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Working Paper 9019

TASTES AND TECHNOLOGY IN A TWO-COUNTRY MODEL OF THE BUSINESS CYCLE: EXPLAINING INTERNATIONAL CO-MOVEMENTS

by Alan C. Stockman and Linda L. Tesar

Alan C. Stockman is a professor of economics at the University of Rochester, and Linda L. Tesar is an assistant professor of economics at the University of California, Santa Barbara. For helpful comments, the authors would like to thank Mark Bils, Mary Finn, and workshop participants at the University of Chicago, the Federal Reserve Bank of Richmond, Washington University, the Rochester Conference on the International Transmission of Business Cycles, and the NBER Summer Institute. They would also like to thank Rick Pace, Mike Pakko, and Kazimierz Stanczak for research assistance. Mr. Stockman gratefully acknowledges research support from the Federal Reserve Bank of Cleveland and the National Science Foundation. Both authors acknowledge research support from the University of Rochester Workshop on International Markets, supported by a grant from the Alfred P. Sloan Foundation.

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April 1991

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1. Introduction

This paper develops a two-country real business cycle model and confronts it with an extensive set of empirical observations. In particular, we examine the model's consistency with the behavior of international as well as domestic variables, the cyclical behavior of relative prices and the model's implications for economic aggregates at the sectoral level. This line of research is motivated by a desire to understand the international transmission of business cycles and changes in international competitiveness as reflected in the behavior of relative prices, such as real exchange rates and the terms of trade. We also hope to extend our understanding of business cycles in closed economies by studying a broader and different set of observations.[1]

Studies of cyclical fluctuations in a closed-economy setting have identified several pervasive features of the business cycle: investment, consumption and work effort are strongly procyclical, investment is more volatile than output, and the time-path of consumption is generally smoother than that of output. These observations characterize business cycles not only in the United States, but also in the larger set of industrial countries (see Dellas, 1986; Backus and Kehoe, 1988; Gerlach, 1988; Baxter and Stockman, 1989; and this paper, Section 2).

These closed-economy features of business cycles have received much attention in the literature. However, there are several open-economy features of the cycle that a model of the international transmission of business cycles should explain. In Section 2, we discuss these open-economy aspects of the

[1]We hope to extend this research in the future to explain *differences* in business cycles across countries; some of these differences are apparent in the data tables at the end of this paper.

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business cycle and present evidence on the cyclical behavior of the trade balance, the current account, the correlation between savings and investment and the cross-country correlations of consumption, output and changes in productivity.

Disaggregation of the standard one-sector real business cycle model into a two-sector model with production of traded and nontraded goods helps to account for some of these international observations; in particular, the incorporation of nontraded goods helps to explain the low cross-country consumption correlations and the high correlation between savings and investment (Tesar, 1990). This disaggregation also introduces a number of new dimensions for evaluating the model.[2] Thus, we present evidence on the cyclical behavior of consumption, output, investment and work effort in the traded- and nontraded-good-producing sectors, and examine the correlations between these variables across sectors.

Finally, we confront the model with data on prices as well as quantities, including the terms of trade, the real exchange rate and the relative price of nontraded goods. Some theoretical models of exchange rates (Stockman, 1980, 1987a; Lucas, 1982) suggest that real disturbances like those emphasized in real business cycle models are the main cause of changes in real (and nominal) exchange rates. Our current paper attempts to provide the foundations of a quantitative analysis of neoclassical international finance that integrates equilibrium models of exchange rates with neoclassical models of business cycles

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[2]This paper does not formally test hypotheses about the model, because the model is clearly false in ways that will become apparent. Our research is instead intended to describe the areas of success and failure of a simple neoclassical model, which we consider a necessary step to further theoretical and empirical analysis.

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and their international transmission.

The empirical evidence is summarized in Section 2. We then describe our basic two-sector, two-country, neoclassical model in Section 3. In Section 4, we discuss calibration of the model[3] and the implications of the model when it is subjected to productivity shocks, as measured by Solow residuals.

We find that when the basic model is driven by technology shocks or Solow residuals, it has several implications that are glaringly at odds with empirical observations. Although the model performs quite well in most dimensions, it fails to replicate observations on the correlation of consumption across countries and the co-movements of prices and quantities. We argue that the model cannot satisfactorily account for those observations without a different source of exogenous disturbances -- disturbances that look like shocks to tastes (or possibly shocks to fiscal policies, which have similar effects).

When the model is extended to include random shocks to preferences (Section 5), we find that most of these glaring inconsistencies vanish.[4] Though there are some features of the data that the model cannot explain, in an overall sense the model is consistent with most of the empirical evidence. We conclude from this study that shocks to technology and *tastes* (or something essentially equivalent) are required to explain the main features of business cycles and

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[3]We calibrate the model and simulate it in order to study its main areas of consistency or inconsistency with empirical observations. Although the model turns out to be remarkably successful in most ways, there are several places where it clearly misses some important element. As a result, we do not formally estimate or test hypotheses about the model; that is reserved for the future, after additional theoretical work and model development.

[4]Benzivinga (1987) has previously studied taste shocks in a real business cycle model. Benhabib, Rogerson and Wright (1990a,b) have recently studied a real business cycle model with "productivity" shocks to household production, which are very much like shocks to preferences.

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their international transmission. This paper shows some of the characteristics that such taste shocks must have in order to successfully match the data. The paper also highlights some interesting puzzles that should be the focus of future research.

2. Empirical Regularities

We focus attention on annual data for the seven largest industrial countries: Canada, France, Germany, Italy, Japan, the United Kingdom and the United States. A major source of our data is the International Sectoral Data Base, compiled by the Organisation for Economic Co-operation and Development (OECD). We also draw on data from the OECD Main Economic Indicators and the OECD Quarterly Accounts. A complete description of the data sources appears in Appendix A.

All empirical estimates referred to in the text of this paper are based on data detrended using the Hodrick-Prescott filter. Results based on data filtered by first-differencing appear in Appendix B. To get a sense of the effect of applying the Hodrick-Prescott filter, Figures 1 and 2 show the raw time series and the Hodrick-Prescott-filtered time series of U.S. output of traded and nontraded goods.

