IMF Working Paper

WP/99/56

INTERNATIONAL MONETARY FUND

Research Department

International Trade and the Business Cycle

Prepared by Eswar S. Prasad[1]

Authorized for distribution by Peter Isard

April 1999

Abstract

This paper develops a new empirical framework for analyzing the dynamics of the trade balance in response to different types of macroeconomic shocks. The model provides a synthetic perspective on the conditional correlations between the business cycle and the trade balance that are generated by different shocks and attempts to reconcile these results with unconditional correlations found in the data. The results suggest that, in the post-Bretton Woods period, nominal shocks have been an important determinant of the forecast error variance for fluctuations in the trade balances of the Group of Seven countries.

JEL Classification Numbers: F14, E32, F41

Keywords: Trade balance, business cycles, vector autoregressions.

Author's E-Mail Address: eprasad@imf.org

---

[1]I am grateful to Manmohan Kumar for his collaboration in the initial stage of this project and to Bankim Chadha, Peter Clark, David Coe, Guy Debelle, Michael Devereux, Peter Isard, Takatoshi Ito, Philip Lane, James Nason, Assaf Razin, Kei-Mu Yi, and seminar participants at the Federal Reserve Board, the IMF, and the World Bank for helpful comments and discussions. I would also like to thank two anonymous referees for detailed comments. Earlier versions of this paper were presented at the annual meetings of the Royal Economic Society, the European Economic Association and the American Economic Association. This paper is forthcoming in *The Economic Journal.*

Contents Page

I. INTRODUCTION

The world economy has become increasingly integrated in recent years, spurred by rapid expansions in trade and financial flows across national borders. The rising share of international trade in world output suggests that trade could potentially have a greater influence on business cycle fluctuations, both within and across countries. Hence, understanding the factors driving fluctuations in international trade is important from a number of different perspectives, including macroeconomic forecasting as well as for short-run domestic policy considerations and international policy coordination.

The existing empirical literature on international aspects of business cycle fluctuations has followed a number of different approaches. One strand of literature uses error component models to identify the sources of business cycle fluctuations and to assess the importance of common international shocks relative to country-specific or industry-specific shocks (see Stockman, 1988; Glick and Rogoff, 1995). Another approach has been to document the role of international trade in the transmission of business cycles across countries (as in Canova and Dellas, 1993; and Canova and Marrinan, 1998). A third approach uses dynamic general equilibrium models to analyze external trade dynamics (see Backus, Kehoe, and Kydland, 1992,1994). These models rely on stylized facts that are based on unconditional correlations between the cyclical components of output and different measures of external trade (as documented, for instance, by Fiorito and Kollintzas, 1994; Baxter, 1995; and Zimmermann, 1995). More recently, there have been attempts to use time series models to examine the dynamics of the current account in response to specific factors such as productivity shocks (e.g., Elliott and Fatás, 1996).

The main contribution of this paper is to synthesize some of these disparate empirical approaches and integrate them in a structural framework that enables an investigation of the patterns of trade dynamics in response to different sources of macroeconomic fluctuations. Since alternative macroeconomic shocks could have similar short-run effects on output but different effects on the real exchange rate, bivariate correlations and other unconditional measures are inadequate for characterizing the cyclical dynamics of the trade balance. For instance, domestic fiscal and monetary contractions could have similar effects on domestic output but markedly different effects on the exchange rate and, therefore, on trade variables. Further, time series models that focus on only one source of shocks would paint at best an incomplete picture since the main determinants of short-term fluctuations in trade flows–including domestic and foreign output and real exchange rates–could be affected in different ways by alternative shocks. In addition, the absence of obvious causal relationships among these variables, whose short-run movements are determined simultaneously by the same set of macroeconomic shocks, vitiates a reduced-form approach to examining trade dynamics.

To address these issues, I construct a structural vector autoregression model that can be used to provide quantitative estimates of the effects of different sources of macroeconomic fluctuations on the dynamics of international trade. Following a strategy originally proposed by Blanchard and Quah (1988), the empirical model is identified by imposing a set of long-run restrictions derived from a stylized theoretical model. The econometric framework is designed to simultaneously identify the effects of various types of structural shocks on output, the real exchange rate, and external trade, both in the short run and in the long run. Since external demand conditions could influence the trade balance, the model also accounts for the correlation of business cycles across countries by using relative output variables that control for changes in external demand conditions. This paper builds upon the work of authors such as Lastrapes (1992), Ahmed, Ickes, Wang, and Yoo (1993), and Clarida and Gali (1994), who have extended the Blanchard-Quah approach to an open economy setting. While much of this previous work has tended to focus on exchange rate dynamics, the model in this paper provides a characterization of the joint dynamics of both price and quantity variables related to international trade and does so in a multilateral rather than bilateral context.

I find many consistent features across G-7 countries in the dynamics of the trade balance in response to different macroeconomic shocks. Relative real demand shocks, which, ceteris paribus, lead to a temporary increase in domestic output relative to foreign output as well as a persistent appreciation of the real exchange rate, typically lead to a deterioration of the trade balance (expressed as a ratio to GDP). Relative nominal demand shocks, which increase relative output in the short run but also result in temporary but sharp real exchange rate depreciations, appear to have the opposite effect, thereby generating a positive conditional correlation between relative output and the trade balance. Relative supply shocks, which permanently affect the levels of both relative output and the real exchange rate, often have smaller effects on the trade balance than other shocks.

An important finding of this paper is that nominal shocks account for a large fraction of the forecast error variance of changes in the trade balance, although the relative importance of supply and real demand shocks tends to increase at longer forecast horizons. The paper attempts to reconcile these results with the stylized fact, based on unconditional correlations, that variations in the trade balance are countercyclical.

II. Theoretical Framework

This section presents a stylized theoretical model that illustrates the main channels through which different types of macroeconomic shocks influence the cyclical dynamics of the trade balance. By explicitly incorporating the trade balance, the model extends Clarida and Gali's (1994) stochastic version of Obstfeld's (1985) open economy macroeconomic model. Since the basic structure of the model is not new, only the key elements of the model and the extensions developed in this paper are presented here.

The model is essentially a stochastic version of the Mundell-Fleming model that has been extended to incorporate sluggish price adjustment. Except for the interest rate and the trade balance, the variables in the model are in logarithms and, except for the trade balance, are expressed as deviations of domestic levels from foreign levels of the corresponding variables. Thus, 'output' refers to domestic output relative to foreign output, the latter measured as a composite trade-weighted aggregate of output in trading partner countries. Likewise, a 'demand shock', for instance, will be taken to mean a demand shock in the home country relative to its trading partners. For brevity, the term 'demand shock' will be used in the remainder of the paper to refer to a *real* demand shock while the phrase 'nominal shock' will refer to a *nominal* demand shock. The precise meaning of these terms will become clear below. The model can be written as follows:

$$y_t^d = d_t + \eta\,(s_t - p_t) - \sigma(i_t - E_t\,(p_{t+1} - p_t)) \tag{1}$$

$$p = (1-\theta)\,E \quad p + \theta p \qquad 0<\theta\leq 1 \tag{2}$$

$$m_t^s - p_t = y_t - \lambda i_t \tag{3}$$

$$i_t = E_t\,(s_{t+1} - s_t) \tag{4}$$

Output demand is denoted by y_t^d, d_t is a demand shock, s_t represents the nominal exchange rate, p_t is the aggregate price level, i_t stands for the nominal interest rate, p_t^e is the flexible price level, and m_t^s denotes the money supply. Equation (1) is an open economy IS equation. Equation (2) captures the sluggish adjustment of the price level to its flexible price equilibrium, where the speed of adjustment is determined by the parameter θ. Equation (3) is a standard LM equation and equation (4) is an interest parity condition.

