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International Evidence on the Determinants of Trade Dynamics

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Abstract

This paper provides some new empirical perspectives on the relationship between international trade and macroeconomic fluctuations in industrial economies. First, a comprehensive set of stylized facts concerning fluctuations in trade variables and their determinants are presented. A measure of the quantitative importance of international trade for the propagation of domestic business cycles is then constructed, focusing on the role of external trade as a catalyst for cyclical recoveries. Finally, structural vector autoregression models are used to characterize the joint dynamics of output, exchange rates, and trade variables in response to different types of macroeconomic shocks.

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SUMMARY

This paper provides some new empirical perspectives on the relationship between international trade and aggregate macroeconomic fluctuations in OECD industrial economies. First, it presents a comprehensive set of stylized facts on the volatility of price and quantity variables related to international trade and the correlations of these variables with domestic business cycles.

A quantitative measure of the importance of external trade for business cycle recoveries is then constructed. This measure reveals that the trade balance has generally not contributed significantly to cyclical recoveries in industrial economies. Exports, on the other hand, do appear to serve as a catalyst for recoveries, with the magnitude of this role positively related to the degree of an economy's openness to international trade.

A multivariate econometric model is then used to characterize the joint dynamics of relative output, the real exchange rate, and trade variables in response to different types of macroeconomic shocks. The empirical model controls for changes in external demand conditions and is identified using a set of long-run restrictions derived from a stylized theoretical model.

The results indicate that relative nominal shocks are the main determinants of fluctuations in trade variables, especially in the short run, and that these shocks induce a positive correlation between cyclical output and the trade balance. Relative supply and demand shocks, on the other hand, tend to induce a negative correlation between these variables. These results shed light on the empirical relevance of different models of trade dynamics.

The paper also reconciles the relative importance of nominal shocks and the positive correlation that these shocks induce between output and the trade balance with the negative *unconditional* correlation between these variables. This highlights the importance of accounting for different sources of macroeconomic fluctuations for understanding and interpreting stylized facts based on bivariate unconditional correlations.

I. Introduction

The concept of 'globalization' has recently been the subject of considerable attention in both academic and policy circles. This phenomenon broadly refers to the increasing integration of the world economy through financial and trade flows. As economies become more open to international trade, the transmission and propagation of economic fluctuations through trade links has assumed increased importance. An analysis of the cyclical dynamics of international trade therefore has implications in a number of different dimensions, including macroeconomic forecasting, short-run policy making, and international policy coordination.

The objective of this paper is to provide a comprehensive set of stylized facts concerning the relationship between external trade and aggregate macroeconomic fluctuations. We assemble a data set that covers the OECD industrial economies and that includes the main price and quantity variables relevant to international trade since 1970. Thus, we re-examine, for a broader set of countries, a few stylized facts reported by other authors, introduce a number of new stylized facts, and attempt to provide a unified analysis of various features of the data based on recent theoretical advances in open economy macroeconomics.

In the first part of the paper, we provide a systematic documentation of the relationship, as measured by unconditional correlations, between trade variables and domestic business cycles. We also examine patterns of volatility of macroeconomic quantities and prices relevant for international trade. These stylized facts serve a number of different purposes. First, they help isolate key features of the data and thereby provide building blocks for theoretical models of the dynamics of international trade. Second, they provide a metric against which to measure the performance of calibrated general equilibrium models. Finally, they provide an indication of the types of macroeconomic shocks that are important determinants of fluctuations in trade variables.

Unconditional correlations, however, provide information only about the average relationship between these variables and output over different phases of the business cycle. Of more interest, from a forecasting as well as policy perspective, is the role of trade in serving as a catalyst for business cycle recoveries. To examine this issue, we construct a quantitative measure of the importance of international trade in generating business cycle recoveries. Somewhat surprisingly, this measure reveals that the trade balance (i.e., net exports of goods and nonfactor services) has in fact played only a limited role in business cycle recoveries in the OECD economies. The average contribution of the trade balance to output growth from business cycle troughs is quite small for most industrial economies.

An alternative hypothesis is that of 'export-led recoveries,' wherein an increase in export demand serves as a catalyst for the recovery in domestic demand. A concomitant increase in the imports of investment goods and intermediate inputs could, in this case, result in a smaller improvement or, possibly, even a deterioration in the trade balance. We do indeed find that exports appear to play a significant role in business cycle recoveries in industrial economies. We also find that the average magnitude of this contribution is closely related to the degree of openness of these economies to international trade.

The relationship between trade and the business cycle could, however, depend crucially on two factors. The first is the correlation of business cycles across countries. If business cycles across countries were perfectly synchronized, international trade would be less likely to have a significant influence on domestic business cycles. The second consideration is that changes in exchange rates are likely to have a strong influence on the relationship between trade and the business cycle. Different shocks that have similar business cycle effects but that vary in their exchange rate consequences could have very different effects on trade variables. To address these issues, we construct a multivariate econometric model that accounts for changes in domestic and external demand conditions and that captures the effects of exchange rate changes on trade. This part of the paper builds upon the work of Prasad and Kumar (1997), although, unlike these authors, we examine a much broader set of countries than just the G-7 and, therefore, provide a more comprehensive picture of trade dynamics in industrial countries. In addition, we extend the framework to separately examine fluctuations in imports and exports.

An important feature of the empirical model is that it enables us to disentangle different sources of macroeconomic shocks and to analyze the responses of trade variables to these shocks. Much of the literature on current account dynamics has focussed on the role of productivity shocks, both global and country-specific (see, e.g., Backus, Kehoe, and Kydland (1992), Glick and Rogoff (1995), and Elliott and Fatás (1996)). Through the effects of exchange rate changes, it is likely that other types of shocks could also significantly influence the dynamics of the trade balance. The framework in this paper enables us to simultaneously characterize the short-run and long-run dynamics of output, the real exchange rate, and the trade balance in response to various types of macroeconomic shocks.

This paper is also related to the large body of recent work that has provided theoretical and empirical analyses of the intertemporal effects of productivity and government spending shocks on consumption, investment, and the current account (see Obstfeld and Rogoff (1996) and references therein). However, much of this literature has implicitly assumed the absence of quantitatively important nominal rigidities, which could potentially play an important role in short-run fluctuations of real variables. The strong positive correlation between real and nominal exchange rates, for instance, suggests that nominal rigidities influence real relative prices in the short run and could, therefore, have real effects. This paper contributes to this literature by providing an empirical characterization of the relative importance of these effects on the dynamics of the trade balance in the presence of nominal rigidities.

The next section of the paper documents a number of stylized facts concerning the relationship between international trade and the business cycle. Section III implements a direct measure of the contribution of international trade to business cycle recoveries. Section IV describes a multivariate structural model for identifying different types of macroeconomic shocks and their effects on trade variables. Section V presents results from estimates of this model. Section VI pulls together and synthesizes the main results from the different empirical approaches adopted in the paper. Section VII discusses avenues for further research.

II. STYLIZED FACTS

In this section, we compile a comprehensive set of stylized facts concerning the relationship between international trade and the business cycle. First, we present various measures of openness to international trade in order to gauge the importance of trade for industrial countries. Next, we examine the volatility of various trade variables relative to the aggregate business cycle in each country. We then present unconditional correlations between trade variables and the business cycle at various lags and leads in order to highlight important features of trade dynamics over the business cycle.

The data sources and variables used in the analysis are described in Appendix I. Some of the results presented in this section build upon the work of Backus and Kehoe (1992), Fiorito and Kollintzas (1994), Baxter (1995), and Zimmermann (1995), although we extend the results of these authors to a broader sample of OECD countries and to a larger set of variables related to international trade. Most of the variables examined here are nonstationary in levels over our sample period. To facilitate comparisons with the existing literature, in this section we focus on the cyclical components of all variables obtained using the Hodrick-Prescott (HP) filter. In later sections of the paper, we allow for more general stochastic trends in these variables.

Much of the open economy macroeconomics literature, including recent work on international consumption smoothing and risk-sharing, has tended to focus on variation in the current account. The current account incorporates trade as well as net interest payments and, from the perspective of saving-investment balances, is the appropriate concept. For investigating the dynamics of trade, however, measures of trade in goods and nonfactor services would appear to be more appropriate than the current account. Variations in net factor incomes are, presumably, driven by a different set of determinants. In any case, as noted by Baxter (1995), short-term variation in net exports and the current account are highly correlated since the discrepancy between these two measures tends to change very slowly over time. For the purposes of forecasting and short-run policy-determination, net exports are indeed the relevant concept from the perspective of the national income accounts. Hence, the analysis in this paper is limited to the national income accounts definition of trade in goods and nonfactor services.

A. The Importance of International Trade

First, we examine the economic significance of international trade for OECD industrial economies. The ratio of total trade volumes to real GDP is often used as an indicator of an economy's openness to international trade. The average of this ratio over the period 1970–95, shown in the first column of Table 1, ranges from about 20 percent for Japan and the United States to over 100 percent for Belgium, Ireland, and the Netherlands.

Averages of this ratio over different sub-samples show that this ratio increased for almost all countries in the 1980s, reflecting the growing importance of international trade to the world economy. This ratio continued to increase in the 1990s for many countries but declined marginally for a few countries. The second panel of Table 1 shows that exports constitute a significant fraction of total output for a number of countries in the sample. The ratio of exports to GDP also increased in the 1980s for virtually all countries in the sample and continued to increase in the 1990s for most countries. As shown in the bottom row of Table 1, rising trade volumes are also reflected in increases of the ratio of the overall trade of OECD economies to total GDP (constructed using 1990 purchasing power parity weights) in these economies.

Table 1 presents clear evidence of the rapid increase in trade volumes for the main industrial economies since the 1970s. Understanding the role of trade in accentuating or dampening domestic macroeconomic fluctuations is thus of increasing importance as the global economy becomes more integrated through trade flows.

B. Volatility of Trade Variables

We now examine the unconditional volatility, as measured by the standard deviation, of various quantities and prices relevant to trade dynamics, relative to the aggregate business cycle. The output and exchange rate variables were first transformed into logarithms and their cyclical components were then derived using the HP filter with a smoothness parameter of 1600. The trade variables are expressed as ratios of aggregate GDP in order to control for scale effects. The trade ratios (not in logarithms) were also detrended using the HP filter.

The first column of Table 2 contains the standard deviation (interpretable as the quarterly percentage standard deviation) of domestic output. These standard deviations generally lie in the range of 1 to 2 percent. The next three columns show the standard deviations of the trade ratios, divided by the standard deviation of output. For most countries, net exports are markedly more volatile than aggregate output.[2] The United States is an outlier

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[2]Note that the ratio of the trade balance (or the other trade variables) to total output is generally a very small number. Hence, fluctuations in this ratio that appear numerically similar to the percentage standard deviations of output in fact indicate enormous relative volatility in the trade variables, often one or two orders of magnitude greater than the volatility of output.

Table 1. Measures of Openness to International Trade

	Ratio of Sum of Exports and Imports to GDP				Ratio of Exports to GDP			
	Full Sample	1970-79	1980-89	1990-95	Full Sample	1970-79	1980-89	1990-95
Australia	35.1	30.6	33.9	37.4	17.1	15.3	16.1	18.5
Austria	74.0	65.4	75.8	76.4	37.1	32.5	38.1	38.4
Belgium	134.6	111.2	142.3	138.3	68.5	55.8	72.0	71.2
Canada	54.1	47.6	51.9	59.1	27.5	24.0	26.7	29.6
Denmark	65.2	60.2	67.4	64.9	33.9	28.9	34.4	35.4
Finland	56.2	55.6	55.9	56.6	28.8	27.6	28.2	30.0
France	43.4	38.3	44.5	44.0	22.0	19.4	22.2	22.7
Germany	50.8	45.7	56.3	48.2	26.5	24.0	29.8	24.7
Greece	43.0	33.4	43.6	43.4	16.6	12.5	17.4	16.5
Iceland	66.8	70.9	70.1	65.0	34.1	35.3	35.3	33.5
Ireland	117.8	99.7	112.4	126.5	60.2	44.1	55.8	67.5
Italy	39.9	40.8	39.9	39.8	19.9	19.8	19.3	20.5
Japan	21.2	23.4	23.2	17.8	11.4	12.1	12.6	9.8
Netherlands	100.6	92.3	105.8	99.5	52.2	46.8	54.7	52.5
New Zealand	58.0	54.7	58.2	58.7	29.2	26.1	28.8	30.4
Norway	73.8	79.7	74.2	71.4	38.8	38.4	38.8	39.0
Portugal	69.1	51.9	70.5	69.5	30.6	21.0	31.6	30.8
Spain	39.4	30.3	39.6	41.0	19.2	14.5	19.6	19.8
Sweden	62.5	56.0	64.5	62.7	32.2	27.9	33.0	32.9
Switzerland	70.1	65.9	73.8	68.7	35.7	33.2	36.9	36.0
United Kingdom	52.2	53.5	52.0	52.0	25.6	26.5	25.6	25.4
United States	19.3	15.6	18.7	21.6	9.0	7.6	8.4	10.3
OECD average	35.3	32.1	36.1	35.8	17.7	16.0	17.9	18.0

Notes: Exports (imports) refers to the national income accounts definition of exports (imports) of goods and nonfactor services. The ratios shown above are average ratios over the relevant periods. The OECD average is a weighted average constructed using 1990 GDP weights based on purchasing power parities.