The International Regularities

There are several features of the data that a model of the international transmission of business cycles should explain. First, the correlation of output growth across countries is large and positive. Part A of Table 1 shows the cross-country correlations of output based on data detrended using the Hodrick-Prescott filter: The top number in each element of the table shows the

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correlation between aggregate output in the two countries, the middle number shows the cross-country correlation between traded-good outputs, and the bottom number shows the correlation between nontraded-good outputs. The correlations between aggregate outputs are positive and range from 0.437 between Canada and Japan to 0.858 between the United States and Germany, with an average of 0.69. The sectoral correlations are slightly lower on average than the aggregate correlations.

Second, the cross-country correlations of consumption are positive but generally smaller than the cross-country correlations of output. Table 2 reports cross-country correlations of consumption based on data from International Financial Statistics (IFS), published by IMF, and data reported by the OECD. Despite the high correlations between output growth rates across countries, the correlations between consumption growth rates are surprisingly low, particularly in the IFS data. In the OECD data, the correlation between aggregate consumption ranges from 0.028 between the United States and France to 0.822 between Japan and France; the average is 0.50.[5] The cross-country correlation between consumptions of nontraded goods is smaller on average (0.30) than that between consumptions of traded goods (0.42), though on a country-by-country basis this ordering is sometimes reversed.

The low cross-country correlations of consumption pose a problem for two-country neoclassical models which assume that financial markets are well integrated. In many such models (with complete markets and without distortions), consumption is perfectly (or nearly perfectly) correlated across countries.

[5] In Part B of Table 2, the top figure in each cell is the cross-country correlation between aggregate consumptions, the second figure is between private final consumptions, the third is between consumption of traded goods and the fourth is between consumption of nontraded goods.

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Backus, Kehoe and Kydland (1989) study a one-sector, two-country model in which consumption is imperfectly correlated across countries because leisure and consumption are good substitutes in utility. In this setting, a persistent productivity shock in the home country raises the domestic marginal product of labor and reduces leisure. Because leisure and consumption are substitutes, equilibrium consumption in the home country rises more than in the foreign country (or falls less), breaking the close link between foreign and domestic consumption. This is one of several mechanisms that break the link between home and foreign consumption in our model. The fact that consumption is less closely correlated across countries than is output is related to the much-discussed positive relation between national saving and investment (Feldstein and Horioka, 1980; Tesar, 1990; Baxter and Crucini, 1990).[6]

Third, Solow residuals are positively correlated across countries, but are *less* positively correlated than outputs (see also Costello, 1990). The Solow residuals for each sector i (i = aggregate, traded and nontraded) are

$$A_t^i = Y_t^i - (1-\alpha^i)\, K_t^i - \alpha^i\, N_t^i, \tag{2.1}$$

where α^i is the labor share in each sector, and output, capital and labor are detrended series. (The estimates of the labor shares used in the calculation of the Solow residuals are shown in Table 3.) Part B of Table 1 reports cross-country correlations of Solow residuals. The Solow residuals are generally positively correlated, but are notably smaller than the output correlations for

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[6]Backus, Kehoe and Kydland (1989) and Tesar (1990) also present evidence on the cross-country correlations of consumption and output.

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all pairs of countries except the United States and Canada. The average cross-country correlation of aggregate Solow residuals is 0.33, compared to 0.64 for output. The average cross-country correlations of Solow residuals for the traded and nontraded sectors of the economy are 0.27 and 0.25, respectively, while the corresponding average output correlations are 0.56 and 0.58.[7] This evidence casts doubt on the view that positively correlated Solow residuals are the sole explanation for international co-movements of output. It suggests either that other exogenous disturbances help to create the stronger cross-country correlation of output, or that a model must endogenously amplify the effects of the underlying disturbances to productivity.

Fourth, the balance of trade surplus and current account surplus are countercyclical (see also Backus, Kehoe and Kydland, 1989). The second and third columns of Table 4 show the correlations between the trade balance or current account and aggregate output for five countries. The average correlations are -0.34 and -0.43, respectively. Because the trade balance can be negative, and we want to compare results using the Hodrick-Prescott filter with results using the growth-rate filter, we define the trade balance as detrended exports minus detrended imports rather than as the detrended difference. We employ this definition consistently in the data and in the model. We define the current account in a similar manner:

$$TB_t = EXP_t - IMP_t \tag{2.2}$$

[7] Interestingly, the correlations between the Solow residuals of Canada and the United States are higher than the output correlations at both the sectoral and the aggregate level. This suggests that models of the international transmission of the business cycle calibrated to the United States and Canada are likely to lead to very different conclusions than those incorporating a larger number of the OECD countries.

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$$CA_t = SAV_t - INV_t, \tag{2.3}$$

where exports, imports, savings and investment are detrended series.[8] The degree of countercyclicality of the trade balance and the current account is sensitive to the method of detrending. (This can be seen by comparing the figures in Table 4 to those in Table B3 in Appendix B.)[9]

The first column of Table 4 shows the well-documented, strongly positive correlation between savings and investment. The last two columns of Table 4 show the correlations of the terms of trade with output and the trade balance. These relations are mixed, appearing to be strongly positive in some cases and strongly negative in other cases.

A summary of the relationships between the real exchange rate and consumption, output and the trade balance appears in Table 5. We define the real exchange rate as the ratio of the home Consumer Price Index to the foreign

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[8]Unless otherwise noted, the trade balance and the current account are treated as in equations (2.2) and (2.3). This treatment of the data is consistent with the time series produced by the simulations in Sections 4 and 5.

[9]A countercyclical trade balance may seem to contradict the implications of a model based on productivity shocks. In the case of purely temporary changes in productivity, consumption-smoothing would suggest that the country with high productivity will increase its net exports. However, persistent shocks raise the marginal product of capital, which raises investment in the high-productivity country. If the increase in investment exceeds the increase in output, then the country with a positive productivity shock initially reduces its net exports. Eventually, as the exogenous disturbance dies out, the country's net investment falls and its net exports rise (see Backus and Kehoe, 1988).

In our model, the presence of nontraded goods also contributes to a countercyclical trade balance. Because there is some complementarity between traded and nontraded goods, an increase in the output of the nontraded good in the home country will increase consumption of the nontraded good and increase demand for the traded good (see Tesar, 1990).

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Consumer Price Index.[10] There appears to be no consistent co-movement between these macroeconomic aggregates and the real exchange rate.[11] Table 6 reports standard deviations of the terms of trade, the Consumer Price Index, the trade balance and the current account.

