	1.1	0.0	0.1
	4	28.4	0.7	15.4	51.3	3.5	0.2	0.2	0.3
	8	25.1	1.0	12.1	57.9	3.2	0.1	0.3	0.3
Netherlands	0	65.3	0.6	5.8	28.2	0.0	0.0	0.0	0.0
	1	69.3	1.4	9.1	19.3	0.4	0.0	0.1	0.3
	4	58.9	4.7	15.3	18.3	0.1	0.7	0.7	1.2
	8	58.0	8.2	12.4	17.0	0.1	2.7	0.8	0.9
Sweden	0	35.5	1.8	27.8	34.9	0.0	0.0	0.0	0.0
	1	41.9	0.8	16.3	38.1	1.4	0.8	0.1	0.6
	4	27.4	1.3	4.9	47.1	3.2	1.9	4.1	10.1
	8	22.8	2.2	2.2	39.2	3.5	0.9	4.3	24.9
Switzerland	0	27.5	0.8	10.3	61.4	0.0	0.0	0.0	0.0
	1	31.5	2.8	7.6	53.0	1.0	3.6	0.0	0.3
	4	33.6	1.6	7.9	44.1	2.9	9.0	0.1	0.8
	8	31.4	1.2	5.5	46.5	4.6	7.9	1.4	1.4

Table A2

Variance decomposition of PPI

Country	Forecast Horizon	Percentage of forecast variance attributed to: oil prices	output gap	exch. rate	import pr.	PPI	CPI	int. rate	money
United States	0	38.7	0.1	0.0	13.2	48.0	0.0	0.0	0.0
	1	54.5	0.8	0.0	10.9	32.2	1.0	0.0	0.6
	4	45.6	3.2	0.1	21.4	19.6	2.3	0.7	7.0
	8	35.3	5.6	1.4	24.0	14.1	3.5	2.4	13.8
Japan	0	2.1	19.3	0.1	18.3	60.3	0.0	0.0	0.0
	1	16.8	14.2	0.3	26.7	41.8	0.2	0.0	0.0
	4	48.0	9.1	0.2	14.3	20.4	4.6	1.8	1.5
	8	44.5	3.6	6.0	8.9	17.9	4.9	4.5	9.7
Germany	0	27.8	2.1	5.9	38.3	25.9	0.0	0.0	0.0
	1	34.7	8.9	3.7	35.7	15.2	0.0	0.8	1.0
	4	37.2	13.7	7.0	32.1	4.9	0.0	1.4	3.8
	8	37.8	14.5	6.1	32.4	2.3	0.1	1.3	5.4
France	0	12.1	0.2	0.5	34.3	52.9	0.0	0.0	0.0
	1	16.7	0.4	0.9	29.6	51.0	0.0	0.0	1.3
	4	15.1	0.1	1.0	18.3	60.4	1.9	1.3	1.8
	8	9.4	0.0	0.4	14.9	62.6	5.9	4.4	2.4
United Kingdom	0	14.7	0.3	0.4	16.2	68.4	0.0	0.0	0.0
	1	19.3	0.9	1.1	13.3	64.3	0.3	0.0	0.8
	4	29.0	1.4	2.2	13.9	50.8	2.3	0.1	0.4
	8	28.4	2.4	2.1	9.4	51.6	3.9	0.1	2.0
Belgium	0	50.0	0.1	7.8	16.1	26.0	0.0	0.0	0.0
	1	37.9	0.0	14.6	25.0	20.9	1.5	0.2	0.0
	4	23.5	0.0	14.8	46.2	12.7	0.7	1.8	0.3
	8	21.6	0.0	10.8	54.1	8.7	0.4	2.7	1.7
Netherlands	0	23.3	2.9	3.7	4.0	66.1	0.0	0.0	0.0
	1	41.6	2.3	4.5	8.5	41.3	0.5	1.3	0.0
	4	60.5	8.2	11.1	6.2	10.0	1.4	2.3	0.4
	8	57.9	9.5	11.2	6.6	5.8	3.5	4.6	1.0
Sweden	0	14.8	10.7	11.0	38.6	24.9	0.0	0.0	0.0
	1	16.1	7.5	5.9	40.0	29.5	0.0	0.2	0.7
	4	11.9	4.8	2.7	48.4	23.4	0.8	0.1	7.9
	8	10.2	1.9	3.0	41.2	19.9	0.7	0.1	23.1
Switzerland	0	0.4	3.2	1.7	44.9	49.8	0.0	0.0	0.0
	1	5.2	4.0	3.0	50.1	37.4	0.1	0.0	0.2
	4	16.3	4.1	5.1	42.5	28.3	1.3	1.6	0.7
	8	15.6	3.0	3.0	37.6	30.3	0.6	2.5	7.3