Table 2. Measures of Volatility of Cyclical Components

	y	netx/y	exp/y	imp/y	y*	y-y*	reer	neer
Australia	1.57	0.86	0.39	0.63	0.70	0.93	4.18	4.30
Austria	1.20	0.88	0.86	0.97	0.93	0.67	1.44	1.39
Belgium	1.24	0.57	0.97	1.29	0.85	0.71	2.07	2.02
Canada	1.65	0.55	0.51	0.52	0.82	0.70	2.66	2.58
Denmark	1.58	0.94	0.62	0.76	0.64	0.83	1.55	1.44
Finland	2.62	0.59	0.48	0.41	0.38	0.88	1.91	1.78
France	1.08	0.70	0.48	0.62	1.00	0.67	2.51	2.61
Germany	1.41	0.75	0.80	0.34	0.73	0.66	2.04	1.93
Greece	1.78	0.53	0.33	0.43	0.60	0.81	2.04	1.93
Iceland	2.11	1.27	0.71	0.85	0.48	0.94	2.62	3.99
Ireland	1.68	1.38	0.88	1.52	0.68	1.01	1.57	1.77
Italy	1.52	0.53	0.40	0.38	0.69	0.68	2.16	2.33
Japan	1.40	0.46	0.30	0.35	0.86	0.87	5.03	5.01
Netherlands	1.12	0.83	0.92	0.98	0.96	0.76	1.99	1.94
New Zealand	3.27	0.62	0.30	0.46	0.32	1.04	1.65	1.53
Norway	1.24	1.41	0.66	1.19	0.83	1.15	1.87	1.80
Portugal	2.32	0.79	0.61	0.72	0.43	0.77	1.77	2.19
Spain	1.20	0.86	0.45	0.59	0.91	0.84	3.38	3.81
Sweden	1.48	0.76	0.64	0.68	0.72	0.99	2.80	2.76
Switzerland	1.90	0.68	0.45	0.71	0.57	0.76	1.91	1.95
United Kingdom	1.82	0.45	0.31	0.39	0.57	0.79	2.91	2.60
United States	1.79	0.28	0.15	0.18	0.58	0.69	3.02	3.23

Notes: The numbers reported above are standard deviations of the respective cyclical components computed using the HP filter. For all variables except domestic output, the standard deviations are expressed as a ratio of the standard deviation of domestic output. The variable definitions are as follows: y: domestic ouput; netx/y: the ratio of net exports to domestic ouput; exp/y: the ratio of exports to domestic output; imp/y: the ratio of imports to domestic output; y*: index of output in trading partner countries; y-y*: relative (domestic minus foreign) output; reer: real effective exchange rate; neer: nominal effective exchange rate. All variables other than the trade ratios were used in logarithmic form.

among the major industrial countries in terms of the low relative volatility of net exports.[3] The next column shows that exports are generally less volatile than net exports and often display much lower volatility. In general, imports are about as volatile as exports although, in a few cases, they are more volatile than exports.

An important consideration for the dynamics of the trade balance is the commonality of shocks across countries. The pattern of short-run trade dynamics could depend on whether shocks that drive business cycle fluctuations are primarily global or country-specific. In addition, the nature of shocks could be important—global shocks are more likely to take the form of productivity or other supply shocks while demand shocks would tend to be country-specific. This issue will be dealt with in more detail in the formal econometric model below. Nevertheless, it is useful at this juncture to examine the relative volatility of global output from the perspective of each country.

Rather than construct one uniform measure of global output, for each country we construct a trade-weighted measure of total output in its trading partner countries. The volatility of this measure of partner country output, which is interpretable as effective foreign demand, is shown in the fifth column of Table 2. For most countries, partner country output has lower volatility than domestic output. In large part, this is because the measure of partner country output is, by construction, an average measure of output across many countries.

Fluctuations in relative output, defined as domestic minus partner country output, provide a rough indication of how important global shocks are for each country. For instance, a strong positive correlation between domestic and world output fluctuations would imply that relative output fluctuates much less then domestic output. This is indeed the case for most countries in the sample, suggesting that there is a significant common component in international economic fluctuations.[4]

Finally, we examine the volatility of the relative price that is most closely associated with international trade, i.e., the exchange rate. The cyclical component of the real effective exchange rate fluctuates more than output in all countries. Interestingly, for most countries, the volatility of nominal and real effective exchange rates is very similar. The correlations between the real and nominal measures of the exchange rate (not reported here) also turned out to be very strongly positive for all countries in the sample, consistent with a large body of

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[3]Baxter (1995) makes a similar point. In her empirical work, Baxter uses the band-pass filter described in Baxter and King (1995) but notes that, for quarterly data, using the Hodrick-Prescott filter with a smoothness parameter of 1600 yields cyclical components similar to those obtained using the band-pass filter.

[4]For more evidence on this issue, see Lumsdaine and Prasad (1997).

literature that has documented the close relationship between these variables at business cycle frequencies (see, e.g., Mussa (1986)).[5]

C. Unconditional Correlations

Next, we turn our attention to correlations between the cyclical components of output and the various trade variables. We examine contemporaneous correlations as well as correlations at various leads and lags in order to explore the dynamic patterns in the data.

The first panel of Table 3 shows the correlations between the cyclical components of output and net exports. The countercyclical behavior of net exports that has been documented by numerous other authors is evident for virtually all the countries in our sample. The second panel of this table documents that this result is driven largely by the strongly procyclical behavior of imports, as shown by the strong positive correlations between the cyclical components of imports and output for all countries except Ireland, New Zealand, and Norway. In these three countries, the correlations between output and leads of imports turn positive, indicating a delayed response of imports to changes in domestic output. In all other countries, the positive correlations between these variables peak contemporaneously or at very short leads, indicating that changes in domestic demand are translated into changes in import demand quite rapidly.

The cyclical behavior of exports, shown in the third panel of Table 3, is, on the other hand, very different across countries. The contemporaneous correlations are positive for a few countries, negative for a few, and not statistically significantly different from zero for a majority of the countries. Among the G-7 countries, this correlation is positive for Canada, negative for Germany and Japan, and close to zero for the others. A number of possible reasons could be cited for these mixed results. For instance, variation in exports could be influenced not just by domestic demand conditions but by changes in external demand from trading partner countries. In addition, exchange rate developments over the course of the business cycle could also have a significant influence on these correlations. These factors would not be reflected in unconditional bivariate correlations. Thus, a model that, at a minimum, captured the effects of changes in external demand conditions and exchange rates, would appear to be necessary to model export dynamics in an appropriate manner. Before turning to such a model, however, it is useful to examine the importance of trade in business cycle recoveries. This could potentially yield a very different picture of trade dynamics compared to the correlations discussed above that depict only the average relationship over different phases of the business cycle.

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[5]Mussa (1986) attributes these positive correlations to short-run price rigidities. Stockman (1988), on the other hand, argues that these correlations are consistent with other evidence that indicate a predominant role for supply shocks in business cycle fluctuations.

Table 3. Correlations of Trade Variables and the Business Cycle

	GDP, Net Exports / GDP					GDP, Imports / GDP					GDP, Exports / GDP				
Lag:	8	4	0	-4	-8	8	4	0	-4	-8	8	4	0	-4	-8
Australia	0.02	-0.22	-0.31	0.18	0.33	0.14	0.20	0.26	-0.22	-0.24	-0.19	-0.17	-0.25	0.03	0.34
Austria	0.31	0.14	-0.31	-0.04	0.10	-0.31	-0.11	0.59	0.16	-0.29	-0.04	0.02	0.35	0.15	-0.22
Belgium	0.22	-0.05	-0.28	-0.20	-0.03	-0.51	-0.24	0.50	0.33	-0.01	-0.54	-0.34	0.49	0.33	-0.03
Canada	-0.34	-0.11	-0.20	0.23	0.28	-0.15	0.06	0.67	0.04	-0.26	-0.52	-0.06	0.48	0.29	0.04
Denmark	0.23	-0.16	-0.59	-0.17	0.08	-0.23	0.07	0.44	-0.14	-0.14	0.07	-0.14	-0.37	-0.42	-0.05
Finland	-0.27	-0.45	-0.39	0.17	0.39	-0.18	0.07	0.44	0.14	-0.05	-0.48	-0.48	-0.11	0.33	0.43
France	0.17	0.12	-0.43	-0.20	-0.02	-0.14	0.01	0.70	0.19	-0.16	0.06	0.19	0.27	-0.05	-0.24
Germany	0.05	-0.20	-0.53	-0.15	0.37	-0.52	-0.28	0.24	0.42	0.21	-0.18	-0.31	-0.40	0.04	0.43
Greece	0.06	-0.20	-0.21	0.22	0.14	-0.11	0.28	0.34	-0.27	-0.08	-0.05	0.04	0.11	0.01	0.12
Iceland	0.04	-0.26	-0.57	0.43	0.33	-0.24	0.24	0.62	-0.18	-0.25	-0.20	-0.17	-0.27	0.57	0.29
Ireland	0.06	-0.29	-0.02	-0.22	0.11	-0.13	0.07	-0.04	0.36	0.03	-0.14	-0.35	-0.10	0.28	0.22
Italy	-0.05	-0.20	-0.44	0.06	0.46	-0.07	-0.04	0.56	0.16	-0.27	-0.13	-0.30	-0.05	0.23	0.34
Japan	0.31	-0.17	-0.50	-0.14	-0.08	-0.32	0.30	0.36	0.11	0.11	0.11	0.08	-0.35	-0.09	0.00
Netherlands	0.09	-0.06	-0.18	-0.25	-0.05	-0.11	-0.20	0.27	0.37	-0.07	-0.04	-0.27	0.13	0.17	-0.12
New Zealand	-0.03	-0.28	-0.05	0.05	0.07	-0.19	0.03	-0.03	0.03	0.12	-0.41	-0.55	-0.17	0.16	0.37
Norway	0.18	0.05	-0.15	-0.05	-0.15	-0.20	-0.16	-0.05	0.06	0.10	0.07	-0.14	-0.37	0.00	-0.15
Portugal	0.08	-0.49	-0.38	0.21	0.12	-0.28	0.43	0.65	0.15	-0.07	-0.23	-0.13	0.28	0.45	0.06
Spain	-0.27	-0.34	-0.50	-0.10	0.12	0.01	0.08	0.56	0.27	-0.12	-0.51	-0.54	-0.23	0.16	0.07
Sweden	-0.10	-0.40	-0.17	0.21	0.36	-0.33	0.02	0.32	0.17	-0.03	-0.46	-0.46	0.14	0.43	0.40
Switzerland	0.25	-0.03	-0.39	-0.34	-0.13	-0.54	-0.22	0.42	0.48	0.18	-0.48	-0.39	0.08	0.25	0.09
United Kingdom	0.05	-0.13	-0.37	-0.15	0.32	-0.12	0.20	0.36	-0.02	-0.20	-0.07	0.06	-0.08	-0.24	0.22
United States	0.67	0.23	-0.47	-0.62	-0.37	-0.60	0.02	0.64	0.46	0.14	0.52	0.45	-0.09	-0.59	-0.52

Notes: The cross-correlations reported here are for HP-filtered cyclical components of real GDP and the respective trade variables. Lag 8 indicates the correlation of output and the 8th lag of the trade variable. A negative lag denotes a lead. The approximate standard error of these correlation coefficients, under the null hypothesis that the true correlation coefficient is zero, is about 0.10.