The presence of nontraded goods provides part of the explanation for the cyclical behavior of some of these international variables. Consumption of nontraded goods breaks the strong link between foreign and domestic consumptions and contributes to the countercyclical behavior of the trade balance. Nontraded capital goods help to explain the strong link between domestic investment and national savings (Tesar, 1990). This disaggregation also introduces a number of new dimensions for evaluating the usefulness of our model.

Empirical Regularities within Countries

Perhaps the most striking feature of the data for the seven industrialized countries is the large share of nontraded goods in their economies. Following Kravis, Heston and Summers (1982) as closely as possible, we categorize the 10 sectors reported by the OECD Intersectoral Data Base into traded and nontraded industries. Table 7 shows the sectors included in the two categories and reports the share of each of the 10 sectors in 1984 GDP. Nontraded goods account for

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[10] The rows of Table 5 refer to the output (consumption or trade balance) of country i, while the columns are the real exchange rates, defined as the ratio of the Consumer Price Index of country i to that of country j.

[11] It is difficult to draw conclusions about the cyclical behavior of the terms of trade and the real exchange rate in either Hodrick-Prescott-filtered data or first-differenced data. However, it may be possible to use the results from specific countries in a study calibrated to a particular pair of countries.

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about *half* of output.[12] This corresponds closely with the 52 percent share reported by Kravis, Heston and Summers for their 10-country sample of industrialized countries.[13]

Table 8 shows the standard deviations of output, the capital stock, work effort, investment and the estimated Solow residuals. Part B of the table shows the standard deviations of these series relative to the standard deviations of output in each sector. The standard deviations of the Solow residuals in each industry are approximately the same magnitude as the standard deviations of output in that industry, and are higher in the traded than in the nontraded sector. Investment is two to three times as variable as output in most countries and in both industries, while labor is less variable than output. Interestingly, fluctuations in the capital stock appear to be much larger in the nontraded-good-producing industry than in the traded-good-producing industry.[14]

The shares of nontraded goods in private final consumption in the seven

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[12]A good case can be made that most retail services -- retail and wholesale trade, and services of restaurants and hotels -- should be considered nontraded goods. We include value added of retail and wholesale trade in the traded-good category to be consistent with Kravis, Heston and Summers. They, however, treat restaurants and hotels as nontraded goods. We include restaurants and hotels in our measure of traded goods because the data are not reported for all countries, and the share of restaurants and hotels in total GDP is small enough (less than 3 percent) that this should have little effect on the overall results. Kravis, Heston and Summers also treat public transportation and communication as nontraded goods. We treat them as traded goods because we lack data to separate these categories from private automobile purchases, which is the largest component of the transportation category.

[13]See <u>World Product and Income: International Comparisons and Real GDP</u>, Tables 6-10, p. 194.

[14]Note that this is true of the capital stock series but not generally of the investment series. This may be due to the method used by the OECD to estimate the gross capital stock from investment time series. In assessing the simulation results, we will focus on the investment data rather than on the capital data.

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OECD countries are shown in Table 9. We estimate these shares in two ways. One estimate treats services and nontraded goods as equivalent. The second measure is based on a breakdown of private consumption expenditure by type, following as closely as possible the decomposition specified by Kravis, Heston and Summers. When services are used as a proxy, the data indicate that nontradables are a large and growing component of consumption. By the 1980s, services accounted for roughly 50 percent of private final consumption, while the second measure of nontradables indicates a share closer to one-third.[15] The second measure is a smaller number because several of the categories considered by Kravis, Heston and Summers to be nontradables are not reported by the OECD.[16] The measure for the United States is based on data from Citibase, which include all of the relevant categories (see footnote [f] in the table) and are consistent with the measure based on services.

Finally, the standard deviations of consumption by sector are provided in Table 10. For five of the six countries, consumption of the traded good appears to be more volatile than consumption of nontradables. Interestingly, a comparison of the data in Tables 10 and 8 suggests that consumption of traded goods is nearly as volatile or, in some cases, even more volatile than output of

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[15] One problem with using services as a proxy for nontradables is that trade in some types of services has been increasing. In the United States, there is evidence that trade in services has expanded at a rate faster than the increase in output of services. However, most services were generally nontraded in the sample covered by this paper.

[16] The second measure of nontradables includes the categories "rent, fuel and power" and "transportation and communication" reported by the OECD. To the extent that transportation includes the purchase of automobiles, inclusion of this category clearly overstates the importance of nontradables in private consumption. However, since the other categories included in the Kravis-Heston-Summers definition of nontradables are unavailable, we believe that the overall figure underestimates, rather than overestimates, the share of nontradables in consumption.

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traded goods.

The large proportion of nontraded consumption and output is consistent with the relative importance of trade in these economies. On average, trade is about 20 percent of aggregate output (see Table 11). In contrast, a simple model in the tradition of Lucas (1982), abstracting from nontradables, would predict that trade is half of output. Investment is approximately 20 percent of output.

The inclusion of nontraded goods in our theoretical model allows us to consider the co-movements of variables across sectors over the business cycle. The third column of Table 12 shows the correlation between the price of nontraded goods (relative to traded goods) and the ratio of consumption of nontraded to traded goods. We find the correlation to be negative, with the six-country average at -0.42.[17] The magnitude of this correlation proves to be a problem for the model based on productivity shocks alone: In such a setting, an increase in productivity causes an increase in consumption of the good and a large drop in its relative price. The small but positive correlation between the relative price of nontraded goods and the relative output of nontraded goods runs counter to models based on productivity shocks or on taste shocks. Table 12 also reports a strongly positive correlation between consumptions and outputs across sectors.[18]

3. A Two-Sector, Two-Country Model

In this section, we develop a two-sector, two-country model to account for

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[17]The corresponding number for data using the growth-rate filter is -0.2.

[18]Table B9 in Appendix B shows the correlations between consumption and investment with output in Hodrick-Prescott-filtered data and in first-differenced data. Some of these data will be used in evaluating the simulation results.

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the cyclical properties of the data outlined in Section 2. Our research builds on the work in several recent papers on international real business cycles (Dellas, 1986; Backus, Kehoe and Kydland, 1989; Ahmed, Ickes, Wang and Yoo, 1989; Schlagenhauf, 1989; and Baxter and Crucini, 1990).