This basic model is then augmented with an auxiliary equation that determines the composition of domestic output. In the national income accounting identity, real GDP is the sum of total domestic demand and net exports of goods and nonfactor services (net exports and the trade balance are analogous here). It is therefore sufficient to specify the determinants of the trade balance since, given total output, this accounting identity then pins down total domestic demand. The two main determinants of the trade balance are assumed to be relative output and the real exchange rate (see Dornbusch, 1980). The equation for the home country's trade balance can then be written as follows:

$$tb_t = \xi q_t - \beta y_t \tag{5}$$

where the parameters ξ and β denote the elasticities of the trade balance with respect to the real exchange rate, q_t, and relative output, y_t, respectively.[2] This specification implies that, if business cycles were perfectly synchronized between the home and foreign countries, the composition of domestic output would depend solely on the level of the real exchange rate.

Next, I specify the stochastic processes that drive the relative supply of output, the relative real demand shock, and relative money. I refer to these as supply, demand, and nominal shocks. The first two stochastic processes are assumed to be simple random walks while the demand shock is allowed to have a permanent as well as a transitory component:[3]

$$y_t^s = y_{t-1}^s + z_t \tag{6}$$

$$d_t = d_{t-1} + \delta_t - \gamma\delta_{t-1} \tag{7}$$

$$m_t = m_{t-1} + v_t \tag{8}$$

The innovations z_t, δ_t, and v_t are assumed to be serially and mutually uncorrelated. The flexible-price rational expectations solution to the model is as follows:[4]

$$y_t^e = y_t^s \tag{9}$$

$$q_t^e = \frac{y_t^s - d_t}{\eta} + \frac{1}{\eta(\eta + \sigma)}\sigma\gamma\delta_t \tag{10}$$

---

[2]Note that is not an independent equation but writing it in this form (following some algebraic manipulation) is useful for describing the effects of various shocks on the trade balance.

[3]The assumption that supply and nominal shocks do not have transitory components is mainly for expositional convenience and follows the tradition in this literature. Allowing the demand shock to have a transitory component helps to illustrate that temporary demand shocks can have permanent effects on the relative price level. In this framework, given output supply and money, *permanent* relative demand shocks drive up home and foreign prices in tandem through their effects on interest rates and, therefore, do not influence the *relative* price level in the long run (see footnote 3 below).

[4]The solution for the price level in the flexible-price equilibrium is given by:

$$p_t^e = m_t - y_t^s + \lambda(1 + \lambda)^{-1} (\eta + \sigma)^{-1} \gamma\delta_t \quad .$$

Substituting these expressions into equation (5), the flexible-price equilibrium solution for the trade balance is then given by:

$$tb_t^e = y_t^s \left(\frac{\xi}{\eta} - \beta \right) + \frac{\xi}{\eta} \left| -d_t + \frac{1}{(\eta + \sigma)} \sigma\gamma\delta_t \right| \tag{11}$$

Equations 9-11 could also be interpreted as the long-run solution for the model. These equations imply that, in the long run, the level of output is not affected by either nominal or demand shocks. Further, nominal shocks do not influence the long-run level of the real exchange rate. These are the three long-run restrictions that will be used to identify the econometric model. An additional implication of the theoretical model is that the long-run level of the trade balance is not influenced by nominal shocks. However, there exist some models, such as those of Baldwin (1988, 1990), in which temporary exchange rate changes could lead to persistent effects on the trade balance through 'hysteresis' or 'beach-head' effects in international goods markets. Hence, although the model is not rich enough to capture these types of effects, I do not use this restriction for identification.

Since the underlying shocks have permanent (random walk) components, the model implies that output, the real exchange rate, and the trade balance are nonstationary in levels but stationary in first differences. A further implication of the model is that relative output, the real exchange rate, and the trade balance are not cointegrated since their long-run dynamics are determined by different shocks.[5]

I now characterize the short-run equilibrium in the presence of sluggish price adjustment. The short-run dynamics in the model are given by the following equations:

$$y_t = y_t^s + \phi(\eta + \sigma)\ (1-\theta)\ (v_t - z_t + \alpha\gamma\delta_t) \tag{12}$$

$$q_t = q_t^e + \phi(1-\theta)\ (v_t - z_t + \alpha\gamma\delta_t) \tag{13}$$

---

[5]For instance, only the component of output attributable to supply shocks is nonstationary while the components of the real exchange rate attributable to both supply and real demand shocks are nonstationary. Note that intertemporal models typically imply that the current account to GDP ratio is a stationary variable. In principle, the trade balance is not subject to this constraint and, as discussed below, the trade balance (expressed as a ratio to G.P. to control for scale effects) appears clearly nonstationary in the data. The robustness of the results to this assumption will be tested later.

where $\alpha \equiv \lambda(1+\lambda)^{-1}(\eta+\sigma)^{-1}$ and $\phi \equiv (1+\lambda)(\lambda+\sigma+\eta)^{-1}$. Equation 14 can be rewritten in terms of the fundamental shocks of the model as follows:

$$tb_t = \xi q_t^e - \beta y_t^s + (\xi - \beta(\eta+\sigma))\,|\phi(1-\theta)(\nu_t - z_t + \alpha\gamma\delta_t)| \tag{14}$$

$$tb_t = \left[\frac{\xi}{\eta} - \beta\right] y_t^s - \frac{\xi}{\eta} d_t + \Phi\nu_t - \Phi z_t + \left[\Phi\alpha + \frac{\xi\sigma}{\eta(\eta+\sigma)}\right]\gamma\delta_t \tag{15}$$

where $\Phi \equiv \phi(1-\theta)\,[\xi - \beta\,(\eta+\sigma)]$. This equation indicates that the effects of supply shocks and nominal shocks on the trade balance are ambiguous and depend, *inter alia*, on the elasticities of the trade balance with respect to relative output and the real exchange rate. On the other hand, permanent demand shocks, which result in an appreciation of the real exchange rate concomitantly with a transitory increase in relative output, produce an unambiguous trade balance response.

This framework indicates the limitations of models of trade (or current account) dynamics that focus solely on productivity shocks (e.g., Backus, Kehoe, and Kydland, 1992; and Elliott and Fatás, 1996). Econometric models that distinguish only between real and nominal shocks (e.g., Lastrapes, 1992; and Robertson and Wickens, 1997) would also be inadequate for modeling trade balance dynamics since supply and demand shocks, which could both be viewed as real shocks, have different effects on the real exchange rate.