III. HOW IMPORTANT IS INTERNATIONAL TRADE FOR BUSINESS CYCLE RECOVERIES?

It is quite typical for international trade to be attributed a critical role in short-term macroeconomic forecasts, especially for smaller industrial economies. Even in large economies that are relatively closed, the external sector is often viewed as being an important catalyst for business cycle recoveries. The evidence on the quantitative importance of international trade in generating economic recoveries is, however, rather limited.

To address this issue, we construct a measure of the contribution of the trade balance to output growth from business cycle troughs. For each country in our sample, we identify historical business cycle troughs and then construct a measure of the contribution of the trade balance to total output growth over different time horizons relative to those troughs. Our procedure for identifying business cycle troughs is described in Appendix II. The formula for calculating the growth contribution of the trade balance over different time horizons is as follows:

$$CB(j) = \frac{TB(t+j) - TB(t)}{Y(t)} \qquad (1)$$

where CB(j) indicates the contribution to output growth over a j-period horizon from the cyclical trough, TB(t) indicates the trade balance at time t (the cyclical trough), and Y(t) denotes aggregate GDP at time t.[6]

The first panel of Table 4 reports the average contributions of the trade balance to output growth over different horizons ranging from one to twelve quarters. There are notable differences across countries. For instance, at a horizon of four quarters from cyclical troughs, the average contribution of the trade balance to output growth ranges from a high of 2.2 percentage points for Ireland to a low of -1.9 percentage points for Austria. Over horizons of one to twelve quarters, the contributions of the trade balance to output growth are consistently negative for a number of countries, including Austria, Denmark, Japan, Spain, and Switzerland. For these countries, there is no evidence in historical data that the trade balance has contributed, in economically significant terms, to output recoveries from recessions. It is quite striking that, for a majority of the OECD economies, the average contributions of the trade balance to output growth at four, eight, and twelve quarter horizons from cyclical troughs are negative or close to zero.

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[6]Note that this contribution measure indicates how much output would have increased relative to its level at the trough if domestic demand remained unchanged. Expressing this contribution as a fraction of actual output growth is not informative since this measure fluctuates considerably and is difficult to interpret. The measure constructed here isolates the direct contribution of trade to output recoveries.

Table 4. The Role of International Trade in Business Cycle Recoveries

	Cyclical troughs	Contribution of trade balance to output growth from troughs					Contribution of exports to output growth from troughs				
		t+1	*t+2*	*t+4*	*t+8*	*t+12*	*t+1*	*t+2*	*t+4*	*t+8*	*t+12*
Australia	4	0.28	-0.41	-0.54	-0.35	-1.52	0.10	0.10	1.12	2.59	3.20
Austria	3	-0.63	-1.00	-1.89	-1.98	-0.84	0.99	1.52	3.54	6.94	8.79
Belgium	2	0.09	0.29	0.48	-0.80	-0.78	1.46	3.76	7.32	10.63	13.37
Canada	5	-0.17	-0.22	-1.08	0.13	-0.69	0.52	1.05	2.45	6.28	7.69
Denmark	3	-0.02	-0.99	-0.63	-1.27	-3.12	0.38	0.06	1.45	3.72	3.13
Finland	4	-0.18	0.52	-0.12	-0.06	0.88	1.48	2.19	3.26	5.44	6.23
France	2	-0.31	-0.24	-1.06	0.01	0.50	0.46	1.65	1.86	3.90	5.70
Germany	2	-0.14	-0.40	-0.60	0.68	0.50	0.13	0.24	1.31	3.40	4.01
Greece	3	0.09	0.21	0.59	-0.80	-2.01	0.35	0.77	1.68	2.57	2.86
Iceland	3	1.05	1.26	0.91	0.39	2.00	0.67	1.14	2.46	5.94	7.90
Ireland	3	1.05	0.26	2.25	0.46	-2.09	1.92	3.11	5.52	10.82	14.18
Italy	4	0.00	-0.10	0.09	-0.01	0.30	0.23	0.51	1.53	2.53	2.39
Japan	3	-0.31	-0.32	-0.43	-0.93	-0.15	0.04	0.06	0.74	1.61	2.81
Netherlands	3	0.94	0.82	0.69	0.13	-0.46	1.85	2.75	4.69	6.24	7.17
New Zealand	5	0.11	-0.03	-1.09	2.18	1.37	0.35	1.02	2.06	4.21	4.50
Norway	3	0.27	0.74	1.23	1.05	4.84	0.63	1.45	3.08	5.16	7.49
Portugal	4	0.31	0.48	0.63	-1.17	-4.22	0.70	1.64	3.22	4.82	4.93
Spain	2	-0.26	-0.55	-1.53	-3.00	-5.84	0.39	0.83	1.51	2.98	3.42
Sweden	3	0.43	0.02	0.79	-1.15	0.03	0.84	1.24	2.92	3.19	2.74
Switzerland	4	-0.88	-1.50	-0.61	-1.76	-1.58	0.21	0.48	1.93	4.21	6.15
United Kingdom	5	-0.14	-0.04	0.13	0.64	0.32	0.46	0.40	1.25	2.76	3.81
United States	4	0.07	-0.36	-0.68	-1.41	-1.47	-0.01	0.03	0.14	0.72	1.32

Notes: The contributions shown above are average percentage point contributions of trade to output growth from the respective cyclical troughs. For a list of business cycle trough dates for each country, see Appendix 1.

In the context of the national income accounting identity, the net trade balance would appear to be the appropriate variable for examining the contribution of international trade to business cycle recoveries. However, an alternative hypothesis is that export demand, rather than net exports, provides the catalyst for economic recovery. An increase in current and projected exports due to strong external demand or an exchange rate depreciation could trigger a recovery in domestic output. It is therefore possible that, with a concomitant increase in imports of investment goods and intermediate inputs, the trade balance could deteriorate despite the export stimulus to domestic demand.

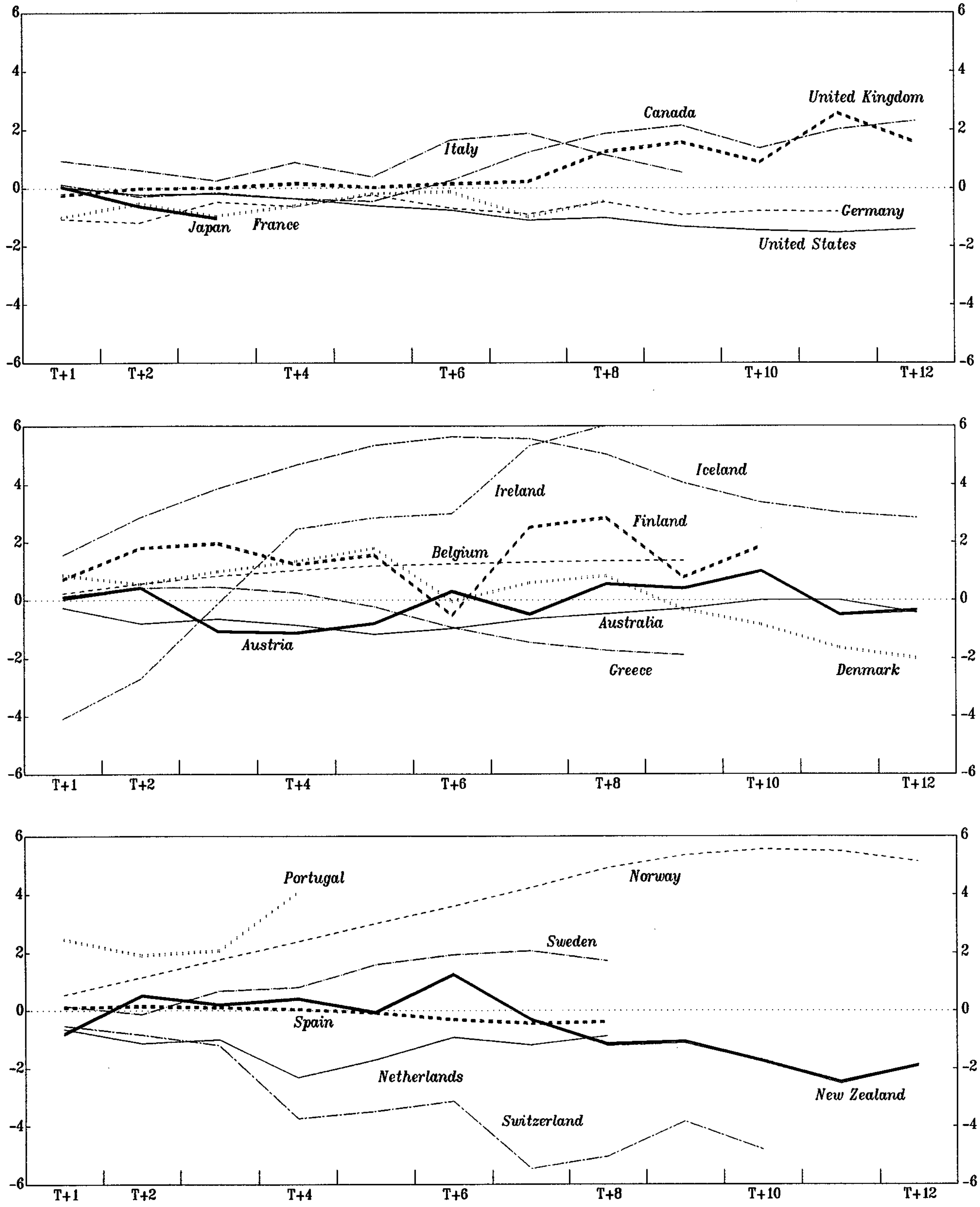
To examine the alternative hypothesis of export-led recoveries, we now examine the contribution of exports to output growth using the same measure used above for the trade balance. These results are reported in the second panel of Table 4. The main finding here is that, for virtually all countries, exports do make a significant and sizeable contribution to cyclical recoveries. There are, however, marked differences across countries. For Belgium and Ireland, the contribution of exports to output growth from cyclical troughs is quite large and rises to over 13 percent over a twelve-quarter horizon. The Unites States has a zero growth contribution from exports at a one-quarter horizon and a contribution of only 1.3 percentage points from exports to output growth over twelve quarters, the lowest in the sample.

Figures 1 and 2 show the growth contributions of the trade balance and exports, respectively, during the most recent cyclical recovery. Note that, since the data sample ends in 1995:Q4, the available time horizon relative to the trough is rather limited for certain countries. The top panels of Figures 1 and 2 show that, among the G-7 countries, the recent recoveries in Canada and Italy have relied to a significant extent on increases in external demand. For the United Kingdom, external trade, although not an important factor in the early stages of the most recent recovery, has helped sustain and strengthen the expansion of output. Although France and Germany experienced strong increases in exports, the direct contribution of the trade balance to their respective cyclical recoveries has been rather small.

Among the smaller industrial economies, the picture is quite disparate. Ireland appears to have received the biggest boost from the external sector during the most recent recovery. Some countries like Austria, Spain, the Netherlands, and New Zealand experienced robust increases in exports but these were accompanied by large increases in imports. These countries are prime examples of the notion that exports could serve as a catalyst for cyclical recoveries despite a negligible direct contribution from the trade balance to output growth.