In this paper, countries are assumed to be linked via trade in some types of consumption goods and trade in financial assets. The model is based on Lucas (1982) as extended to include nontraded goods in Stockman and Dellas (1989), and adds production and investment. We assume that each country is specialized in the production of a tradable commodity and that it produces a nontraded good for domestic consumption and investment. We study the implications of the model for both the behavior of aggregate macroeconomic variables -- including quantities *and* relative prices -- and the co-movements of variables across sectors and across countries. Rather than emphasizing the differences in countries' production structures or factor endowments, we focus instead on the large degree of symmetry in the cyclical behavior of the industrialized countries. To do this, we calibrate the model to an "average" industrialized country. Our model can be thought of as an attempt to capture the dynamic interactions between two similar industrialized economies.

In this setup, each country produces two goods: one for trade in international markets, and a second for domestic consumption and investment. The home country is specialized in the production of good 1 (denoted by Y_t^T, which it produces by combining domestic labor and a capital good specific to that industry:

$$Y_t^T = A_t^T F(K_t^T, N_t^T). \tag{3.1}$$

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Output of the traded good is subject to a random disturbance of total factor productivity, A^T. The economy grows at a constant rate of γ through labor-augmenting technical progress; we assume that the productivity shocks are transitory deviations from this steady-state growth path. Capital depreciates at a rate of δ, so capital and investment are related by:

$$I_t^T = K_{t+1}^T - (1-\delta)\ K_t^T. \tag{3.2}$$

The steady-state level of investment is then related to the trend growth rate and the depreciation rate:

$$I^T = (\gamma + \delta - 1)\ K^T. \tag{3.3}$$

Production of the nontraded good in the home country requires inputs of labor and a specialized capital good, and is also subject to random disturbances to productivity:

$$Y_t^{NT} = A_t^{NT}\ G(K_t^{NT},\ N_t^{NT}). \tag{3.4}$$

Investment and capital in the nontraded-good sector are related by:

$$I_t^{NT} = K_{t+1}^{NT} - (1-\delta)K_t^{NT}. \tag{3.5}$$

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We assume equal rates of technical progress and depreciation of the capital stocks in the two industries.

Labor is mobile between the traded-good and nontraded-good sectors. We normalize each country's population and the endowment of time of the representative household in each country at one, so the labor constraint is

$$N_t^T + N_t^{NT} + L_t = 1. \tag{3.6}$$

The foreign country has symmetric technologies for producing its traded and nontraded goods, and faces a similar labor constraint.

The representative household in the home country derives utility from the consumption of the good produced by domestic firms, c_1, the good produced by foreign firms, c_2, the nontraded good, d, and leisure, L. At date t, the household chooses a lifetime (contingent) plan of consumption and work effort to maximize its expected lifetime utility subject to a wealth constraint:[19]

$$\beta^t E_t \sum_{t=0}^{\infty} u(c_{1t}, c_{2t} d_t, L_t). \tag{3.7}$$

[19] We assume that the household faces a complete contingent claims market. More specifically, contracts can be written contingent on outcomes in both the traded- and nontraded-good industries, which allows the household to insure *partially* against fluctuations in leisure and in the local supply of nontraded goods. The household's wealth constraint has the obvious form for complete contingent markets. Rather than solving for the equilibrium directly, we solve a social planning problem corresponding to the competitive equilibrium in which the countries are assumed to have equal wealths.

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In a similar way, the representative consumer in the foreign country chooses plans for $\{c_1^*, c_2^*, d^*, L^*\}$ to maximize lifetime utility subject to its wealth constraint.

In equilibrium, the world supply of each good must be exhausted by world consumption and investment demand for each good. In the market for the home-produced traded good, output must be equal to consumption of the home good in the two countries, plus investment of the good in next period's production:

$$Y_t^T = C_{1t}^T + C_{1t}^{T*} + I_t^T. \tag{3.8}$$

Equation (3.8) is the symmetric market-clearing condition for the foreign-produced traded good:

$$Y_t^{T*} = C_{2t}^T + C_{2t}^{T*} + I_t^{T*}. \tag{3.9}$$

The equilibrium conditions for the nontraded-good industries require that the domestic supply of the good be exhausted by domestic consumption and investment demand:

$$Y_t^{NT} = d_t^{NT} + I_t^{NT} \tag{3.10}$$

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$$Y_t^{NT*} = d_t^{NT*} + I_t^{NT*}. \tag{3.11}$$

We can solve for the equilibrium allocations of consumption, leisure, work effort and capital inputs by considering the problem facing a social planner who maximizes the expected lifetime utilities of the two representative agents subject to world market-clearing conditions. That is, the planner chooses the levels of consumption and investment of each good to maximize:

$$\max \beta^t E_t \sum_{t=0}^{\infty} [\omega\, u(c_{1t}, c_{2t}, d_t, L_t) + (1-\omega)\, u(c_{1t}^*, c_{2t}^*, d_t^*, L_t^*)] \tag{3.12}$$

subject to equations (3.8) through (3.11). The multiplier on the home country's utility function, ω, is the home country's share of world wealth. We abstract from effects deriving from differences in country size or wealth by setting ω equal to one-half.[20]

The disturbances to technology are assumed to follow an AR(1) process:

$$A_{t+1} = \Omega A_t + \epsilon_t, \tag{3.13}$$

where A is the vector $[A^T, A^{NT}, A^{T*}, A^{NT*}]$ and Ω presents a 4x4 matrix describing the

[20]Agents are assumed to trade contingent claims to pool the world supply of traded goods. National savings (abstracting from capital gains and losses) in the home country are defined as:

$$S_t = P_t(\omega\, Y_t^T - c_{1t}) + P_t^{T*}\, (\omega\, Y_t^{T*} - c_{2t}) + P_t^{NT}(Y_t^{NT} - d_t).$$

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autoregressive component of the disturbance. The contemporaneous component of the shock is described by the vector $[\epsilon^T, \epsilon^{NT}, \epsilon^{T*}, \epsilon^{NT*}]$. The variances of the elements of ϵ reflect the exogenous disturbances to each sector. The covariances between the elements of ϵ reflect the extent to which the shocks are common to industries or countries or are global in nature.

We solve for the nonstochastic steady state of the model and approximate the dynamics of the model in response to exogenous shocks by linearizing the first-order conditions around the steady state, as described in King, Plosser and Rebelo (1988). This approximation yields a system of first-order-difference equations in the capital stocks and the exogenous disturbances; we solve this system for the sequences of prices and capital stocks that are consistent with the transversality conditions. The complete social planner's problem and the system of linearized first-order conditions appear in Appendix C.