One issue that arises here is how exchange rate fluctuations determined by factors unrelated to economic fundamentals, such as 'animal spirits', would be classified in this framework. In the identification scheme proposed here, temporary deviations of exchange rates from levels consistent with economic fundamentals would tend to be attributed to nominal shocks. However, as noted by Meese and Rogoff (1983), Huizinga (1987), and others, a substantial fraction of real exchange rate fluctuations are in fact quite persistent. It seems plausible that animal spirits do not have persistent effects on exchange rates and, therefore, are not in general a significant determinant of exchange rate fluctuations. I return to this issue later.

III. The Empirical Model

This section describes the construction of the variables used in the empirical work, summarizes the results of preliminary analysis to confirm that the data have the basic time series properties implied by the theoretical model, and outlines the key features of the empirical model.

Recall that the theoretical model in the previous section delivered implications for domestic output *relative* to foreign output. Hence, for each G-7 country, I construct an index of external demand by taking a trade-weighted average of real GDP in the other G-7 countries.[6] The logarithm of this index is then subtracted from the logarithm of the index of domestic output in order to derive relative output. Using this variable implicitly controls for changes in external demand conditions.[7] Similarly, an index of the real effective exchange rate for each country was constructed by taking a trade-weighted average of bivariate real exchange rates vis-à-vis each of the other G-7 countries, using domestic and foreign CPIs as the price deflators. Thus, I derive consistent measures of relative output and the real exchange rate, although it should be noted that the trade data are more comprehensive and not limited to trade within the G-7. Following the standard practice in the literature, the trade balance is expressed as a ratio of total output in order to control for scale effects. All variables except the trade ratios are used in logarithmic form in the empirical work.

Figure 1 plots the ratio of the trade balance to GDP. In certain countries, most notably Japan, there appears to be a discernible trend in this variable although this is somewhat obscured by the common scale used in all panels of this figure. Japan and the United States appear to have less high frequency volatility in the trade balance than the other G-7 countries. It is also useful, especially from the perspective of interpreting cross-country differences in the empirical results, to examine the degree of openness to international trade. Table 1 reports time averages of the ratio of the sum of exports and imports to GDP. When the averages are broken down by decade, a clear rising trend in openness is evident for all countries over the last three decades, reflecting the increasing integration of national economies through trade.

Next, I turn to a more formal examination of the time series properties of the variables entering the VARs. The theoretical model implies that relative output, the real exchange rate, and the trade balance are nonstationary in levels, stationary in first differences and are not cointegrated. To test whether the implications of the model are consistent with the data, I first implemented a set of standard unit root tests. In almost all cases, the null hypothesis of a unit root could not be rejected against the alternative hypotheses of stationarity per se or stationarity around a deterministic trend. To maintain a uniform specification across countries, I include all variables, including the trade ratios, in first difference form in the VARs. Since the presence of common stochastic trends could affect the modeling strategy, I also performed

---

[6]The analysis is restricted to the G-7 due to data constraints and the desire to have a relatively homogeneous sample of industrial countries. The data used in this paper and the data sources are described in the appendix. As indicated there, for each of the G-7 countries, trade with the other G-7 countries accounts for about two-thirds of total trade.

[7]In effect, this procedure isolates country-specific shocks to output growth. Glick and Rogoff (1995) argue that country-specific shocks are more important determinants of current account variation than global shocks.

cointegration tests but found no evidence of cointegration among these variables for any of the relevant specifications.[8]

The first step in the implementation of the econometric methodology is to estimate the following reduced-form VAR:

$$B(L)X_t = \epsilon_t , \qquad \text{var}(\epsilon_t) = \Omega \tag{16}$$

where X_t is a vector containing the first differences of relative output, the real exchange rate, and the trade balance, and B(L) is a 3 x 3 matrix of lag polynomials. Under normal regularity conditions, this VAR can then be inverted to obtain the following moving average representation:

$$X_t = C(L)\epsilon_t , \quad \text{where} \quad C(L) = B(L)^{-1} \text{ and } C_0 = I. \tag{17}$$

The objective is to derive an alternative moving average representation of the form:

$$X_t = A(L)\eta_t , \qquad \text{var}(\eta_t) = I \tag{18}$$

where I is an identity matrix. Comparing equations (17) and (18), it is evident that $A_j = C_j A_0$ for j=1,2,...; and that $\eta_t = A_0^{-1}\epsilon_t$. Using the fact that $A_0 A_0' = \Omega$ yields a set of six restrictions on the elements of the A_0 matrix since the variance-covariance matrix Ω is symmetric. Three additional restrictions are required to identify the model.

Following Blanchard and Quah (1988), identification is achieved by imposing constraints on certain long-run multipliers in the system, leaving the short-run dynamics

---

[8]For the stationarity tests, Augmented Dickey-Fuller (ADF) regressions with a constant, a linear trend, and four lags of the dependent variable were run for all variables. In virtually all cases, the ADF statistics were below the 5 percent critical value for rejection of the null hypothesis of unit root non-stationarity against the alternative of stationarity around a deterministic time trend. The unit root hypothesis was rejected only for the real exchange rate for Japan, although this variable has a distinct trend. ADF tests were also used to confirm the stationarity of the first differences of these variables (no trend term was included in this set of ADF regressions). The Stock-Watson (1988) common trends test was used to test for cointegration. There was no evidence of cointegration that could affect any of the specifications in the paper. These results are available from the author.

unconstrained. The restrictions implied by the theoretical model—that nominal and demand shocks have no long-run effects on the level of output and that nominal shocks do not have a permanent effect on the level of the real exchange rate—make the A_0 matrix uniquely identified. The mutually uncorrelated shocks η_{1t}, η_2, and η_3 are then interpretable as the underlying supply, demand, and nominal shocks, respectively.

The econometric approach is structural in that relative output fluctuations, variations in the real exchange rate, and changes in the trade balance are jointly determined in response to different shocks. Since the theoretical model identified relative output and the exchange rate as the mechanisms through which different shocks generate differences in the cyclical dynamics of the trade balance, these variables are directly included in the estimation in order to identify the 'fundamental' shocks. In this framework, however, one could think of demand shocks as fiscal shocks and nominal shocks as monetary shocks. For instance, the relative demand shock term d_t would typically capture the effects of relative fiscal shocks.[9]

IV. Results

This section presents the main results from the empirical implementation of the structural VAR described above in order to examine how different sources of macroeconomic fluctuations influence the cyclical dynamics of the trade balance. The analysis focusses on the post-Bretton Woods period.[10] It is important to reiterate that all variables (and, hence, all shocks) referred to below express the home country variables *relative* to a trade-weighted average of partner country variables.

The VARs were estimated independently for each country. Starting with a lag length of 8, which appeared to be the minimum required for adequately capturing business cycle dynamics, a sequence of likelihood ratio tests was performed to determine the appropriate lag lengths for the VARs. Based on these tests, a lag length of 8 was chosen for all countries except Canada (10) and Germany (9).

---

[9]The relationship between changes in current and projected fiscal deficits and the real exchange rate has been the subject of considerable debate recently, with the empirical evidence providing no clear resolution. Using real exchange rates directly in the estimation obviates the need to take a stand on this issue. Also note that nominal shocks could include shocks to both money

[10]Consistent trade data were available for Germany starting only in 1968. Preliminary results indicated that the decomposition did not work well for some of the countries in the sample that included the last few years of the Bretton Woods period. To check the sensitivity of the results to German unification, the model for Germany was re-estimated over the period 1974:1-1989:4. The results reported in this section were qualitatively similar when this limited sample was used.