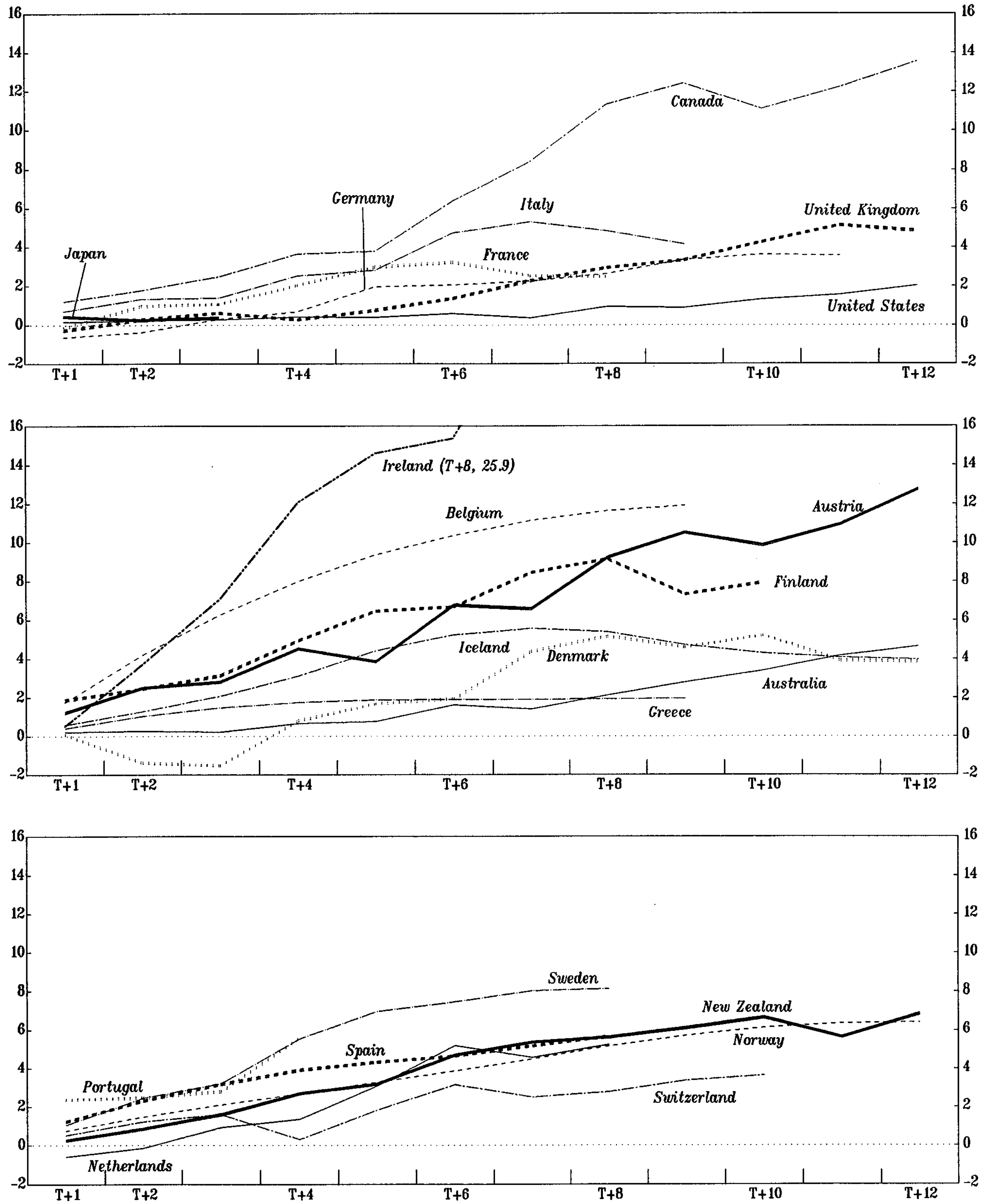
The results in these figures and in Table 4 are consistent with the notion that exports are more important engines of recovery for economies that are relatively more open to international trade. For instance, the contribution measures are among the smallest for Japan and the United States, which have the lowest openness indicators of the countries in our sample (see Table 1). Likewise, the two countries with the largest output contribution measures from exports, Belgium and Ireland, are also the most open to international trade.

Figure 1. Contribution of the Trade Balance to Output Growth During the Latest Cyclical Recovery



Notes: The contributions to output growth are expressed in percentage points. The cyclical troughs for each country (see Table A1) are denoted by T and a j-quarter horizon after the trough is denoted by T+j. The sample period ends in 1995:Q4.

Figure 2. Contribution of Exports to Output Growth During the Latest Cyclical Recovery



Notes: The contributions to output growth are expressed in percentage points. The cyclical troughs for each country (see Table A1) are denoted by T and a j-quarter horizon after the trough is denoted by T+j. The sample period ends in 1995:Q4.

The average contributions of trade to output growth during cyclical recoveries, however, mask substantial variation in these contributions across different cyclical episodes for each country. We examined the minimum and maximum contributions of the trade balance to output growth at horizons of one, two and three years from cyclical troughs.[7] The differences across cyclical episodes were substantial for every country in the sample. There were also large differences in the contributions of exports to output growth across different cycles. For instance, for Canada, the trade balance contribution measure over a three-year horizon ranged from a minimum of -4.9 percentage points to a maximum of 2.9 percentage points while the export contributions ranged from 4.2 to 13.5 percentage points.

These results suggest that unconditional measures of the contributions of trade to output recoveries do not capture the effects of other factors, such as exchange rate variation, on the cyclical dynamics of the trade balance. Significant information could also be lost by averaging over business cycle episodes that could be driven by different shocks and that, therefore, display very different exchange rate dynamics. To control for these effects, we now develop a more formal time series model.

IV. A MULTIVARIATE STRUCTURAL MODEL

In this section, we construct a multivariate structural time series model that enables us to identify different types of macroeconomic shocks and to examine the effects of these shocks on trade variables. The empirical framework, similar to that proposed by Prasad and Kumar (1997), builds on earlier work by Blanchard and Quah (1989) and Clarida and Gali (1994). We first discuss some theoretical considerations that motivate the empirical framework, present results from a preliminary analysis of the data, and then briefly describe the implementation of the econometric methodology.

A. Analytical Considerations[8]

There are two main channels that determine the relationship between external trade and cyclical output fluctuations. Given external demand conditions, the first channel is through domestic demand and the second channel is through changes in real exchange rates. The existence of these two distinct but related channels implies that the sources of business cycle fluctuations could influence the cyclical dynamics of external trade.

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[7]To conserve space, these results are not reported here but are available from the authors.

[8]This discussion is based in part upon a stylized theoretical model presented in Prasad and Kumar (1997). The main features of the model are sketched in Appendix III.

Consider the case of a domestic fiscal contraction that leads to a contraction in aggregate domestic demand. In the standard Mundell-Fleming type of framework (with capital mobility), this would be accompanied by a real exchange rate depreciation which, in addition to depressed domestic demand, would tend to induce a negative correlation between cyclical output and the trade balance (or exports). Thus, in this case, both the domestic demand and real exchange rate effects work in the same direction. On the other hand, a monetary contraction (which would also tend to depress domestic demand) would lead to an appreciation of the exchange rate, thereby creating an effect on the trade balance (or exports) opposite to that of the domestic demand effect. The relative importance of these two effects is then an empirical issue and would depend on various trade elasticities.

Another important issue, which is crucial from the perspectives of both theoretical models and empirical work, is the persistence of fluctuations in output and the exchange rate. Highly persistent changes in output or the exchange rate could have very different effects on trade dynamics compared to the effects of transitory changes in these variables (see, e.g., Glick and Rogoff (1995) and Phillips (1996)). Standard open economy macro models can be used to derive implications concerning the persistence of the output and exchange rate effects of different sources of macroeconomic shocks. We exploit these theoretical considerations to derive a set of identifying restrictions that enable us to identify different types of macroeconomic shocks and to characterize the joint dynamics of output, exchange rates, and trade variables in response to these shocks.

In the empirical work, we separately identify three types of shocks: supply, demand, and nominal shocks. Although we do not directly identify fiscal or monetary shocks, it is reasonable, for heuristic purposes, to think of demand shocks as fiscal shocks and nominal shocks as monetary shocks. The theoretical model (see Appendix III) yields three plausible long-run restrictions that can be used for identification. The model implies that demand and nominal shocks have no long-run effects on the level of output while nominal shocks have no long-run effects on the level of the real exchange rate.

It could also be argued that nominal shocks are unlikely to affect the ratio of the trade balance to output in the long run. However, there is a large body of literature which argues that temporary exchange rate shocks can indeed have persistent effects on external trade through 'hysteresis' or 'beach-head' effects (see, e.g., Baldwin (1988, 1990)). Further, as noted by Lane (1997), temporary exchange rate changes could, through resulting changes in net foreign asset holdings, have persistent effects on the trade balance, although there would be no corresponding long-run effects on the current account. Hence, although the stylized theoretical model is not rich enough to capture these effects, we do not use the restriction that nominal shocks have only transitory effects on the trade balance for identification of the empirical model. The degree of persistence in trade balance fluctuations induced by nominal shocks is therefore an empirical matter and the model can, in principle, help resolve this issue.

An important virtue of the identification approach is that the short-run dynamics are unconstrained. The identification scheme can therefore be evaluated by examining whether the short-run dynamics implied by the estimates of the empirical model appear reasonable and in accordance with the predictions of the theoretical model. Another feature of this identification approach is that it does not require us to take a stand on the causal ordering of the variables in the VAR, as would be necessary, for instance, in a standard Cholesky-type orthogonal decomposition. This is particularly useful since there is no clear evidence that any of these variables is predetermined relative to the others in a Granger-causal sense.

This discussion 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.

B. Preliminary Data Analysis

An important consideration for the empirical work is that the above discussion implicitly assumes that external demand conditions remain constant. Since this is unlikely to be the case, the relevant output variable for the econometric model is relative real output, i.e. domestic output relative to external demand. For each country, we constructed an index of external demand by taking a trade-weighted average of real GDP in the remaining OECD countries. The logarithm of this index was then subtracted from the logarithm of the index of domestic output in order to derive relative output.[9] 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 OECD economies, using domestic and foreign CPIs as the price deflators. Thus, we derive consistent measures of relative output and the real exchange rate, although it should be noted that the merchandise trade numbers are more comprehensive and not limited to trade within the OECD.

It is necessary to first determine the time series properties of the variables entering the VAR. The model presented in Appendix III implies that relative output, the real effective exchange rate, and the ratio of the trade balance to GDP (and other trade ratios) are all stationary in first differences and that their levels are not cointegrated. To conserve space, here we only briefly summarize the results of formal statistical tests for these empirical features of the data. Tables containing detailed results are available upon request.

For the trade ratios, the results indicated that, in nearly all cases, the null hypothesis of a unit root could not be rejected against the alternative of stationarity around a deterministic

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

trend. To maintain a uniform specification, the trade variables for all countries were included in first-difference form in the VARs. Since relative output and the real exchange rate also appeared to be first-difference stationary for the countries in the sample, their logarithmic first differences, i.e. their growth rates, were included in the VARs.[10] We then tested for cointegration in each of the trivariate systems using the Stock-Watson (1988) common trends test. With the exceptions of a few borderline rejections of the null hypothesis of no cointegration (for Austria, Belgium, Iceland, and Switzerland), there was little evidence of cointegration for the specifications discussed below. Even for those countries where the null hypothesis of no cointegration could be rejected using the trade balance to GDP ratio, there was no evidence of cointegration when using the imports to GDP ratio (except for Iceland) or the exports to GDP ratio. Hence, to maintain a uniform specification across countries, the reduced-form VARs include first differences of the relevant variables. This specification also has the virtue of facilitating the interpretation of the results.

C. The Econometric Model

The econometric model builds upon the work of Blanchard and Quah (1988) and Clarida and Gali (1994).[11] The methodology involves the estimation of a three-variable VAR comprising the first differences of relative output, the real exchange rate, and the ratio of the trade balance (or exports or imports) to domestic output, with the first two variables used in logarithmic form. Using a set of long-run restrictions, the VAR errors are then transformed into a set of 'fundamental' disturbances that have an economic interpretation—supply, demand, and nominal shocks. The short-run dynamics of the model are unconstrained and identification is achieved by imposing constraints on certain long-run multipliers in the system.

As noted earlier, we do not explicitly include monetary or fiscal variables in the estimation. Since we have identified the exchange rate as the mechanism through which different shocks influence the relationship between external trade and the business cycle,

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[10]Augmented Dickey-Fuller (ADF) regressions were run for all variables with a constant, a linear trend, and four lags. In nearly all cases, we were unable to reject the unit root null for the levels of relative output, the real effective exchange rate, and the trade ratios. We then ran similar ADF tests, but without a trend term, to test for the stationarity of the first differences of these variables. In virtually all cases, we were able to reject the unit root null although, in some cases, the null could be rejected only at the 10 percent (rather than the conventional 5 percent) level of significance.

[11]See Lastrapes (1992), Ahmed, Ickes, Wang, and Yoo (1993), and Rogers (1996) for other extensions of the Blanchard-Quah decomposition technique to open economy settings.

exchange rates are included directly in the estimation in order to identify these shocks.[12] Thus, the econometric approach is structural in that relative output fluctuations, variations in the real exchange rate, and changes in the trade variables are jointly determined in response to different shocks. Also note that, since relative output growth is used in the estimation, the shocks are more appropriately thought of as *relative* supply shocks, *relative* demand shocks, and *relative* nominal shocks. For brevity, this terminology is used sparingly below.

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

$$B(L)X_t = \epsilon_t , \qquad \text{var}(\epsilon_t) = \Omega \tag{2}$$

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

$$X_t = C(L)\epsilon_t , \quad \text{where} \quad C(L) = B(L)^{-1} \text{ and } C_0 = I. \tag{3}$$

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

$$X_t = A(L)\eta_t , \qquad \text{var}(\eta_t) = I \tag{4}$$

where the mutually uncorrelated shocks η_{1t}, η_{2t} and η_{3t} can be interpreted as fundamental macroeconomic shocks. Comparing equations 3 and 4, 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.