4. Calibration of the Model and Results

To compare our theoretical model with the empirical evidence discussed in Section 2, we choose specific functional forms to describe preferences and technology, and estimate parameters for these functional forms consistent with the steady-state behavior of an "average" industrialized country. To capture the dynamics of these economies, we calculate the Solow residuals for a sample of five countries, including Canada, Germany, Italy, Japan and the United States, for the years 1970-1986. We then use the properties of these estimated Solow residuals to run simulations of our theoretical economy.

The parameter values used in the simulations are summarized in Table 13. We calibrate the model to moments of annual data. The growth rate of aggregate

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output is 2.73 percent per annum, the average trend growth of our five-country sample in the 1970-1985 period.[21] The depreciation rate of capital is set equal to 10 percent per annum. The technologies used to produce the traded and nontraded goods are assumed to be Cobb-Douglas:

$$Y_t^i = A_t^i \, K_t^{i(1-\alpha^i)} \, N_t^{i\alpha^i}, \tag{4.1}$$

where α^i equals the average labor share in the seven countries appearing in Table 14.[22] The value of the output of the nontraded-good-producing industry ($P^{NT}Y^{NT}$) is set equal to the value of the output of the traded-good-producing industry (P^TY^T) so that nontraded goods comprise half of output, consistent with the figures in Table 2. These restrictions imply a steady-state allocation of work effort of 52.1 percent to the traded-good industry and 47.9 percent to the nontraded-good industry.

We assume that preferences of the representative household in the home country take the form:

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[21]This is the average of the trend components for the five countries when the trend is calculated with the Hodrick-Prescott filter. The average annual growth rate for the five countries is 3.07 when calculated from first-differenced data.

[22]Table 14 shows the labor shares in the traded- and nontraded-goods industries. Interestingly, for five of the seven countries, the traded-good-producing sector appears to be more labor intensive than the nontraded-good-producing sector. Italy and Japan have the lowest labor shares in both industries, while the United States and the United Kingdom have the highest labor shares.

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$$u(c_{1t},c_{2t},d_t,L_t) = \frac{1}{1-\sigma}\{[(c_{1t}^{\theta}\ c_{2t}^{1-\theta})^{-\mu} + d_t^{-\mu}] - \frac{1}{\mu}\}^{1-\sigma}L_t^{a}. \tag{4.2}$$

This form ensures the existence of a steady state (namely, an allocation of time to work effort and leisure that is constant over time) with continuing labor-augmenting technical change.

Following Kravis and Lipsey (1987, footnote 12, p. 130), we estimate the elasticity of substitution between traded and nontraded goods from the cross-sectional data provided in the World Bank's Income Comparison Project.[23] We find that there is a low degree of substitutability in consumption, with an elasticity of substitution $[1/(1+\mu)]$ of 0.44. The rate of time discount is set equal to 0.96 and the intertemporal elasticity of substitution $(1/\sigma)$ is set equal to 0.5.[24] The intertemporal elasticity of substitution in leisure (1/a) is set equal to -3.173, which is consistent with a steady-state allocation of 20 percent of the time endowment to work effort and 80 percent to leisure.

These parameters determine the steady-state shares of consumption and investment in output of the two goods. The remaining parameter value to be chosen is the share of domestic goods in the domestic consumer's total consumption bundle. This share is difficult to estimate directly from the data; however, under the assumption of complete specialization, the share can be inferred from data on trade flows between the industrialized countries. As

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[23] We calculate the elasticity of substitution between traded and nontraded goods in a sample of 30 countries using data on per capita GDP (World Product and Income, p. 12), expenditure shares on traded and nontraded goods (ibid, p. 194) and price indices for traded and nontraded goods (ibid, p. 196).

[24] Different values of σ result in the expected changes in aggregate consumption and investment behavior, but have little impact on the features of the data studied here.

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discussed in Section 2, since investment is about 20 percent of GDP, about half of investment is allocated to the nontraded-good industry, and nontraded goods are about half of GDP, 40 percent of GDP remains for consumption of traded goods. With perfect pooling of traded goods, this implies that trade is 20 percent of GDP, which is consistent with the data. The volume of trade implied by our model is

$$\frac{Trade}{GNP}=(1/2)\theta(1-s_i^T), \tag{4.3}$$

where "trade" is defined as the average of exports plus imports and s_i^T is the investment share in total output of the domestic traded good. Referring back to Table 11, the bottom rows indicate the trade flows implied by different trade shares. Interestingly, a share equal to 0.5, i.e., equal shares of the home-traded good and the foreign-traded good in each country's consumption bundle, has the closest fit to the volume of trade in these countries.[25]

The technology shocks to the two industries display a low degree of persistence when calculated from Hodrick-Prescott-filtered data.[26] The estimated autocorrelation matrix for the vector of shocks $[A^T, A^{NT}, A^{T*}, A^{NT*}]$ is

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[25]Our model does not address the fact that the share of trade in GDP has been growing over time in most countries, but treats the volume of trade in output as a constant. Our model does, however, suggest that in the presence of nontraded goods and specialized production, the long-run share of trade in output is likely to level off at a number significantly less than one-half.

[26]The estimated autocorrelation and variance-covariance matrices based on data that are log-linear detrended are reported in Appendix D.

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$$[\Omega] = \begin{vmatrix} .154 & .040 & -.199 & .262 \\ -.015 & .632 & -.110 & .125 \\ -.199 & .262 & .154 & .040 \\ -.110 & .125 & -.015 & .632 \end{vmatrix} \qquad (4.4)$$

The degree of autocorrelation is quite low, especially in the traded-good industry. The estimated variance-covariance matrix of the contemporaneous component of the shock is

$$V[\epsilon] = \begin{vmatrix} 3.62 & 1.23 & 1.21 & 0.51 \\ 1.23 & 1.99 & 0.51 & 0.27 \\ 1.21 & 0.51 & 3.62 & 1.23 \\ 0.51 & 0.27 & 1.23 & 1.99 \end{vmatrix} \qquad (4.5)$$

The disturbances to the traded-good industry are nearly twice the magnitude of the shocks to the nontraded-good industry. There is little evidence that disturbances are readily transmitted abroad, and no evidence that industry-specific disturbances are more prominent than country-specific disturbances. The correlation between innovations to the traded-good sectors in the two countries is 0.33, while the correlation between innovations to the nontraded-good sectors is 0.14. Country-specific innovations (across sectors within a country) appear to be slightly more significant, with a cross-sector correlation of 0.46.