A. Impulse Responses

I first examined the estimated impulse response functions.[11] Since the original reduced-form VARs were run with the first differences of the relevant variables, the impulse responses to the structural shocks were cumulated in order to arrive at the level responses. Figure 2 shows the impulse responses of the ratio of the trade balance to output in response to different types of shocks.[12] The short-run response of the trade balance to a supply shock is rather small for most countries. Supply shocks tend to result in a permanent positive effect on output and a permanent depreciation of the real exchange rate, both in the theoretical model and in the estimated impulse responses. Thus, the output and exchange rate effects on the trade balance tend to work in opposite directions over both short and long time horizons. Over the long run, the trade balance response to a supply shock is weakly positive for Canada, negative for Germany and the United States, and close to zero for the others.[13]

A demand shock, which could be interpreted, for instance, as a domestic fiscal expansion, would tend to increase output and cause an exchange rate appreciation in the short run. Hence, the trade balance should be negatively affected in the short run through both the exchange rate and relative output channels. However, for most countries, demand shocks appear to have a small and statistically insignificant impact effect on the trade balance in the

---

[11]To conserve space, I do not present here the impulse responses for relative output and the real exchange rate, which looked quite reasonable. Supply shocks have a permanent positive effect on the level of output and lead to a persistent depreciation of the real exchange rate (all shocks referred to here are unit positive shocks). Demand and nominal shocks have positive but transitory effects on the level of output. A demand shock leads to a persistent appreciation of the real exchange rate while a nominal shock results in a temporary depreciation. These responses are similar to those reported by Clarida and Gali (1994), who use bilateral relative variables, and Chadha and Prasad (1997).

[12] The results reported here are responses to unit (one standard deviation) positive shocks. Since the estimated models are all linear, the responses to positive and negative shocks are symmetric. To reduce clutter, the standard error bands are not shown. As noted before, the trade balance is expressed as a ratio to GDP in order to control for scale effects. Fluctuations in the trade balance are substantially larger than those of output and dominate the fluctuations in this ratio. Hence, these impulse responses can be regarded as being essentially the responses of the trade balance. To confirm this, I examined the correlations between changes in the trade balance and changes in the trade balance to GDP ratio. These correlations were greater than 0.98 for all countries.

[13]Except for the case of Japan, this result is consistent with Elliott and Fatás's (1996) finding that country-specific productivity shocks lead to persistent current account deficits in Japan, the United States, and a composite aggregate of the European G-7 countries.

short run. One possible reason is that the elasticity of imports with respect to transitory output fluctuations is much smaller than with respect to persistent changes in output. In addition, the effects of demand shocks are transmitted to real exchange rates more slowly than are the effects of nominal shocks. Demand shocks do not have long-run effects on output but result in persistent real exchange rate depreciations. Consequently, the long-run effect of a demand shock would be expected to be negative. This is indeed the case for all countries, although the long-run responses are statistically significant only for Canada, Italy, and the United States.

A nominal shock, which could be interpreted as a relative monetary easing in the home country, increases output but also tends to result in an exchange rate depreciation, although both of these effects are temporary. As in the case of supply shocks, the relative importance of these two opposing effects on the trade balance has to be resolved empirically. For virtually all countries in the sample, nominal shocks in fact lead to a significant improvement in the trade balance. This indicates that the effects on the trade balance of the real exchange rate depreciation caused by relative monetary easing outweigh the effects of the expansion of relative output. In large part, this result is driven by the fact that the exchange rate effects of nominal shocks are relatively large and occur fairly quickly while the effects on output are generally quite small and occur with a considerable lag. Eichenbaum and Evans (1995), for instance, find that the effects of nominal shocks are transmitted fairly rapidly to both nominal and real exchange rates. Also interesting is the fact that nominal shocks appear to have persistent effects on the trade balance. This suggests that hysteresis and beach-head effects, which could translate temporary but sharp exchange rate changes into persistent effects on trade variables, could be important for trade dynamics. As noted earlier, Baldwin (1988, 1990), among others, reaches similar conclusions using different empirical techniques.

B. Variance Decompositions

A different but complementary perspective on the relative importance of alternative macroeconomic shocks for variation in the trade balance is provided by computing the forecast error variance decompositions from the structural VARs. Table 2 presents the variance decompositions for forecast errors at different time horizons for the changes in the ratio of the trade balance to output. At long forecast horizons, these variance decompositions can be interpreted as the unconditional variance shares attributable to different shocks.

For most countries, the contribution of supply shocks to the forecast error variance at a horizon of less than one year is about 10 percent. Over long forecast horizons, these contributions increase but remain small for most countries except for Germany, Italy, and the United States, where they increase to about 20 percent. These three countries also happen to be those where the long-run negative impulse responses of the trade balance to supply shocks are the largest (in terms of absolute magnitude). The contribution of demand shocks to the forecast error variance increases with the length of the forecast horizon for most countries. This is consistent with the earlier discussion regarding the slow transmission of demand shocks to the real exchange rate. At long horizons, demand shocks contribute about one-third of the total forecast error variance in Canada, Japan, and the United States and about 20 percent in the European economies, except in Italy, where this contribution is lower.

The striking feature of this table, however, is the substantial contribution of nominal shocks to the forecast error variance of changes in the trade balance. Over short forecast horizons, this contribution is close to or greater than 50 percent for all countries. The relative importance of nominal shocks declines over longer horizons but remains significantly large, accounting for about two-thirds of the long-horizon forecast error variance in France, Italy, and the United Kingdom, and about 50 percent in the remaining countries.

These results indicate that supply shocks could indeed be important for output fluctuations but, due to their offsetting effects on real exchange rates, are less important for variations in the trade balance. Demand shocks become increasingly important at longer forecast horizons as their effects on exchange rates influence the trade variables. Nominal shocks appear to play a prominent role in trade balance fluctuations at short and long forecast horizons. As noted earlier, this could be because nominal shocks are transmitted to real exchange rates fairly quickly while their effects on output are small and highly transitory. Further, nominal shocks also appear to have persistent effects on trade variables.

A possible concern at this juncture might be that the identification scheme could ascribe a major fraction of short-term fluctuations in exchange rates (and, consequently, in the trade balance) to nominal shocks. Hence, if short-run exchange rate fluctuations were driven largely by 'non-fundamental' shocks, the methodology would attribute too much importance to nominal shocks. However, as noted earlier, the empirical evidence in the literature indicates that variations in the real exchange rate are highly persistent. Further, I find, as do Clarida and Gali (1994), that demand shocks rather than nominal shocks account for a large fraction of the forecast error variance of real exchange rate changes for the G-7 countries. Thus, the result that nominal shocks account for an important fraction of the forecast error variance for changes in the trade balance can not be attributed to the identification scheme.

In summary, the sources of macroeconomic fluctuations have an important influence on the cyclical dynamics of the trade balance. Demand and nominal shocks, which are often viewed together as aggregate demand shocks, can lead to similar variations in output but very different patterns of variation in real exchange rates and, hence, in trade variables. The effects of supply shocks on these variables often differ substantially from the effects of demand or nominal shocks, especially over longer horizons. The relative importance of these shocks varies considerably over different time horizons and across countries.