In order to identify the A_0 matrix, three additional restrictions are imposed on the system. These restrictions constrain certain long-run multipliers in the system to be zero. The long-run multipliers of the above system are denoted by the matrix $A(1) = [A_0 + A_1 + A_2 + ...]$. Using the relation derived above between A_0 and A_j for j=1,2,..., this can be rewritten as $A(1) = [I + C_1 + C_2 + ...]*A_0$, where I denotes the identity matrix. Thus, given the estimates of C_j for j=1,2...., a restriction on a particular long-run multiplier effectively imposes a linear

[12]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 for us to take a stand on this issue.

restriction on the elements of the A_0 matrix. As noted above, we assume that nominal shocks and demand shocks do not have permanent effects on the level of output and that nominal shocks do not have a permanent effect on the level of the real exchange rate. These restrictions constrain the (1,2), (1,3) and (2,3) elements of A(1) to be zero and, using the relation between the elements of A(1) and A_0, jointly make the A_0 matrix uniquely identified. The lower triangular structure of A(1) implies that η_{1t}, η_{2t} and η_{3t} can then be interpreted as the underlying supply, demand, and nominal shocks, respectively.[13]

V. Results

Although the theoretical framework was used to analyze the dynamics of only the trade balance, it is straightforward to extend the methodology to separately examine the constituents of net trade—exports and imports. The maintained assumption here is that exports and imports are driven by the same set of determinants as the trade balance.

The empirical model was estimated separately for each country. As will be clear from the results, there is substantial heterogeneity across countries in the dynamics of trade variables, making a panel approach to estimation inadvisable. The sample period is 1975:Q1–1995:Q4, obviating possible concerns about parameter instability associated with the break-up of Bretton Woods in 1973 and the first OPEC oil shock in 1974.[14] The empirical model allows for higher-order dynamics than those in the stylized theoretical model (where prices fully adjust to their equilibrium levels in one period). Each of the estimated equations in the reduced-form VARs included a constant and eight lags of each of the three variables.[15]

We first examine the estimated impulse response functions, which show the dynamic effects of different types of shocks on the trade variables, and then present forecast error variance decompositions. Since the trade balance, exports, and imports are tied together by an

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[13]Lippi and Reichlin (1993) and Faust and Leeper (1994) have raised some concerns about the type of identification procedure used in this paper. As noted by Blanchard and Quah (1993), the Lippi-Reichlin criticism is more relevant to common trends models rather than the type of standard VAR used in this paper. Further, since each of the shocks are individually identified in the empirical model used here, the Faust-Leeper critique of structural VAR models that can only identify particular linear combinations of fundamental shocks does not apply.

[14]To check the sensitivity of the results to German unification, we reestimated the models for Germany over the period 1975:Q1–1989:Q4. The results reported in this section were qualitatively similar when this limited sample was used.

[15]This seemed to be the appropriate minimum number of lags necessary to adequately capture trade dynamics in quarterly data. Likelihood ratio tests indicated little evidence in favor of higher order lags for most countries in our sample.

identity, we report the impulse responses of only the first two variables. However, we separately examine variance decompositions for all three trade variables since this is of interest from the perspective of reduced-form equations for import and export volumes.

A. Impulse Responses

Table 5 presents the impulse responses of the trade balance and exports to different types of shocks.[16] Note that, although the trade variables are expressed as ratios of output in order to control for scale effects, these variables are substantially more volatile than output (see Table 2), implying that the responses of the trade ratios can be regarded as indicating purely the responses of the trade variables rather than reflecting changes in output.[17]

A striking feature of the impulse response functions for the trade balance is that, in every country, nominal shocks have a positive effect on the trade balance. Since relative nominal shocks lead to increases in relative output accompanied by exchange rate depreciations, this suggests that the exchange rate effects on the trade balance tend to dominate the output effects of these shocks. This is consistent with the findings of other authors that nominal shocks result in rapid and sharp exchange rate responses (see, e.g., Eichenbaum and Evans (1995)) but have only very small and transitory effects on output. These patterns were also evident in our estimated impulse responses for output and the exchange rate (not shown here). Interestingly, positive effects of nominal shocks on the U.S. trade balance have also been uncovered recently by Lane (1997) using VARs with identification schemes based on more traditional short-run restrictions and using direct measures of innovations in monetary policy.

As would be expected, relative demand shocks, which lead to increases in relative output and concomitant exchange rate appreciations, result in declines in the trade balance in almost all cases. The effects of supply shocks, on the other hand, are mixed. Supply shocks typically have large and permanent effects on output. Their effects on real exchange rates,

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[16]Since the focus of this analysis is on trade variables, we do not present the impulse responses for output and the real exchange rate here. These responses were generally quite reasonable and consistent with theory. Supply shocks lead to permanent increases in the level of (relative) output while demand and nominal shocks lead to positive but transitory increases. Demand shocks result in permanent real exchange rate appreciations while supply shocks tend to result in depreciations. Nominal shocks lead to transitory exchange rate depreciations. These impulse responses are similar to those obtained, using a different model, by Clarida and Gali (1994) and Chadha and Prasad (1997).

[17]To confirm this point, we examined the correlations between changes in the trade balance and changes in the trade balance to GDP ratio. These correlations were almost all between 0.95 and 0.99. Similar results were obtained for exports and imports.

Table 5. Impulse Responses

Horizon	Trade Balance SS	Trade Balance DD	Trade Balance NM	Exports SS	Exports DD	Exports NM
			Australia			
1	-0.07	-0.11	0.52	0.03	-0.14	0.46
2	-0.12	-0.32	0.46	0.13	-0.16	0.38
4	-0.09	-0.60	0.39	0.09	-0.20	0.32
8	-0.11	-0.60	0.16	0.08	-0.20	0.20
16	-0.17	-0.21	0.30	0.03	-0.18	0.26
32	-0.21	-0.35	0.23	0.00	-0.18	0.25
			Austria			
1	0.05	-0.28	0.97	0.28	-0.58	0.62
2	0.22	-0.36	0.31	0.23	-0.36	0.05
4	0.08	-0.25	0.32	0.17	-0.48	0.23
8	0.24	-0.42	0.31	0.19	-0.41	0.29
16	0.20	-0.36	0.35	0.14	-0.42	0.28
32	0.19	-0.38	0.35	0.13	-0.39	0.28
			Belgium			
1	-0.04	-0.04	0.04	-0.01	0.06	0.08
2	-0.07	-0.11	0.11	-0.04	0.18	0.19
4	-0.11	-0.29	0.30	-0.10	0.46	0.45
8	0.04	-0.43	0.25	-0.19	0.56	0.33
16	0.13	-0.64	0.27	-0.32	0.74	0.50
32	0.13	-0.60	0.22	-0.44	0.85	0.52
			Canada			
1	0.04	-0.33	0.55	0.24	-0.49	0.35
2	-0.05	-0.42	0.43	0.22	-0.47	0.28
4	-0.17	-0.48	0.43	0.32	-0.46	0.20
8	-0.03	-0.28	0.57	0.21	-0.76	0.38
16	0.10	-0.25	0.55	0.17	-1.04	0.68
32	0.07	-0.29	0.54	0.12	-1.08	0.86
			Denmark			
1	0.22	-0.37	0.59	-0.22	-0.31	0.52
2	0.00	-0.49	0.49	-0.15	-0.36	0.25
4	-0.07	-0.76	0.54	-0.15	-0.33	0.37
8	-0.45	-0.54	0.36	-0.50	-0.34	0.11
16	-0.37	-0.37	0.31	-0.45	-0.11	0.27
32	-0.30	-0.45	0.33	-0.45	-0.16	0.17
			Finland			
1	0.13	-0.07	1.05	-0.35	-0.03	0.86
2	0.05	-0.35	0.76	-0.14	-0.15	0.45
4	-0.07	-0.49	0.90	-0.29	-0.12	0.49
8	-0.19	-0.21	0.82	-0.54	-0.25	0.55
16	-0.41	-0.18	0.82	-1.14	-0.22	0.62
32	-0.24	-0.25	0.80	-0.88	-0.23	0.62

Horizon	Trade Balance SS	Trade Balance DD	Trade Balance NM	Exports SS	Exports DD	Exports NM
			France			
1	0.06	-0.09	0.50	0.06	0.09	0.36
2	0.00	-0.21	0.39	0.05	0.00	0.37
4	-0.02	-0.21	0.33	-0.03	0.00	0.24
8	0.07	-0.24	0.24	-0.02	0.03	0.32
16	0.17	-0.23	0.33	0.07	-0.03	0.35
32	0.12	-0.21	0.29	0.06	0.01	0.38
			Germany			
1	0.14	0.05	0.57	0.26	-0.10	0.60
2	0.05	-0.15	0.44	0.20	-0.24	0.60
4	-0.19	-0.19	0.25	-0.02	-0.15	0.28
8	-0.53	-0.52	0.32	-0.52	-0.45	0.41
16	-0.57	-0.17	0.19	-0.58	-0.18	0.27
32	-0.54	-0.26	0.21	-0.53	-0.25	0.29
			Greece			
1	0.04	-0.02	0.11	0.00	-0.02	0.07
2	0.11	-0.07	0.27	0.01	-0.04	0.17
4	0.24	-0.22	0.58	-0.01	-0.13	0.39
8	0.19	-0.37	0.32	-0.05	-0.31	0.42
16	0.31	-0.22	0.25	0.04	-0.19	0.29
32	0.32	-0.20	0.32	-0.01	-0.19	0.33
			Iceland			
1	0.11	-0.20	0.23	0.10	-0.06	0.12
2	0.25	-0.49	0.52	0.25	-0.17	0.30
4	0.36	-0.99	0.93	0.54	-0.44	0.63
8	-0.12	-0.20	0.77	0.42	-0.04	0.60
16	-0.11	-0.53	0.50	0.15	-0.15	0.45
32	-0.12	-0.40	0.56	0.27	-0.16	0.49
			Ireland			
1	0.21	-0.69	1.42	0.53	-0.84	0.67
2	0.38	-0.18	1.06	0.53	-0.60	0.46
4	0.33	-0.22	1.20	0.41	-0.82	0.46
8	-0.14	-0.43	0.75	0.63	-0.89	0.84
16	-0.22	-0.05	0.76	0.83	-0.74	0.66
32	-0.18	-0.14	0.74	0.84	-0.79	0.72
			Italy			
1	0.05	-0.07	0.53	0.06	-0.11	0.51
2	-0.09	-0.26	0.38	-0.02	-0.26	0.31
4	-0.31	-0.30	0.40	-0.25	-0.19	0.25
8	-0.26	-0.43	0.23	-0.35	-0.35	0.28
16	-0.26	-0.38	0.21	-0.28	-0.33	0.19
32	-0.28	-0.39	0.22	-0.29	-0.32	0.19