The results of simulations of the model given these disturbances to technology are shown in Table 14. The numbers in the column labeled "Data" are five-country averages of the standard deviations or correlations presented in the tables referenced in Section 2. We will evaluate our model in terms of these cross-country averages. Centered 95 percent confidence intervals for those data

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appear in parentheses.[27]

The results marked Case 1 show the implications of the model driven by Solow residuals as technology shocks. The standard deviations of aggregate variables match the data fairly closely, though the standard deviation of consumption is only three-fourths its size in the data (this is well within the centered two-standard-deviation band). The standard deviations of traded-good aggregates indicate two types of problems: Investment in the traded-good sector is roughly 30 percent too volatile, and the standard deviation of consumption is much too small (only one-third of its mean in the data). The standard deviation of output of nontraded goods is larger in the model than in the data, while the standard deviation of consumption of nontraded goods is again well below its mean in the data. In general, the model matches the standard deviations of the data reasonably well; however, the model implies a much lower variability in consumption than appears in the data.[28]

The model delivers a good approximation of the correlation between consumption and output, though it overpredicts the correlation between investment and output. It also matches the correlation between consumption of traded and nontraded goods. Although the model implies a correlation of output in the two sectors that is smaller than the mean in the data, the result is within the two-standard-deviation band.

Table 14 also shows that the correlation between the aggregate average product of labor (APL) and output is, on average for the five countries, 0.76.

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[27]These intervals ignore sampling error in estimating the moments reported in the earlier tables. The cases with asterisks are those in which an outlying observation has been omitted.

[28]Taste shocks are an obvious potential solution to this problem, as we demonstrate below.

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This correlation ignores variation in hours worked, so it overstates the appropriate correlation by about 10 percent.[29] The model implies a correlation of 0.69, thereby matching this feature of the data. This is an important result because the correlation implied by most closed-economy real business cycle models is too high to match the data.

The model fails when it is confronted by price data. The model predicts that the correlation between the relative price of nontraded (to traded) goods and the relative consumption of nontraded (to traded) goods is *minus one*; the correlation is -0.42 in the data, with a two-standard-deviation band between -0.12 and -0.71. The technology shocks driving the model act mainly as relative supply shocks, leading to shifts in supply curves along rather stable (relative) demand curves. The data suggest a combination of shifts in the relative supply and the relative demand curves. The same problem arises in matching the correlation between the relative price and relative outputs of traded and nontraded goods.

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[29]There are several reasons that the 0.76 correlation (which is a five-country average) is above the 0.33 correlation for the United States shown in Prescott (1986). First, Prescott excludes farm labor, though farm output is included in overall output. Second, we use a longer sample. These changes alone raise the U.S. correlation from 0.33 to 0.52. Third, our Table 14 reports statistics on annual rather than quarterly data. For the United States, this raises the correlation from 0.52 to 0.76. Fourth, we lack data on variations in hours, so our labor series is employment. In the United States, using employment rather than total hours raises the correlation from 0.76 to 0.87. (At a quarterly frequency, it raises the correlation from 0.52 to 0.79.) So, based on U.S. data, our use of employment rather than hours implies about a 10 percent overstatement of the correlation. Hours variation appears to be much more important relative to employment variation in the other countries in our sample; see, e.g., Kennan (1987). So, because the labor input appropriate to our theoretical model is total hours, we would like the model to imply a correlation that is no more than 10 percent smaller than the 0.76 correlation appearing in Table 14, and ideally, smaller than that. Though the model in Case 1 matches this 10 percent reduction, the other cases discussed below imply smaller correlations that appear to be more consistent with the average experience in our sample.

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In terms of international data, the model does a good job of matching the correlation between aggregate output across countries. However, it overpredicts the cross-country correlation of consumption by more than 50 percent. The model slightly overstates the correlation between savings and investment, but is within the two-standard-deviation band. It does quite well at matching the correlation between output and the balance of trade, though it understates the countercyclical nature of the current account.[30] The model's predictions for the standard deviations of trade variables -- the terms of trade, trade balance and current account -- are much too low.

Overall, the model driven by Solow residuals has several problems. One of these problems, the high cross-country correlation of consumption, was already known to be present in one-sector models. This observation motivated our disaggregation into traded and nontraded sectors; this disaggregation introduced a number of new dimensions for testing the model. While the disaggregated model provides more reasonable predictions for the correlation between consumptions across countries, the countercyclical behavior of the trade balance and the current account, and the correlations between quantities across sectors, the model fails to predict the magnitude of the variability of consumption and the co-movements between quantities and prices. The next section shows that some, though not all, of these problems vanish if the model is subject to taste shocks as well as productivity shocks.

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[30]The model's ability to produce strongly countercyclical movements in the trade balance and the current account is a direct consequence of the incorporation of nontraded-goods production and the complementarity between consumption of traded and nontraded goods. In one-sector models, the trade balance is generally found to be procyclical.

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5. The Effects of Taste Shocks

Table 14 shows simulation results in which the model is subjected to six different kinds of taste shocks (labeled Cases 2 through 7), as well as to technology shocks. The economy is identical to the model in Section 4, except that the utility function is now

$$u(c_{1t},c_{2t},d_t,L_t) = \frac{1}{1-\sigma}\{[((\tau_{1t}+c_{1t})^{\theta}(\tau_{2t}+c_{2t})^{1-\theta})^{-\mu} + (\tau_{3t}+d_t)^{-\mu}]^{-\frac{1}{\mu}}\}^{1-\sigma}L_t^{a},$$

where τ (for i = 1,2,3) is a positive random variable with mean zero representing a taste shock. There are three analogous taste shocks for the representative foreign household. We assume that taste shocks are independent across countries, that they are independent of technology shocks, and that the vector $\tau = (\tau_1,\tau_2,\tau_3)$ follows a first-order autoregressive process. Table 15 shows the matrix of autoregression coefficients and the covariance matrix of the disturbances in each case. The form of the taste shocks has a simple interpretation: A unit increase in τ_1 lowers marginal utility of good one by the same amount as would a unit increase in c_1.