V. Discussion and Some Robustness Tests

The impulse responses indicated that nominal shocks lead to procyclical variation in the trade balance, i.e., a positive correlation between short-run variations in output and the trade balance. Supply and demand shocks, on the other hand, tend to generate a negative correlation, although these effects are statistically insignificant in some countries.

Given this evidence, an issue that arises is how the large contribution of nominal shocks to the forecast error variance of changes in the trade balance can be reconciled with the well-documented counter cyclical behavior of the trade balance. An important point here is that, although nominal shocks do indeed generate a positive (conditional) correlation between the trade balance and output, the actual increases in output resulting from nominal shocks turned out to be quite small and highly transitory in the impulse responses (not shown here).[14] Further, the variance decompositions for changes in output indicated that, in all G-7 countries, nominal shocks account for a relatively small fraction of the forecast error variance, even at short forecast horizons. Supply shocks are the main determinant of output growth fluctuations in most countries, especially at longer horizons, while demand shocks are also important at short horizons. Thus, the results in this paper are consistent with the negative *unconditional* correlations between output and the trade balance found in the data. Further, based on the weak impulse response patterns of the trade balance to supply shocks and the relative importance of these shocks for output fluctuations, negative correlations between output and the trade balance do not necessarily imply a substantial contribution, in terms of economic magnitudes, from external trade to output growth during business cycle recoveries.

A second issue is related to the specification of the trade balance as stationary in first differences rather than in levels. The theoretical model implied that the long-run *level* of the trade balance to GDP ratio is affected by the fundamental shocks, rendering this variable potentially nonstationary in levels. However, the model is not rich enough to incorporate feedback effects from the evolution of the stock of net foreign assets (or liabilities) to the real exchange rate. For instance, an economy that had an unsustainable accumulation of net foreign liabilities would tend to face a real exchange rate depreciation, with a consequent positive effect on the trade balance, thereby improving, or at least stabilizing, the net foreign liabilities to GDP ratio. Hence, although the trade balance is evidently nonstationary within sample, the assumption of nonstationarity in levels might not be appropriate.[15,16]

---

[14]The small and delayed output response to money shocks is similar to the evidence in the literature from both structural and non-structural VARs in a closed-economy context.

[15]Blanchard and Quah (1988) face a similar problem since their theoretical model implies that the unemployment rate is stationary in levels, while statistical tests on the actual data can not rule out the null hypothesis of nonstationarity. They resolve this problem by detrending the unemployment rate and then, as in this paper, by examining the robustness of their results to this assumption.

[16]From a long-run PPP perspective, one might argue that the real exchange rate should also be stationary. The evidence on this is far from conclusive, even in studies that use long data

(continued...)

To examine the robustness of the results to this assumption, the VARs were redone using the levels rather than the first differences of the trade balance. The results from the forecast error variance decompositions, shown in table 3, indicate some differences relative to the baseline results. Nevertheless, the result that nominal shocks account for a significant fraction of fluctuations in the trade balance is preserved. Over a forecast horizon of 4 to 8 quarters, nominal shocks account for more than 50 percent of the forecast error variance in the trade balance for all countries except Italy and the United States. Over longer forecast horizons, nominal shocks account for the largest fraction of this forecast error variance in 4 countries while, in the other 3 countries–Canada, Italy, and the United States–these shocks still account for between 30 and 40 percent.

The model described in this paper can also be adapted to study the dynamics of the ratio of exports to output. These results, which provide a robustness check along a different dimension, were presented in an earlier version of this paper and are briefly summarized here. The forecast error variance decompositions for changes in the ratio of exports to output did not reveal any sharp differences compared to the results for the trade balance. As in table 2, the relative importance of nominal shocks declined over longer forecast horizons while the relative importance of demand and supply shocks tended to rise at longer horizons. The relative importance of supply shocks was generally larger than for variations in the trade balance. The main conclusion was that, as in the case of fluctuations in the trade balance, nominal shocks are a key determinant of the forecast error variance at both short and long forecast horizons for all countries in the sample

Finally, I also analyzed the historical sequence of shocks identified by the model. This was used to confirm that the behavior of the trade variables during cyclical recoveries was in fact consistent with the shocks that were identified and with the estimated impulse responses. This analysis was performed for all countries and the results were generally quite consistent with other evidence about the sources of fluctuations in output and the trade variables for the main cyclical episodes in the sample.[17]

---

[16](...continued)
samples. Assuming stationarity of the real exchange rate would make it difficult to disentangle the demand and nominal shocks in this framework.

[17]These results were also presented in an earlier version of this paper and are available from the author. Further, I decomposed the historical forecast errors of the variables in the VAR into the components attributable to each of the shocks. These decompositions are more difficult to interpret since they represent the cumulative effects of current and past shocks. Nevertheless, these decompositions appeared to be consistent with other historical evidence. For instance, the 1982 recession in the United States is seen to be the result of a nominal contraction while the real appreciation of the U.S. dollar in the 1980s is attributed largely to a sharp increase in the demand component of the exchange rate, consistent with the Reagan-era
(continued...)

VI. Concluding Remarks

This paper has provided new evidence on the relationship between international trade and the business cycle. I constructed and implemented a structural VAR model that was used to characterize trade dynamics in response to different types of shocks and to obtain quantitative estimates of the relative importance of these shocks for fluctuations in the trade balance. An interesting finding is that, in the post-Bretton Woods period, nominal shocks appear to have played an important role in determining fluctuations in trade variables in G-7 countries. These shocks tend to generate positive correlations between output and the trade balance. The paper reconciled these results with the stylized fact, based on unconditional correlations, of counter cyclical variation of the trade balance. The results in this paper suggest that calibrated simulations of general equilibrium models as well as further econometric and forecasting exercises in this area need to incorporate distinct roles for different types of macroeconomic shocks in order to gain a better understanding of various aspects of fluctuations in trade variables.

---

[17](...continued)
fiscal expansion.

Data sources and definitions

Quarterly, seasonally adjusted data on real GDP, real exports of goods and nonfactor services, and real imports of goods and nonfactor services were obtained from the OECD Analytical Databank. Exports and imports are measured according to the national income accounts definition. The real trade balance is measured as the difference between exports and imports. The IMF's International Financial Statistics tape was the source for the CPI and nominal exchange rate data (lines 64 and rf, respectively). Nominal exchange rates were measured as quarterly averages. The trade weights used to construct the measures of relative output and real effective exchange rates were obtained from the IMF's Information Notice System. These weights account for bilateral trade competition as well as competition in third markets. The proportion of the total trade weights for each country accounted for by the other G-7 countries is as follows:

Canada	France	Germany	Italy	Japan	U.K.	U.S.
83.8	66.9	56.7	68.9	57.6	64.6	63.5

These weights were then normalized so that, for each G-7 country, the sum of the trade weights on the other six countries in the sample is 100.