Table 5 (concluded). Impulse Responses

	Trade Balance			Exports				Trade Balance			Exports		
Horizon	SS	DD	NM	SS	DD	NM	Horizon	SS	DD	NM	SS	DD	NM
			Japan							Spain			
1	**-0.12**	**0.11**	**0.19**	-0.04	**-0.06**	**0.15**	1	**-0.12**	**-0.09**	**0.09**	-0.06	**-0.05**	**0.09**
2	**-0.14**	0.01	**0.27**	**-0.07**	**-0.13**	**0.14**	2	**-0.32**	**-0.26**	**0.16**	**-0.15**	**-0.14**	**0.19**
4	**-0.15**	-0.04	**0.40**	**-0.11**	**-0.18**	**0.19**	4	**-0.65**	**-0.53**	**0.22**	**-0.28**	**-0.30**	**0.18**
8	0.04	**-0.21**	**0.44**	**-0.05**	**-0.20**	**0.14**	8	**-0.78**	**-0.72**	**0.20**	**-0.35**	**-0.52**	**0.26**
16	**0.19**	**-0.23**	**0.42**	0.02	**-0.12**	**0.13**	16	**-1.08**	**-0.60**	**0.22**	**-0.50**	**-0.49**	**0.26**
32	0.10	**-0.17**	**0.39**	0.00	**-0.15**	**0.13**	32	**-1.15**	**-0.64**	**0.21**	**-0.52**	**-0.50**	**0.28**
			Netherlands							Sweden			
1	0.12	-0.02	**0.83**	**0.26**	-0.09	**0.87**	1	**0.31**	**-0.17**	**0.59**	**0.37**	0.07	**0.54**
2	0.09	**-0.17**	**0.53**	0.15	-0.12	**0.47**	2	**0.28**	**-0.43**	**0.39**	**0.33**	**-0.16**	**0.28**
4	0.09	**-0.17**	**0.60**	**0.16**	**-0.20**	**0.38**	4	0.03	**-0.62**	**0.44**	**0.33**	**-0.28**	**0.44**
8	-0.04	**-0.16**	**0.61**	**0.10**	0.05	**0.54**	8	0.01	**-0.41**	**0.32**	**0.43**	**-0.25**	**0.58**
16	-0.08	**-0.15**	**0.48**	**0.18**	-0.03	**0.39**	16	**-0.13**	**-0.34**	**0.24**	**0.26**	**-0.41**	**0.57**
32	-0.13	**-0.15**	**0.50**	**0.18**	0.00	**0.41**	32	-0.06	**-0.34**	**0.26**	**0.26**	**-0.29**	**0.51**
			New Zealand							Switzerland			
1	0.05	**-0.25**	**1.14**	**-0.22**	**-0.11**	**0.61**	1	**-0.39**	**-0.17**	**0.63**	**-0.28**	**0.29**	**0.41**
2	-0.12	**-0.31**	**0.84**	**-0.08**	-0.06	**0.35**	2	**-0.29**	**-0.33**	**0.54**	**-0.16**	**0.16**	**0.42**
4	-0.06	**-0.33**	**0.72**	-0.05	**-0.18**	**0.41**	4	**-0.38**	**-0.47**	**0.73**	**-0.28**	**0.09**	**0.38**
8	0.02	**-0.38**	**0.35**	**-0.17**	**-0.23**	**0.18**	8	**-0.33**	**-0.48**	**0.71**	**-0.28**	**0.06**	**0.34**
16	-0.08	**-0.38**	**0.45**	**-0.25**	**-0.15**	**0.25**	16	**-0.18**	**-0.27**	**0.46**	**-0.36**	**0.07**	**0.25**
32	-0.07	**-0.37**	**0.48**	**-0.28**	**-0.16**	**0.20**	32	**-0.23**	**-0.33**	**0.53**	**-0.42**	**0.08**	**0.27**
			Norway							United Kingdom			
1	0.07	**-0.12**	**0.14**	0.00	**-0.04**	**0.05**	1	**0.13**	**0.17**	**0.59**	0.05	0.03	**0.45**
2	**0.20**	**-0.32**	**0.35**	0.00	**-0.09**	**0.14**	2	0.00	0.09	**0.46**	0.00	**-0.08**	**0.24**
4	**0.42**	**-0.73**	**0.72**	0.00	**-0.18**	**0.34**	4	-0.02	-0.03	**0.57**	-0.05	**-0.12**	**0.37**
8	0.05	**-0.46**	**0.67**	**-0.14**	-0.09	**0.51**	8	**-0.11**	-0.09	**0.60**	-0.04	**-0.18**	**0.21**
16	**-0.25**	**-0.45**	**0.35**	**-0.42**	-0.10	**0.46**	16	-0.05	**-0.09**	**0.32**	-0.01	**-0.13**	**0.18**
32	0.01	**-0.48**	**0.51**	**-0.19**	**-0.13**	**0.29**	32	-0.05	**-0.10**	**0.39**	-0.02	**-0.14**	**0.20**
			Portugal							United States			
1	**-0.35**	**-0.24**	**0.71**	**-0.17**	**0.34**	**0.43**	1	**-0.07**	**0.14**	**0.09**	**-0.05**	**0.07**	**0.10**
2	**-0.32**	**-0.43**	**0.56**	**-0.20**	**0.29**	**0.39**	2	**-0.11**	**0.12**	**0.05**	**-0.06**	**0.05**	**0.09**
4	**-0.80**	**-0.79**	**0.86**	**-0.34**	**0.17**	**0.61**	4	**-0.13**	**0.11**	**0.05**	**-0.10**	**0.03**	**0.10**
8	**-1.02**	**-0.86**	**0.69**	**-0.45**	**-0.26**	**0.43**	8	**-0.26**	**0.08**	**0.14**	**-0.18**	**-0.04**	**0.13**
16	**-0.85**	**-0.83**	**0.76**	**-0.50**	**-0.16**	**0.23**	16	**-0.35**	**-0.07**	**0.19**	**-0.23**	**-0.14**	**0.19**
32	**-0.90**	**-0.90**	**0.80**	**-0.53**	**-0.11**	**0.31**	32	**-0.21**	-0.01	**0.11**	**-0.23**	**-0.14**	**0.18**

Notes: The impulse response functions of the trade ratios show the dynamic responses of the trade variables to unit (one standard deviation) supply (SS), demand (DD), and (nominal) NM shocks. The impulse responses of changes in the trade ratios were cumulated in order to derive the responses in terms of levels. Bold entries indicate statistical significance at the 5 percent level. Standard errors for the impulse responses were computed using Monte Carlo simulations with 500 replications.

however, differ across countries. Supply shocks generally tend to result in exchange rate depreciations or have small and statistically insignificant exchange rate effects. In some cases, however, the effects of supply shocks on the exchange rate are positive. For this group of countries—Finland, Iceland, the Netherlands, and Spain—it is likely that these effects reflect positive terms-of-trade shocks that result in permanent increases in the levels of both output and real exchange rates. It is also interesting to note that, for some small economies that are highly open to international trade (Iceland, Ireland, Norway, and Sweden), country-specific supply shocks result in significant but temporary improvements in the trade balance.

Intertemporal models of the trade balance (see Obstfeld and Rogoff (1996)) imply that temporary increases in domestic output would tend to increase domestic saving since optimal consumption, which is determined by permanent rather than current income in these models, would increase by less than the temporary increase in output. Hence, transitory output fluctuations would tend to be accompanied by increases in exports and in the trade balance. The estimated trade balance responses to nominal shocks support this implication of this class of models.

The impulse responses for exports also portray a similar picture of nominal shocks, which result in temporary increases in relative output and simultaneous exchange rate depreciations, leading to increases in exports, although these effects are often attenuated at longer horizons. Demand shocks typically lead to a fall in exports, reflecting the exchange rate appreciation that accompanies these shocks. The effects of supply shocks on exports, however, differ markedly across countries and it is difficult to discern a clear pattern.

An interesting feature of the estimated impulse response functions is that nominal shocks appear to have persistent effects on the trade balance. Even at long horizons, the impulse responses of the trade balance in response to these shocks are significantly different from zero for most countries. Since, in this framework, nominal shocks have only transitory effects on both relative output and the real exchange rate, this result suggests that 'hysteresis' and 'beach-head' effects are quantitatively important for the medium-term dynamics of international trade. As Baldwin (1988, 1990) and Baldwin and Krugman (1990) have argued, these effects can translate transitory (but sufficiently large) exchange rate changes into persistent effects on trade prices and volumes. We also find these effects to be important for the dynamics of both export and import volumes.

B. Variance Decompositions

Next, we examine the forecast error variance decompositions for the trade variables. These decompositions indicate the proportion of the variance in the forecast error of the trade variables that can be attributed to each of the three types of shocks. By providing a quantitative measure of the relative importance of different types of shocks that drive fluctuations in the trade variables, these decompositions complement the information obtained from the impulse responses.

Table 6 shows that, for a majority of the countries, nominal shocks account for the largest fraction of the forecast error variance of changes in the trade balance, at both short and long forecast horizons. The relative importance of nominal shocks, however, tends to decline over longer forecast horizons. For a number of countries, the contribution of demand shocks is quite important, particularly over longer horizons. Supply shocks are quantitatively significant in these variance decompositions for only a handful of countries.

Some interesting cases are worth noting. For Belgium, Iceland, Norway, Spain and the United States, nominal shocks do not account for the majority of the forecast error variance of changes in the trade balance even at short forecast horizons. With the exception of Spain, demand shocks appear to be important determinants of trade balance fluctuations in these countries. At long forecast horizons, supply shocks account for about half of the forecast error variance of changes in the trade balance in Spain and for about a quarter in Denmark, Germany, Japan, Norway, Portugal, Sweden, Switzerland, and the United States.

The variance decompositions for exports indicate that nominal shocks are also the key determinant of fluctuations in exports. That is, changes in exports appear to be largely driven by transitory movements in both relative output and the real exchange rate. Over longer forecast horizons, of course, the relative importance of these shocks diminishes; in many cases, the contribution of these shocks falls below 50 percent. Nevertheless, the fact that nominal shocks remain important even at medium-term forecast horizons suggests that hysteresis and 'beach-head' effects in international trade do in fact have empirical relevance. Finally, the variance decompositions for imports also indicate the dominant role of nominal shocks, again suggestive of the fact that exchange rate fluctuations are a more important determinant of trade dynamics in most countries than are changes in relative output.

It is also of interest to examine the variance decompositions for Japan and the United States in more detail. These are the only countries (other than Belgium) where demand shocks appear to be the most important determinants of fluctuations in imports. These two countries are the least open to international trade among the OECD countries and are also among the largest in terms of output. Thus, it is reasonable that country-specific demand shocks in these countries appear to have a much greater influence than exchange rate movements on variations in their imports. Interestingly, in terms of the variance decompositions for exports, these countries are similar to other countries in that nominal shocks are relatively more important than supply or demand shocks. As noted before, nominal shocks have small output effects but large and rapid exchange rate effects. Since the exports of these two countries compete on world markets, exchange rate effects appear to be far more important for their exports than for the dynamics of their import volumes.

Demand and nominal shocks typically reflect country-specific rather than global fluctuations. Thus, the fact that these two shocks account for a significant fraction of the forecast error variance of the trade variables for most countries suggests that country-specific fluctuations, as would be expected, are an important determinant of fluctuations in the trade balance. Supply shocks tend to be more global in nature and are less likely to influence

Table 6. Variance Decompositions

Horizon	Trade Balance SS	Trade Balance DD	Trade Balance NM	Exports SS	Exports DD	Exports NM	Imports SS	Imports DD	Imports NM
				Australia					
1	1.7	4.0	94.3	0.3	8.5	91.1	12.5	0.6	86.9
2	2.1	17.1	80.8	4.1	8.1	87.8	11.8	13.9	74.3
4	1.9	25.7	72.4	5.4	8.8	85.8	10.6	25.6	63.8
8	11.4	23.9	64.7	6.8	11.7	81.5	19.2	21.7	59.1
16	13.7	27.4	58.9	11.5	13.9	74.6	18.4	23.1	58.5
32	14.0	28.0	58.0	11.9	14.0	74.1	18.5	22.9	58.6
				Austria					
1	0.3	7.7	92.0	10.1	42.5	47.4	3.2	6.5	90.3
2	2.1	5.7	92.2	7.1	33.5	59.4	3.5	6.3	90.2
4	4.4	6.4	89.1	6.7	35.3	58.0	3.7	7.3	88.9
8	8.8	6.7	84.5	11.9	33.2	54.9	4.7	11.3	84.1
16	10.0	7.0	83.1	14.3	32.6	53.1	4.8	11.7	83.5
32	10.0	7.1	82.9	14.7	32.5	52.8	4.8	11.8	83.5
				Belgium					
1	30.3	29.5	40.2	1.4	38.5	60.2	13.1	48.6	38.3
2	16.3	43.6	40.1	2.2	47.4	50.4	5.0	64.6	30.3
4	7.0	46.1	46.9	2.4	51.4	46.2	2.6	69.4	28.1
8	12.6	41.9	45.5	3.5	51.9	44.6	17.3	57.4	25.4
16	13.5	43.3	43.3	5.8	50.8	43.4	16.3	58.4	25.3
32	14.2	42.7	43.1	6.7	50.2	43.1	18.0	56.5	25.5
				Canada					
1	0.4	26.8	72.9	13.3	57.1	29.6	3.0	0.0	97.0
2	2.2	26.6	71.2	13.2	56.3	30.5	3.5	5.0	91.6
4	4.1	26.0	69.9	14.0	55.6	30.4	7.9	6.0	86.1
8	7.4	27.3	65.2	14.0	52.8	33.2	14.5	12.6	72.9
16	8.2	28.6	63.3	13.7	51.8	34.5	15.9	12.5	71.5
32	8.4	28.7	62.9	13.7	51.5	34.8	16.4	12.5	71.1
				Denmark					
1	9.2	24.9	65.9	11.3	23.5	65.2	46.8	0.5	52.7
2	16.3	24.3	59.3	10.5	20.0	69.5	51.0	0.9	48.2
4	15.6	29.0	55.5	10.2	19.6	70.1	47.1	8.7	44.2
8	23.2	27.9	48.9	15.1	18.0	66.9	45.0	10.9	44.1
16	23.1	31.4	45.6	14.7	19.2	66.1	41.4	16.0	42.6
32	23.3	32.1	44.5	14.6	19.3	66.1	41.1	16.4	42.6
				Finland					
1	1.5	0.5	98.1	14.0	0.1	85.9	14.6	2.4	83.0
2	1.7	6.3	92.0	15.0	1.5	83.5	20.2	1.5	78.2
4	2.5	7.6	89.9	17.6	1.5	80.9	23.5	3.9	72.7
8	6.8	12.3	80.9	27.7	2.1	70.1	22.3	9.3	68.5
16	10.6	14.1	75.2	32.5	2.5	65.0	22.9	9.4	67.6
32	11.1	14.2	74.8	33.0	2.7	64.3	23.2	9.6	67.3