In addition to technology shocks, Case 2 subjects the model to taste shocks for the home-produced traded good. We assume that the variance of τ_1 and the corresponding taste shock in the foreign country (for their home-produced traded good), τ_1^*, are the same as the variances of the Solow residuals for traded-good production. In this sense, Case 2 considers taste shocks that are of the same magnitude as the technology shocks. However, when the autocorrelation matrix of

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taste shocks is set equal to that of technology shocks, the standard deviations of consumption remain much too low in the model relative to the data. Therefore, the figures reported for Case 2 correspond to taste shocks with an autocorrelation of 0.9 (per year).

Adding these taste shocks for home-produced traded goods raises the standard deviation of consumption of traded goods to about its size in the data. It also raises the standard deviation of labor in the traded sector. These shocks have little effect on the nontraded sector, despite the complementarity between traded and nontraded goods in consumption. The taste shocks raise the correlation between the relative price and the relative consumption of nontraded goods from -1 to -0.45, which is much closer to the mean of the data. Adding the taste shocks also raises slightly the correlation between the relative price and the relative output of nontraded goods. The taste shocks reduce the cross-country correlation of consumption in half, from 0.78, which was above the two-standard-deviation band, to 0.39, which is within that band. This kind of taste shock does not improve the model's performance for the standard deviation of the terms of trade or trade balance. However, it does raise the standard deviation of output to within the two-standard-deviation band of the data. Not surprisingly, the shock also results in a correlation between consumption of traded and nontraded goods that is too small.

Case 3 shows the results of making the taste shocks much smaller but more autocorrelated. In this case, the variance of the taste shocks is one *one-hundredth* the magnitude of the traded-sector Solow residuals. The shocks are nearly permanent, with an autocorrelation of 0.999. Interestingly, the results of Case 3 are very similar to those of Case 2.

Case 4 considers taste shocks for the nontraded good (along with technology

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shocks). As in Case 2, we set the variance of the taste shocks for each good equal to the variance of the Solow residuals in that sector. We also set the autocorrelation of the taste shocks equal to that of the Solow residuals. In this sense, the taste shocks and technology shocks are the same size.

The nontraded-good taste shocks in Case 4 affect standard deviations mainly in the nontraded-good sector. The standard deviations of consumption and labor in that sector are closer to the mean in the data. The correlation between the relative price and relative consumption of nontraded goods rises from -1 to -0.54. The cross-country correlation of consumption falls, but still remains above the mean in the data. The standard deviations of the trade variables are too low, the correlations of consumption and output across sectors are too low, and the standard deviation of consumption of traded goods is much too low.

Case 5 combines the taste shocks from Cases 2 and 4 by setting the taste shocks for each good equal in size to the productivity shocks in the two sectors. Case 5 assumes that these shocks are uncorrelated across sectors but are positively autocorrelated. The standard deviations of consumption -- in the aggregate and in each sector -- are now close to the mean in the data. The cross-country correlation of consumption is closer to its mean in the data, as are the correlations of consumption, investment, the trade balance and current account with output. The correlation of savings and investment also gets closer to its mean in the data. As in Cases 2 and 3, the standard deviation of the current account is within the two-standard-deviation band in the data.

There are a number of problems with the combined shocks considered in Case 5. Aggregate labor is too volatile relative to the data, investment in the traded-good sector continues to be too volatile, the correlations of output and consumption across sectors are too small, the standard deviations of the terms

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of trade and trade balance are too small, and the correlation of the relative price of nontradables with relative output continues to be too small.

Case 6 repeats the pattern of taste shocks for both goods considered in Case 5, but makes these shocks more correlated across sectors. The contemporaneous correlation is set at 0.5. The primary result is an increase in the correlation of consumption across sectors. Otherwise, the results are similar to those of Case 5.

Case 7 reduces the variance of the taste shocks to one one-hundredth of their size in Case 5, and adds higher autocorrelation. The results are better in some respects than in Cases 5 and 6, and not as good in other respects.

Impulse-Response Functions

The intuition for some of these results becomes clearer by studying the impulse-response functions of macroeconomic variables following a one-time disturbance to tastes and technology. Figures 3 through 6 show the dynamic responses of consumption, work effort and investment to a 1 percent (above steady state) change in productivity and consumer preferences for traded and nontraded goods. Both types of shocks are assumed to die out at a rate of 20 percent per year (i.e., $\rho = 0.8$). The shocks occur only in the home country; the top graphs show the resulting dynamics in the home country and the bottom graphs show the response in the foreign country.

Figures 3a and 3b show the responses in the two countries to a disturbance in the traded-good-producing sector in the home country. At the time of the productivity disturbance, work effort in the traded-good sector rises in response to the higher marginal product of labor and then gradually decreases as capital investment in that sector rises. Consumers in both countries consume more of the

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home country's traded good and substitute away from the foreign country's traded good. Nontraded-good consumption rises in both countries due to the complementarity between traded and nontraded goods.

When the productivity shock occurs in the nontraded-good sector (Figures 4a and 4b), the response of consumption is quite different. Consumption of the nontraded good rises in the home country, along with investment of the nontraded capital good. Labor again shifts out of the high-productivity sector, resulting in an increase in leisure and in greater effort in the traded-good sector. The consequent increase in output of the home country's traded good leads to an increase in consumption of that good in both countries.

Figures 5a and 5b reveal that the dynamics following a taste shock are markedly different from the smooth, bell-shaped curves that follow a productivity shock. The primary effects are on consumption and work effort; since the shock in these experiments is "unanticipated" and rapidly diminishes, there is no incentive for building up the capital stock to respond to the changes in demand. Work effort rises in the sector where the demand shift occurs and falls in the other sector. Interestingly, labor rises in the foreign country's traded-good sector: Foreign consumers shift out of the now more expensive domestic traded good, increasing demand for their own traded good.

Figures 6a and 6b show the response to an increase in home demand for the domestic nontraded good. In this case, domestic consumers must increase domestic output of the nontraded good in order to meet demand. Work effort in the nontraded-good sector rises dramatically and falls in the traded-good sector. As a result, output of the domestically produced traded good falls and consumption of the good decreases in both countries. Foreign-country labor shifts into the traded-good-producing sector as consumers substitute toward c_2

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and away from c_1.