Table 1. A measure of openness to international trade

	Canada	France	Germany	Italy	Japan	U.K.	U.S.
	The ratio of the sum of exports and imports to GDP (in percent)						
1974:1-1996:4	55.1	47.4	48.6	33.6	19.0	47.2	16.9
1974:1-1979:4	41.6	41.0	42.8	28.5	17.0	40.9	13.0
1980:1-1989:4	51.1	45.5	49.8	31.4	18.4	45.6	15.6
1990:1-1996:4	72.5	55.5	52.0	41.3	21.6	54.8	22.2

Notes: The numbers in this table are average ratios over the indicated periods. Exports and imports refer to exports and imports, respectively, of goods and nonfactor services per the National Income Accounts definition. See Appendix I for a detailed description of the data and data sources.

Table 2. Forecast error variance decompositions for changes in the ratio of the trade balance to output

Forecast	CANADA			FRANCE			GERMANY			ITALY			JAPAN			U.K.			U.S.		
Horizon	Supply	Dmd.	Nom.	Supply	Dmd.	Nom.	Supply	Dmd.	Nom.	Supply	Dmd.	Nom.	Supply	Dmd.	Nom.	Supply	Dmd.	Nom.	Supply	Dmd.	Nom.
1	4.6	48.8	46.7	13.2	0.7	86.1	13.5	3.1	83.4	12.9	0.1	87.0	8.9	38.8	52.3	6.0	7.6	86.4	8.0	32.5	59.5
	(4.7)	(7.5)	(7.6)	(6.9)	(2.0)	(6.9)	(6.8)	(3.7)	(7.4)	(6.7)	(1.5)	(6.8)	(5.8)	(7.9)	(7.6)	(5.2)	(5.3)	(7.0)	(5.7)	(8.0)	(8.2)
2	4.5	47.9	47.6	12.1	7.8	80.1	14.2	13.6	72.2	17.0	4.3	78.7	10.0	36.0	54.0	10.0	9.1	80.9	15.5	28.2	56.3
	(4.5)	(7.3)	(7.3)	(6.1)	(2.2)	(6.0)	(6.0)	(3.6)	(6.3)	(6.4)	(1.5)	(6.4)	(5.4)	(6.6)	(6.7)	(5.6)	(5.3)	(7.2)	(4.4)	(7.2)	(7.0)
4	4.5	48.4	47.0	11.8	10.0	78.2	14.7	15.4	69.9	17.7	9.1	73.1	9.3	33.6	57.1	9.5	15.8	74.7	15.6	30.4	54.0
	(4.5)	(7.2)	(7.3)	(6.0)	(2.5)	(5.9)	(5.3)	(4.0)	(6.0)	(6.0)	(2.1)	(5.9)	(4.8)	(6.0)	(6.3)	(5.0)	(4.9)	(6.3)	(4.1)	(7.0)	(6.7)
8	10.3	45.2	44.5	12.6	18.3	69.1	26.3	22.2	51.6	19.8	9.6	70.5	10.5	37.2	52.3	12.2	20.2	67.6	20.1	34.9	44.9
	(3.4)	(6.7)	(6.4)	(5.2)	(3.6)	(5.6)	(4.9)	(4.3)	(5.3)	(5.9)	(2.2)	(5.8)	(4.3)	(5.5)	(5.6)	(4.0)	(5.1)	(5.9)	(4.1)	(5.8)	(5.6)
16	12.5	37.8	49.7	13.2	18.9	68.0	28.2	25.0	46.8	20.1	10.2	69.7	13.7	35.7	50.6	12.3	19.2	68.4	18.8	36.5	44.6
	(2.9)	(6.3)	(6.1)	(5.2)	(3.6)	(5.6)	(4.8)	(4.1)	(5.0)	(5.8)	(2.2)	(5.7)	(4.3)	(5.3)	(5.4)	(3.9)	(5.1)	(5.8)	(3.9)	(5.4)	(5.3)
32	13.1	37.6	49.3	13.3	19.1	67.7	28.4	25.2	46.4	20.2	10.3	69.5	13.7	35.6	50.7	12.5	19.1	68.4	19.9	36.5	43.6
	(2.9)	(6.1)	(6.0)	(5.2)	(3.6)	(5.6)	(4.8)	(4.1)	(5.0)	(5.8)	(2.2)	(5.7)	(4.3)	(5.3)	(5.4)	(3.8)	(5.0)	(5.8)	(4.0)	(5.3)	(5.2)
50	13.4	37.5	49.2	13.3	19.1	67.7	28.5	25.3	46.3	20.2	10.3	69.5	13.7	35.6	50.7	12.5	19.1	68.4	20.1	36.5	43.4
	(3.0)	(6.1)	(5.9)	(5.2)	(3.6)	(5.6)	(4.8)	(4.1)	(5.0)	(5.8)	(2.2)	(5.7)	(4.3)	(5.3)	(5.4)	(3.8)	(5.0)	(5.8)	(4.0)	(5.2)	(5.2)

Notes: The results reported above are forecast error variance decompositions from trivariate VARs that included the first differences of (logarithms of) relative output and the real effective exchange rate, and first differences of the ratio of the trade balance to GDP. The VARs were estimated independently for each country over the sample period 1974:2-1996:4. Standard errors for the variance decompositions at different forecast horizons are shown in parentheses. These standard errors were computed using Monte Carlo techniques with 1000 replications.

Table 3. Forecast error variance decompositions for the ratio of the trade balance to output

Forecast	CANADA			FRANCE			GERMANY			ITALY			JAPAN			U.K.			U.S.		
Horizon	Supply	Dmd.	Nom.	Supply	Dmd.	Nom.	Supply	Dmd.	Nom.	Supply	Dmd.	Nom.	Supply	Dmd.	Nom.	Supply	Dmd.	Nom.	Supply	Dmd.	Nom.
1	22.5	0.095	77.4	1.4	2.7	95.9	2.9	16.8	80.2	20.0	72.9	7.1	6.1	50.4	43.5	43.9	22.3	33.8	1.3	98.6	0.1
	(8.1)	(1.4)	(8.1)	(3.1)	(3.6)	(4.7)	(3.7)	(7.2)	(7.6)	(8.0)	(7.8)	(1.5)	(5.0)	(7.5)	(7.2)	(8.1)	(6.4)	(6.0)	(2.8)	(2.8)	(0.0)
2	19.7	4.2	76.0	0.8	2.9	96.3	5.1	7.7	87.1	13.7	71.9	14.4	9.2	32.8	58.0	36.8	19.2	44.0	2.5	95.2	2.2
	(7.7)	(3.1)	(7.6)	(2.3)	(1.7)	(2.8)	(4.4)	(4.4)	(5.8)	(6.8)	(6.8)	(2.9)	(5.8)	(7.6)	(8.0)	(8.1)	(6.2)	(7.0)	(1.9)	(2.0)	(0.5)
4	14.6	8.5	76.9	0.5	4.8	94.7	8.1	5.8	86.1	12.0	63.0	25.0	7.5	23.9	68.6	34.8	11.6	53.6	2.9	88.8	8.3
	(6.9)	(4.7)	(7.7)	(1.9)	(2.8)	(3.3)	(5.2)	(2.0)	(5.2)	(6.4)	(7.0)	(4.6)	(5.4)	(7.3)	(8.2)	(8.0)	(4.7)	(7.5)	(2.6)	(3.0)	(1.7)
8	33.6	11.8	54.7	1.2	10.7	88.1	13.0	14.2	72.9	7.9	61.6	30.5	3.9	12.7	83.4	34.5	6.8	58.7	2.5	73.4	24.1
	(7.2)	(4.5)	(7.1)	(1.6)	(4.3)	(4.5)	(6.1)	(4.5)	(6.5)	(4.4)	(6.6)	(5.3)	(3.7)	(5.6)	(6.5)	(7.9)	(3.0)	(7.6)	(2.6)	(4.9)	(4.3)
16	45.7	12.1	42.2	6.5	14.8	78.7	30.4	13.3	56.2	10.3	55.2	34.6	5.7	9.7	84.6	35.7	4.9	59.4	5.1	58.1	36.8
	(6.9)	(4.0)	(6.3)	(2.3)	(4.6)	(5.0)	(6.8)	(4.3)	(6.5)	(3.6)	(6.6)	(5.6)	(2.0)	(5.0)	(5.3)	(7.9)	(2.1)	(7.6)	(2.1)	(6.1)	(5.7)
32	47.0	12.0	40.9	12.4	14.8	72.8	37.1	12.2	50.7	15.3	53.6	31.1	7.4	9.3	83.2	37.6	4.64	57.8	5.51	57.1	37.3
	(6.8)	(4.0)	(6.2)	(3.1)	(4.5)	(5.1)	(6.6)	(3.5)	(6.1)	(4.7)	(6.6)	(5.1)	(2.2)	(4.9)	(5.2)	(7.9)	(1.8)	(7.5)	(2.2)	(6.2)	(5.7)
50	47.1	12.1	40.8	12.5	14.8	72.7	38.5	12.0	49.6	15.2	53.6	31.2	7.4	9.3	83.2	37.7	4.6	57.7	5.7	56.8	37.5
	(6.8)	(4.0)	(6.2)	(3.1)	(4.4)	(5.1)	(6.6)	(3.4)	(6.1)	(4.7)	(6.7)	(5.1)	(2.2)	(4.9)	(5.2)	(7.9)	(1.8)	(7.5)	(2.3)	(6.2)	(5.7)