Horizon	Trade Balance SS	Trade Balance DD	Trade Balance NM	Exports SS	Exports DD	Exports NM	Imports SS	Imports DD	Imports NM
				France					
1	1.2	3.1	95.7	2.3	5.4	92.3	0.2	8.4	91.4
2	2.0	7.9	90.1	2.3	10.6	87.1	2.0	7.5	90.5
4	4.9	7.6	87.5	13.6	8.5	77.9	4.5	8.6	86.9
8	7.6	10.5	81.9	15.8	14.8	69.4	8.3	9.5	82.2
16	9.0	12.4	78.7	18.0	18.3	63.7	9.2	10.7	80.1
32	9.1	12.9	78.0	18.0	18.9	63.2	9.4	10.9	79.7
				Germany					
1	5.7	0.6	93.7	15.5	2.3	82.2	13.0	7.3	79.6
2	7.0	10.2	82.8	15.6	6.2	78.2	14.0	8.6	77.4
4	15.7	9.2	75.1	24.2	5.6	70.2	15.8	13.3	70.9
8	23.8	14.4	61.8	33.3	15.6	51.1	20.1	17.3	62.7
16	22.2	15.8	62.0	32.1	17.4	50.5	20.0	16.3	63.7
32	21.9	15.8	62.3	32.1	17.6	50.3	20.2	16.8	63.0
				Greece					
1	12.6	2.2	85.2	0.3	4.9	94.9	18.8	8.6	72.7
2	13.0	6.0	81.0	0.2	6.3	93.4	19.1	14.2	66.6
4	13.4	12.4	74.2	1.0	11.1	87.9	27.6	15.1	57.3
8	10.7	19.0	70.3	1.5	26.3	72.2	24.8	19.7	55.5
16	12.5	24.3	63.2	4.7	28.5	66.8	32.0	19.3	48.8
32	12.1	25.3	62.6	5.4	28.5	66.1	32.9	19.5	47.7
				Iceland					
1	11.0	37.3	51.7	35.5	12.7	51.8	5.1	23.5	71.5
2	10.4	42.9	46.7	34.2	17.3	48.5	4.8	23.0	72.3
4	7.7	48.9	43.4	32.8	23.3	43.9	9.5	21.1	69.4
8	12.8	57.4	29.8	26.8	39.6	33.6	21.1	25.8	53.2
16	11.5	56.9	31.6	25.5	44.0	30.5	27.9	31.8	40.3
32	11.7	56.7	31.6	25.8	44.1	30.1	26.4	35.0	38.6
				Ireland					
1	1.7	19.0	79.3	19.4	49.5	31.1	5.9	3.7	90.4
2	2.5	25.2	72.3	18.1	50.2	31.7	6.1	6.8	87.1
4	6.7	23.8	69.5	18.0	50.8	31.2	11.3	9.8	78.8
8	8.8	24.4	66.8	28.6	42.0	29.4	11.0	13.9	75.1
16	10.5	27.6	61.9	28.7	44.5	26.8	11.3	13.3	75.4
32	10.9	27.7	61.4	28.8	44.6	26.6	11.3	12.9	75.8
				Italy					
1	1.0	1.8	97.1	1.3	4.7	94.0	0.0	0.0	99.9
2	6.7	10.9	82.4	2.8	9.5	87.7	0.1	1.0	98.9
4	13.5	10.3	76.2	9.1	11.1	79.8	1.4	4.3	94.3
8	12.8	12.4	74.8	10.1	15.0	74.9	6.6	5.5	87.9
16	13.6	12.4	74.0	11.1	15.5	73.4	7.5	7.5	85.0
32	13.7	12.4	73.9	11.3	15.5	73.1	7.6	7.7	84.7

Table 6 (concluded). Variance Decompositions

	Trade Balance			Exports			Imports				Trade Balance			Exports			Imports		
Horizon	SS	DD	NM	SS	DD	NM	SS	DD	NM	Horizon	SS	DD	NM	SS	DD	NM	SS	DD	NM
					Japan										Spain				
1	21.9	18.7	59.5	6.5	12.7	80.8	22.0	76.9	1.1	1	45.9	27.1	26.9	24.1	18.1	57.8	43.9	10.4	45.7
2	17.8	26.2	56.0	7.7	22.8	69.5	18.9	61.4	19.8	2	52.5	34.4	13.1	29.0	26.6	44.4	52.8	14.6	32.6
4	15.2	28.0	56.8	9.0	23.8	67.1	15.1	51.4	33.5	4	55.4	36.9	7.6	33.0	37.2	29.7	55.8	16.3	27.9
8	20.7	32.0	47.3	12.6	22.1	65.3	14.1	47.3	38.6	8	50.7	40.4	8.9	28.0	45.4	26.7	53.6	16.4	29.9
16	25.0	29.9	45.1	20.7	20.6	58.7	15.3	45.7	39.0	16	51.5	38.4	10.1	30.7	43.5	25.8	54.5	16.4	29.1
32	25.5	29.7	44.9	21.7	21.1	57.3	15.2	45.3	39.5	32	51.3	38.5	10.2	30.6	43.5	25.9	54.4	16.5	29.1
					Netherlands										Sweden				
1	2.1	0.1	97.8	8.3	1.0	90.8	0.8	1.1	98.1	1	20.8	5.9	73.3	31.4	1.0	67.6	1.4	1.8	96.7
2	2.0	2.8	95.2	8.2	0.9	91.0	1.0	1.7	97.3	2	17.1	16.6	66.3	24.9	10.0	65.1	1.8	1.9	96.3
4	2.4	2.8	94.8	10.7	1.7	87.6	4.1	3.8	92.1	4	24.6	16.4	59.0	24.5	12.2	63.3	4.4	3.7	91.9
8	5.4	3.4	91.2	11.2	7.6	81.1	7.0	10.4	82.6	8	25.7	21.6	52.7	33.4	16.1	50.5	4.7	8.2	87.1
16	6.2	3.9	89.8	10.9	7.4	81.7	9.2	10.2	80.7	16	25.8	24.3	49.9	31.6	23.2	45.2	7.1	12.0	80.9
32	6.3	3.9	89.7	10.8	7.5	81.7	9.3	10.3	80.3	32	25.7	25.1	49.2	31.0	25.0	44.0	7.4	12.1	80.5
					New Zealand										Switzerland				
1	0.1	4.7	95.1	11.1	2.6	86.3	1.1	6.5	92.5	1	26.5	5.1	68.4	24.5	24.9	50.5	0.7	27.3	72.0
2	2.0	4.5	93.4	13.0	2.6	84.5	2.7	4.9	92.5	2	26.3	8.7	65.0	26.8	27.2	46.0	1.9	26.9	71.2
4	3.2	4.5	92.2	13.1	3.9	83.0	3.1	5.2	91.7	4	25.6	13.2	61.2	27.4	26.9	45.7	4.1	32.1	63.8
8	5.0	6.9	88.1	11.8	11.4	76.8	5.2	6.9	87.9	8	28.4	15.9	55.7	29.1	24.9	46.0	5.5	30.4	64.1
16	5.1	8.6	86.3	14.8	11.0	74.2	6.1	8.5	85.4	16	30.5	17.5	52.0	26.9	24.6	48.5	9.6	28.9	61.5
32	5.9	8.6	85.5	15.7	11.6	72.7	6.6	8.6	84.8	32	32.6	17.4	50.0	27.3	24.4	48.3	10.1	28.9	61.0
					Norway										United Kingdom				
1	13.7	34.6	51.7	11.1	2.6	86.3	1.1	6.5	92.5	1	4.5	7.2	88.3	1.4	0.4	98.2	2.6	1.9	95.5
2	14.8	39.7	45.5	13.0	2.6	84.5	2.7	4.9	92.5	2	7.9	8.1	84.0	2.1	4.6	93.3	4.8	1.9	93.3
4	14.5	43.8	41.8	13.1	3.9	83.0	3.1	5.2	91.7	4	12.7	9.1	78.1	3.9	5.0	91.1	6.3	2.1	91.6
8	24.9	42.6	32.5	11.8	11.4	76.8	5.2	6.9	87.9	8	15.3	11.2	73.5	4.0	10.0	86.0	7.8	6.4	85.8
16	28.0	38.3	33.7	14.8	11.0	74.2	6.1	8.5	85.4	16	15.0	11.0	74.0	4.2	11.3	84.6	8.5	7.6	83.9
32	30.0	37.0	32.9	15.7	11.6	72.7	6.6	8.6	84.8	32	15.2	11.0	73.8	4.2	11.4	84.4	8.5	7.7	83.8
					Portugal										United States				
1	18.0	8.5	73.6	8.5	35.5	56.0	5.4	42.1	52.6	1	15.9	58.2	25.9	18.1	25.8	56.1	21.6	47.6	30.9
2	16.6	12.8	70.6	8.7	35.7	55.6	5.8	40.9	53.3	2	18.5	53.2	28.3	18.0	26.5	55.5	23.4	44.4	32.2
4	26.0	16.2	57.8	11.7	33.4	54.9	9.7	39.4	50.9	4	18.3	53.2	28.5	23.0	25.8	51.2	23.6	43.7	32.7
8	26.5	14.3	59.2	18.3	35.5	46.3	9.4	40.5	50.1	8	24.7	49.0	26.3	23.5	31.7	44.8	28.7	39.7	31.6
16	26.2	15.9	57.8	18.2	36.0	45.8	9.9	41.0	49.1	16	24.1	45.9	30.1	23.0	32.6	44.5	26.8	38.0	35.2
32	26.3	15.9	57.8	18.5	36.0	45.5	10.0	41.1	49.0	32	25.4	45.4	29.2	22.9	32.5	44.6	26.9	38.0	35.1

Notes: The forecast error variance decompositions are for the changes in the trade variables. These decompositions indicate the proportion of the variance of the k-period ahead forecast error that is attributable to different types of shocks, i.e., supply (SS), demand (DD), and nominal (NM) shocks. Bold entries indicate statistical significance at the 5 percent level. Standard errors for the variance decompositions were computed using Monte Carlo simulations with 500 replications.

fluctuations in trade variables. Hence, the small contribution of supply shocks to fluctuations in trade variables is not inconsistent with the possibility that supply shocks are the main determinant of output fluctuations in each country. It should also be noted that the relative supply shocks that we have used in the analysis are probably much smaller than the sum of global and country-specific supply shocks experienced by each country.

VI. Discussion

The results presented in this paper raise a number of interesting issues. The impulse responses indicated that nominal shocks induce positive co-movement between the trade balance and output. Further, the variance decompositions showed that nominal shocks account for a large fraction of fluctuations in the trade balance. An important question that arises here is how these results can be reconciled with the robustly countercyclical variation of the trade balance documented in Section II.

The answer lies in the fact that a negative *unconditional* correlation between output and the trade balance is not inconsistent with a positive *conditional* correlation between these two variables in response to nominal shocks. It turns out that, although nominal shocks are important for trade balance fluctuations, they are relatively unimportant, even at short horizons, for output fluctuations. The variance decompositions for output (not reported here) showed that supply shocks and, to a lesser extent, demand shocks, tend to dominate output fluctuations for most industrial countries. Since demand shocks and, in most cases, supply shocks, induce a negative correlation between output and the trade balance, it is not surprising that the data reveal a negative unconditional correlation between output and the trade balance. This discussion highlights the importance of accounting for the effects of different sources of macroeconomic shocks when trying to interpret bivariate unconditional correlations.