Table A3

Variance decomposition of CPI

Country	Forecast Horizon	Percentage of forecast variance attributed to: oil prices	output gap	exch. rate	import pr.	PPI	CPI	int. rate	money
United States	0	32.0	7.9	0.5	18.6	10.7	30.3	0.0	0.0
	1	51.3	6.0	0.1	13.0	8.9	18.3	0.1	2.3
	4	40.0	7.2	0.1	19.7	8.0	15.4	0.3	9.2
	8	30.2	8.9	1.3	22.0	7.8	12.4	1.2	16.2
Japan	0	1.5	16.2	1.1	4.6	13.6	63.0	0.0	0.0
	1	3.0	12.3	1.7	8.5	14.1	58.7	1.3	0.5
	4	18.6	12.5	0.4	8.6	23.3	29.6	4.8	2.1
	8	27.4	6.0	1.8	5.0	25.6	16.4	7.5	10.2
Germany	0	7.1	2.0	0.2	5.6	2.4	82.7	0.0	0.0
	1	20.0	2.0	1.5	11.6	2.7	61.4	0.2	0.6
	4	28.8	13.5	5.6	15.8	0.7	29.8	1.0	4.8
	8	28.0	23.8	5.5	14.2	0.2	18.3	1.4	8.6
France	0	1.6	0.1	4.9	7.4	33.7	52.3	0.0	0.0
	1	3.4	0.0	4.8	12.7	39.4	39.2	0.0	0.4
	4	2.0	0.2	2.1	15.3	50.8	28.5	0.1	0.8
	8	0.9	0.1	2.7	13.1	52.7	26.0	1.8	2.7
United Kingdom	0	2.3	6.8	0.0	8.5	35.9	46.5	0.0	0.0
	1	4.1	3.1	0.8	10.0	44.9	35.3	1.5	0.2
	4	14.8	2.3	0.2	11.0	38.9	27.8	1.8	3.2
	8	16.3	5.5	0.1	7.3	40.8	20.4	0.9	8.8
Belgium	0	45.4	2.9	0.9	2.8	0.6	47.4	0.0	0.0
	1	49.3	3.5	4.4	7.0	9.3	25.8	0.5	0.2
	4	30.9	4.5	10.7	17.7	13.5	11.7	9.0	2.1
	8	22.7	1.6	9.8	29.3	11.9	6.2	14.6	3.9
Netherlands	0	5.9	6.8	8.1	7.8	3.2	68.1	0.0	0.0
	1	12.3	9.7	15.4	4.8	1.3	56.2	0.0	0.3
	4	24.7	15.0	18.9	4.5	1.2	34.7	0.3	0.9
	8	31.1	19.0	15.7	4.9	0.8	24.1	1.4	3.0
Sweden	0	0.0	20.8	0.7	4.7	9.7	64.1	0.0	0.0
	1	0.7	20.4	0.5	8.3	9.2	57.0	0.1	3.8
	4	5.6	13.1	0.1	16.8	11.0	45.5	2.8	5.2
	8	8.6	14.8	0.1	20.3	14.4	25.2	1.7	14.8
Switzerland	0	16.7	0.0	0.0	11.4	0.7	71.2	0.0	0.0
	1	32.7	0.7	0.0	13.1	1.7	51.0	0.5	0.3
	4	45.0	3.3	0.1	16.4	14.4	17.0	3.2	0.7
	8	36.7	7.4	0.2	17.9	18.1	11.1	6.4	2.2