Notes: The results reported above are forecast error variance decompositions from trivariate VARs that included the first differences of (logarithms of) relative output and the real effective exchange rate, and the level of the ratio of the trade balance to GDP. The VARs were estimated independently for each country over the sample period 1974:2-1996:4. Standard errors for the variance decompositions at different forecast horizons are shown in parentheses. These standard errors were computed using Monte Carlo techniques with 1000 replications.

Figure 1. The Ratio of the Trade Balance to GDP
(In percent)

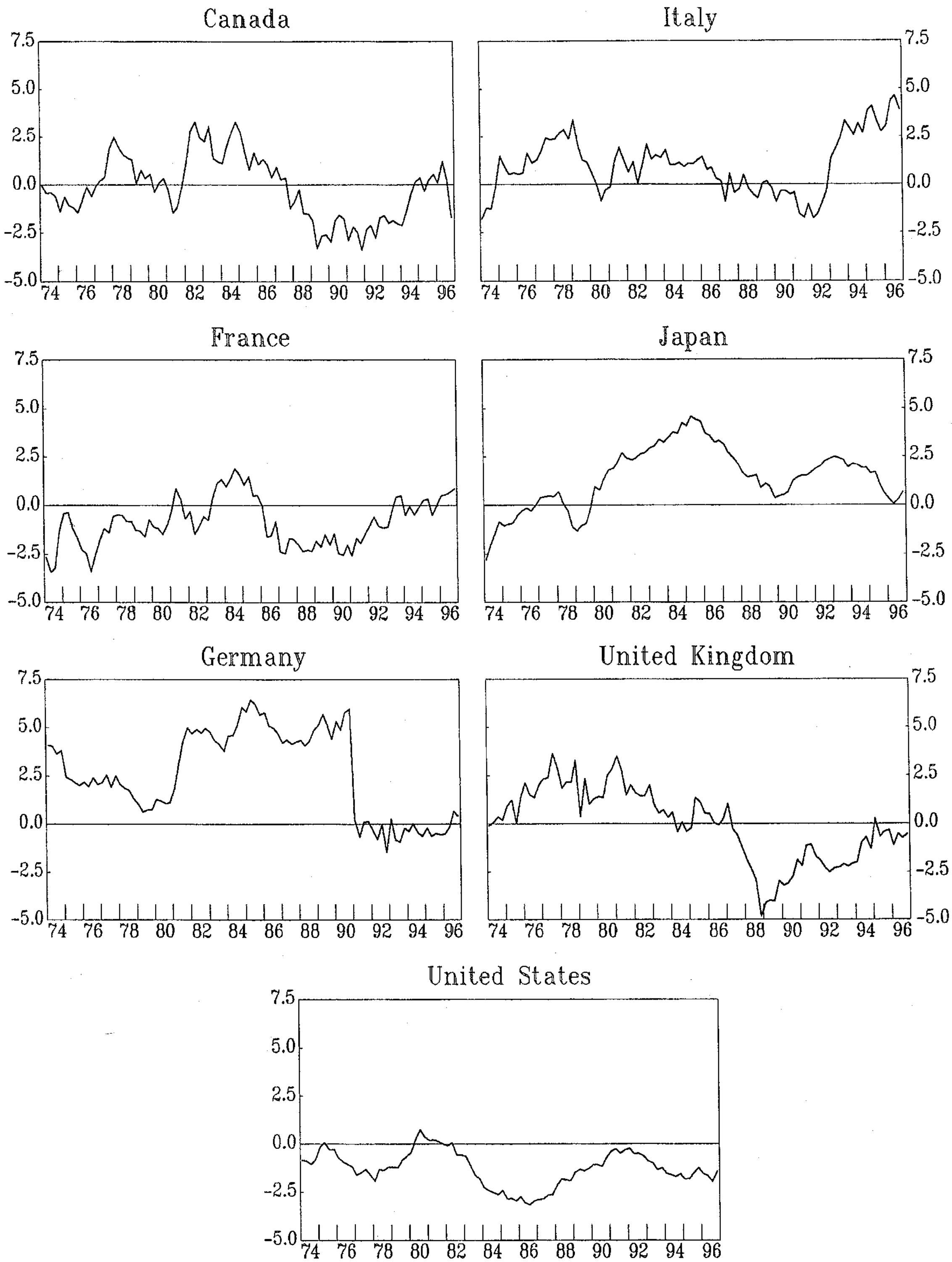
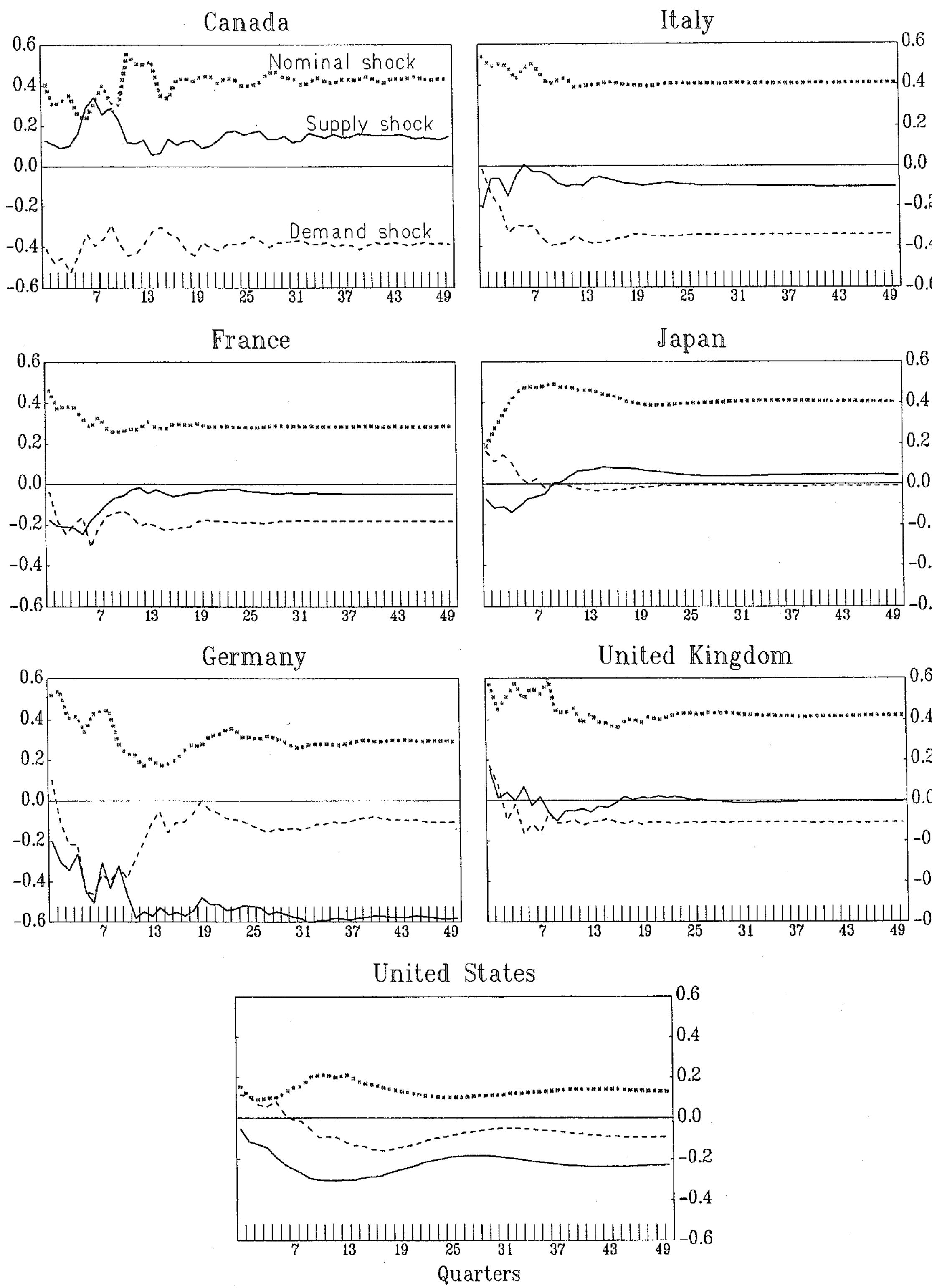