A notable result in this paper is the small contribution of supply shocks to fluctuations in the trade variables. Supply shocks are generally considered to the primary determinants of output fluctuations over long horizons. In fact, real business cycle models ascribe the principal role even in short-run output fluctuations to supply shocks. The small contribution of supply shocks to trade dynamics that we find then appears to present a puzzle. However, it should be noted that supply shocks, especially if they take the form of technology shocks, are likely to be common global shocks rather than country-specific shocks. Thus, it is not surprising that the *relative* supply shocks that we identify are quantitatively less important and are not significant determinants of fluctuations in trade. Our results are, therefore, fully consistent with the findings of Glick and Rogoff (1995) and Gregory and Head (1995) that country-specific shocks are more important for current account fluctuations than global shocks. In fact, our results go further by indicating that country-specific demand shocks are often more important than country-specific supply shocks for trade dynamics.

Finally, we address a possible concern about the identification procedure used in this paper. The issue is how exchange rate movements determined by factors unrelated to economic fundamentals, including purported 'animal spirits,' would be classified in this framework. Such temporary deviations in the exchange rate from the level suggested by observable economic fundamentals would presumably be attributed to nominal shocks, thereby potentially exaggerating the importance of these shocks. However, as noted by Meese and Rogoff (1983), Huizinga (1987), and others, a significant fraction of real exchange rate fluctuations are in fact quite persistent. We find it plausible that 'animal spirits' do not have persistent effects on real exchange rates and, therefore, are not in general a significant determinant of exchange rate fluctuations. Also consistent with this argument, the variance decompositions for the real exchange rate (not shown here) indicated that, for most countries, demand shocks account for the largest fraction of the forecast error variance of the real exchange rate. Thus, our finding that nominal shocks play an important role in trade dynamics is not an artifact of the identification procedure.

VII. Conclusions

In this paper, we have provided a number of different but complementary characterizations of the relationship between international trade and the business cycle in industrial economies. We first documented a number of key stylized facts regarding the dynamics of international trade and its determinants. We then constructed a quantitative measure of the contribution of trade to business cycle recoveries. There is little evidence that variations in the trade balance have contributed significantly to cyclical recoveries in industrial economies since the 1970s. Exports, on the other hand, do appear to have a significant role as a catalyst for business cycle recoveries, with the quantitative importance of this catalytic role positively related to the degree of an economy's openness to international trade.

We then estimated a multivariate model of trade dynamics that enabled us to characterize the joint dynamics of relative output, the real exchange rate, and trade variables in response to different sources of macroeconomic fluctuations. An interesting finding here is that positive nominal shocks, which could be interpreted as monetary expansions, tend to result in short-run improvements in the trade balance and that these shocks account for a significant fraction of fluctuations in the trade balance for most industrial economies. This paper has also provided a reconciliation of these results with the negative unconditional correlation between output and the trade balance found in the data.

This research could be extended in a number of different directions. This paper has examined only the direct effects of international trade in generating business cycle recoveries. An analysis of the overall multiplier effects of exports on real GDP would be of considerable interest. In particular, changes in external demand, through their effects on domestic investment, could potentially have larger and more persistent effects on domestic output than through the channels examined here. This paper has documented a number of stylized facts that could be used to gauge the empirical relevance of calibrated general equilibrium models used to analyze these channels. A more disaggregated analysis of the dynamics of different categories of imports and exports in response to different types of shocks would also shed light on this issue and would be of independent interest from an analytical perspective.

Another useful extension would be to examine the role of trade in the international propagation of business cycles. Most papers in this area, including Cantor and Mark (1988) and Canova and Dellas (1993), have restricted their analysis to the role of productivity shocks. As this paper has shown, the dynamics of international business cycles could be affected in very different ways by alternative sources of macroeconomic fluctuations.

Description of the Dataset

This appendix describes the data set used in the paper. The primary data were obtained from the OECD Analytical Databank and cover the period 1970:1–1995:4. All data were obtained in quarterly, seasonally adjusted form. For a small number of data series, there appeared to be some residual seasonality. The X-11 filter was applied to these series.

Real GDP is used as the measure of output for all countries. The trade variables are real exports and real imports of goods and nonfactor services according to the national income accounts definition. The difference between these two variables yields net exports which, together with total domestic demand, is equal to real GDP.

An important caveat is in order for the data for Belgium, Greece, Iceland, Norway, Portugal, and Spain. For these countries, the national statistical agencies provide only annual rather than quarterly data on national income accounts for part of the sample period. Hence, for part of the sample, the quarterly data for these countries are based on OECD estimates and should, therefore, be treated with caution.

The nominal effective exchange rate for each country was constructed using bilateral nominal exchange rates and trade weights taken from the IMF's Information Notice System. These trade weights, based on trade patterns during 1988-90, take into account not only bilateral trade but also competition in third markets in order to capture the broader effects of exchange rate changes on competitiveness in international markets (see Desruelle and Zanello (1997)). The real effective exchange rate was constructed using bilateral nominal exchange rates, the CPI in both domestic and trading partner countries, and the same set of trade weights described above.

Measures of foreign output for each country were constructed by applying the same set of trade weights described above to real output in that country's trading partners. However, the measures of international trade provide broader coverage since they are not restricted to trade with other OECD economies. This is not a serious concern in terms of the consistency of the data definitions since a substantial fraction of international trade for most OECD industrial economies is with other OECD economies.

One consideration in applying trade weights to output across different countries is that the base year could differ across countries and so could the units. Rather than make an adjustment based on purchasing power parities (which, in any case, were not available for all years in our sample), we created indices of the level of aggregate output for each country that were rebased to 100 at the start of the sample period. Since only growth rates of domestic and relative output are used in the VAR analysis, this obviates the potential problems caused by differences in units and base years across countries.

Identifying Business Cycle Troughs

This appendix describes the procedure we adopted for identifying business cycle troughs in our sample. For each country, we took the logarithm of quarterly real GDP and, using the Hodrick-Prescott filter with a smoothness parameter of 1600, obtained the stationary component of output. We then examined those episodes where the cyclical component of output fell below -1.5 (i.e., a one and a half percentage negative deviation of output from its trend level) and picked as the cyclical trough that quarter in which the cyclical component of output reached its lowest level.

For the countries for which reliable 'official' business cycle trough dates were available, we attempted to supplement our methodology with information obtained from these sources. These sources included Statistics Canada for Canada, Deutsche Bundesbank for Germany, the Economic Planning Agency for Japan, and the National Bureau of Economic Research for the United States. In most cases, the business cycle troughs identified using our methodology were quite similar to these official trough dates. Nevertheless, given the often conflicting signals from different business cycle indicators, the business cycle trough dates listed in Table A1 should be interpreted with caution.

Table A1. Business Cycle Troughs: 1970-95

Australia	77:4	83:1	86:3	91:2	
Austria	75:3	78:1	87:1		
Belgium	75:3	87:2	93:3		
Canada	71:1	75:2	82:4	86:4	92:4
Denmark	75:2	83:3	92:3		
Finland	71:1	75:4	78:3	86:2	93:2
France	75:3	87:1	93:4		
Germany	75:1	82:4	93:1		
Greece	74:3	83:2	87:3	93:3	
Iceland	75:4	83:3	92:4		
Ireland	76:2	83:2	87:1	93:4	
Italy	72:3	75:2	77:4	83:2	93:3
Japan	71:4	75:1	87:2	95:1	
Netherlands	75:3	83:1	88:2	93:4	
New Zealand	73:3	78:1	83:1	92:3	
Norway	75:2	82:3	90:1		
Portugal	71:1	75:3	78:3	84:2	94:4
Spain	71:1	86:2	93:4		
Sweden	72:2	78:3	83:1	93:4	
Switzerland	70:4	76:1	78:3	82:4	93:2
United Kingdom	72:1	75:3	81:2	84:3	92:2
United States	70:4	75:1	82:4	91:4	

Notes: The sample period is 1970:Q1 through 1995:Q4. The procedure used to identify cyclical troughs is described in Appendix II.

A Stylized Theoretical Model

This appendix sketches the key features of the stylized theoretical model presented in Prasad and Kumar (1997). The model illustrates the main channels through which different types of macroeconomic shocks influence the cyclical dynamics of the trade balance. The basic setup closely follows Clarida and Gali's (1994) stochastic version of Obstfeld's (1985) open economy macroeconomic model.

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 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, this terminology will be used sparingly below. The model can be written as follows:

$$y_t^d = d_t + \eta\,(s_t - p_t) - \sigma(i_t - E_t\,(p_{t+1} - p_t)) \qquad \text{(A1)}$$

$$p_t = (1-\theta)\,E_{t-1}\,p_t^e + \theta p_t^e \qquad 0<\theta\leq 1 \qquad \text{(A2)}$$

$$m_t^s - p_t = y_t - \lambda i_t \qquad \text{(A3)}$$

$$i_t = E_t\,(s_{t+1} - s_t) \qquad \text{(A4)}$$

Output demand is denoted by y_t^d, d_t is a demand shock, s_t is the nominal exchange rate, p_t is the aggregate price level, i_t is the domestic interest rate, p_t^e is the flexible price level, and m_t^s denotes the money supply. Equation A1 is an open economy IS equation. Equation A2 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 A3 is a standard LM equation and equation A4 is an interest parity condition.

This basic model is then augmented with an 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 (which is identical to the trade balance 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:

$$tb_t = \xi q_t - \beta y_t \qquad \text{(A5)}$$

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. 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, we specify the stochastic processes that drive the relative supply of output, the relative demand shock, and relative money. For ease of exposition, 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:[18]

$$y_t^s = y_{t-1}^s + z_t \qquad \text{(A6)}$$

$$d_t = d_{t-1} + \delta_t - \gamma\delta_{t-1} \qquad \text{(A7)}$$

$$m_t = m_{t-1} + \nu_t \qquad \text{(A8)}$$

The innovations z_t, δ_t, and ν_t are assumed to be serially and mutually uncorrelated. The flexible-price rational expectations solution to the model is as follows:[19]

$$y_t^e = y_t^s \qquad \text{(A9)}$$

$$q_t^e = \frac{y_t^s - d_t}{\eta} + \frac{1}{\eta(\eta + \sigma)}\sigma\gamma\delta_t \qquad \text{(A10)}$$

Substituting these expressions into equation A5, the flexible-price equilibrium solution for the trade balance is then given by:

$$tb_t^e = y_t^s\left(\frac{\xi}{\eta} - \beta\right) + \frac{\xi}{\eta}\left[-d_t + \frac{1}{(\eta + \sigma)}\sigma\gamma\delta_t\right] \qquad \text{(A11)}$$

Equations A9–A11 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

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[18]Permanent demand shocks raise the levels of domestic and foreign interest rates and lead to proportional increases in domestic and foreign price levels, leaving the relative price level unchanged.

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

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

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 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, we note that 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, we do not use this restriction for identification.[20]

We 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:

$$y_t = y_t^s + \phi(\eta + \sigma)\,(1-\theta)\,(\nu_t - z_t + \alpha\gamma\delta_t) \tag{A12}$$

$$q_t = q_t^e + \phi(1-\theta)\,(\nu_t - z_t + \alpha\gamma\delta_t) \tag{A13}$$

$$tb_t = \xi q_t^e - \beta y_t^s + (\xi - \beta(\eta + \sigma))\left[\phi(1 - \theta)(\nu_t - z_t + \alpha\gamma\delta_t)\right] \tag{A14}$$

where $\alpha \equiv \lambda(1 + \lambda)^{-1}(\eta + \sigma)^{-1}$ and $\phi \equiv (1 + \lambda)(\lambda + \sigma + \eta)^{-1}$. Note that sluggish price adjustment ($\theta \neq 1$) implies that nominal shocks affect output and the real exchange rate in the short run, even though these shocks do not affect the long-run equilibrium levels of these two variables. Consequently, nominal shocks also influence the short-run dynamics of the trade balance. Equation A14 can be rewritten in terms of the fundamental shocks of the model as follows:

$$tb_t = \left[\frac{\xi}{\eta} - \beta\right] y_t^s - \frac{\xi}{\eta} d_t + \Phi\nu_t - \Phi z_t + \left[\Phi\alpha + \frac{\xi\sigma}{\eta(\eta+\sigma)}\right]\gamma\delta_t \tag{A15}$$

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.

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[20]Further, as noted in the text, temporary but sufficiently persistent exchange rate changes could alter the stock of net foreign assets and thereby change the level of the trade balance (but not the current account) over long horizons.

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