Figure 2. Impulse Responses of the Ratio of the Trade Balance to Output

(In percent)



Notes: The impulse response functions for changes in the trade balance to GDP ratio were cumulated in order to derive responses in terms of the levels of this ratio.

REFERENCES

Ahmed, Shaghil, Barry Ickes, Ping Wang, and Sam Yoo, 1993, "International Business Cycles," *American Economic Review*, Vol. 83, pp. 335–59.

Backus, David K., Patrick J. Kehoe, and Finn E. Kydland, 1992, "International Real Business Cycles," *Journal of Political Economy,* Vol. 100, pp. 745–75.

____, 1994, "Dynamics of the Trade Balance and the Terms of Trade: The J-Curve?" *American Economic Review*, Vol. 84, pp. 84–103.

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

____, 1990, "Hysteresis in Trade," *Empirical Economics,* Vol. 15, pp. 127-42.

Baxter, Marianne, 1995, "International Trade and Business Cycles," in *Handbook of International Economics*, ed. by Gene M. Grossman and Kenneth Rogoff. (Amsterdam: Elsevier, North-Holland).

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

Canova, Fabio, and Harris Dellas, 1993, "Trade Interdependence and the Business Cycle," *Journal of International Economics*, Vol. 34, pp. 23–47.

Canova, Fabio, and Jane Marrinan, 1998, "Sources and Propagation of International Cycles: Common Shocks or Transmission?" *Journal of International Economics*, Vol. 46, pp. 133–66.

Chadha, Bankim, and Eswar Prasad, 1997, "Real Exchange Rate Fluctuations and the Business Cycle: Evidence from Japan," *IMF Staff Papers*, Vol. 44, pp. 328–55.

Clarida, Richard, and Jordi Gali, 1994, "Sources of Real Exchange Rate Fluctuations: How Important Are Nominal Shocks?" *Carnegie-Rochester Conference Series on Public Policy*, Vol. 41, pp. 1-56.

Dornbusch, Rudiger, 1980, *Open Economy Macroeconomics*. New York: Basic Books.

Eichenbaum, Martin, and Charles L. Evans, 1995 "Some Empirical Evidence on the Effects of Monetary Policy Shocks on Exchange Rates," *Quarterly Journal of Economics*, Vol. 110, pp. 975–1009.

Elliott, Graham, and Antonio Fatás, 1996, "International Business Cycles and the Dynamics of the Current Account," *European Economic Review*, Vol. 40, pp. 361–87.

Fiorito, Riccardo, and Tryphon Kollintzas, 1994, “Stylized Facts of Business Cycles in the G-7 from a Real Business Cycle Perspective,” *European Economic Review*, Vol. 38, pp. 235–69.

Glick, Reuven, and Kenneth Rogoff, 1995, “Global Versus Country-Specific Productivity Shocks and the Current Account,” *Journal of Monetary Economics*, Vol. 35, pp. 159–92.

Huizinga, John, 1987, “An Empirical Investigation of the Long-Run Behavior of Real Exchange Rates,” *Carnegie-Rochester Conference Series on Public Policy*, Vol. 27, pp. 149-215.

Lastrapes, William, 1992, “Sources of Fluctuations in Real and Nominal Exchange Rates,” *Review of Economics and Statistics*, Vol. 74, pp. 530–39.

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

Obstfeld, Maurice, 1985, “Floating Exchange Rates: Experience and Prospects,” *Brookings Papers on Economic Activity*, Vol. 2, pp. 369-450.

Robertson, Donald, and Mike R. Wickens, 1997, “Measuring Real and Nominal Macroeconomic Shocks and Their Transmission Under Different Monetary Systems,” *Oxford Bulletin of Economics and Statistics*, Vol. 59, pp. 5-27.

Stock, James H., and Mark W. Watson, 1988, “Testing for Common Trends,” *Journal of the American Statistical Association*, Vol. 83, pp. 1097-1107.

Zimmermann, Christian, 1995, “International Trade Over the Business Cycle: Stylized Facts and Remaining Puzzles,” Working Paper 37, Research Center on Employment and Economic Fluctuations, Université du Québec à Montréal, Montréal, Canada.