Overall, the results of these simulation experiments indicate that taste shocks improve the fit of the model. Of course, it is easy to improve the fit when there are free parameters with which to play. However, the central issues are whether certain types of exogenous shocks, like taste shocks, are required to explain that data and, if so, what the nature of those shocks must be. It seems clear that some features of the data cannot be explained by the model with productivity shocks alone. Those shocks cannot explain the high standard deviations of consumption, the fact that the correlation between the relative price and the relative consumption of nontraded goods is so far from -1, or the low correlation between consumptions across countries. Taste shocks, or something like them, seem to be required. These shocks may result from government policies rather than from changes in tastes, or they may result from changes in household production technology. The disturbances must affect mainly consumption, however, and not investment: Investment is already volatile enough in the pure technology-shock model of Case 1.[31]

Although we have shown that taste shocks of a particular form can improve the performance of the model along certain dimensions, there are three dimensions along which the model fares poorly. First, our model does not explain the high standard deviations of the terms of trade or balance of trade, though the model performs better for explaining the standard deviation of the current account. Second, we have not explained the positive correlation between the relative price of nontraded goods and relative output (though the taste shocks help in this

[31] If what we have called taste shocks are really the results of fiscal or monetary policies, it appears that those policies must have their main effects on consumption rather than on investment!

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dimension). Third, the taste shocks we have added are inconsistent with the observed high cross-sectoral correlations of consumption and output.

6. Conclusion

We have constructed and simulated a neoclassical macroeconomic model of a two-country world. The model matches most of the key features of the data. In particular, our model is consistent with the observations that the cross-country correlation of consumption is smaller than that of output, and that the cross-country correlation of output exceeds that of the Solow residuals. The model is also broadly consistent with the standard deviations of main economic aggregates and with those same variables in the traded- and nontraded-good sectors. The model is consistent with the correlations between aggregate output and investment, consumption and the trade balance. It is also consistent with the correlation between the relative price and the relative consumption of nontraded and traded goods.

To match the data, we required a model with shocks to *tastes* as well as to technologies. The disturbances that we have interpreted as taste shocks may actually result from shocks to technology in the household or from fiscal or monetary policies. But we require *some* form of disturbance that, like a taste shock, acts mainly to shift intersectoral demand in order to explain certain features of the data that cannot be explained by the technology-shock model.

There are, however, three main observations that our model does not explain: the intranational correlation between quantities in the traded and nontraded sectors, the correlation between relative quantities and relative prices in those sectors, and the standard deviations of the trade variables. The first two of these observations deal with issues suggested by our disaggregation

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into traded and nontraded sectors. It appears that while some form of taste shock (or disturbance with similar effects) is required to explain the data, we have not yet identified the precise form that those shocks must take.

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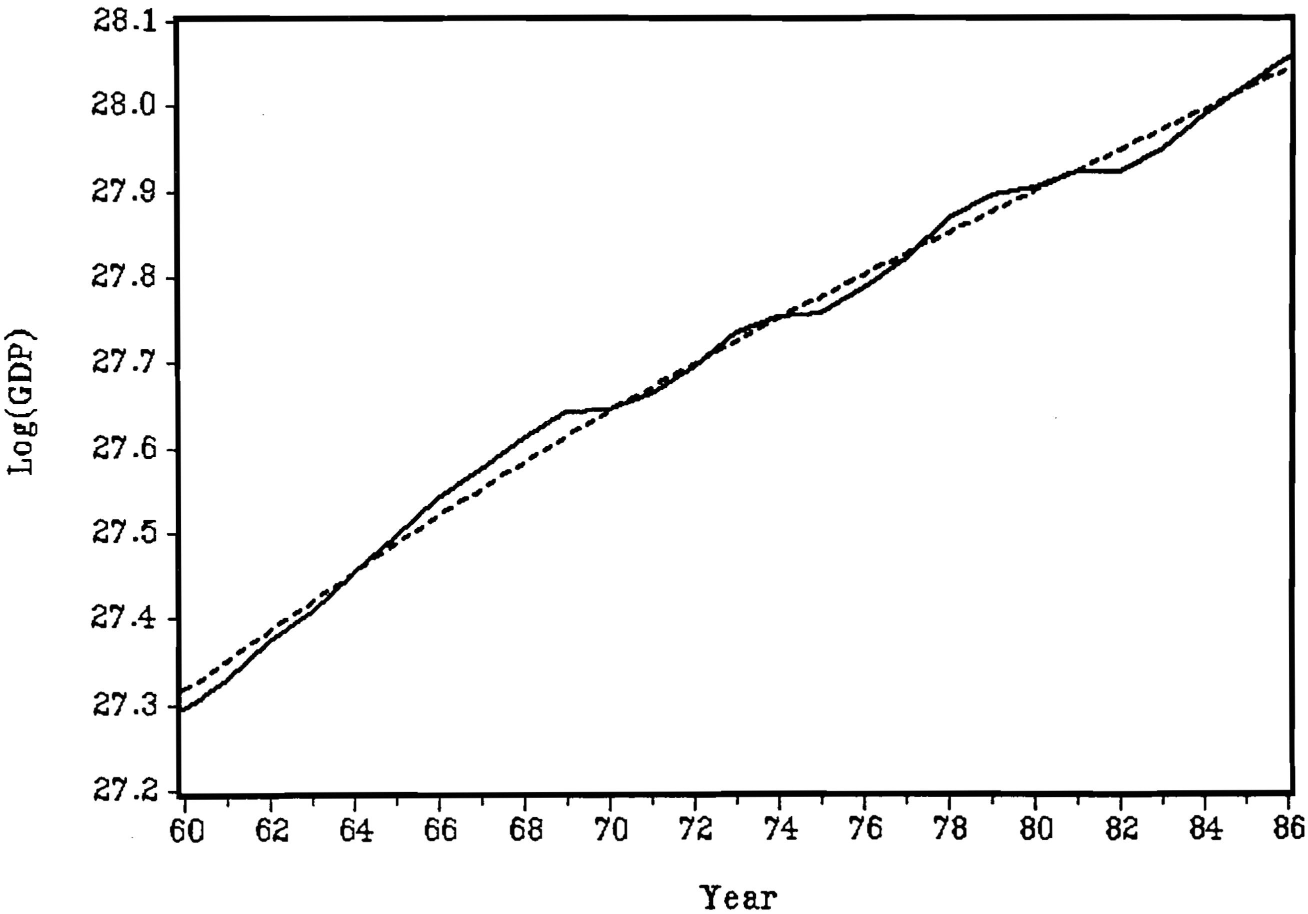
Figure 2: U.S. Output of Nontraded Goods - Hodrick-Prescott Filter



Source: Authors' calculations.

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Figure 4a: Home-Country Response to Nontraded–Good Productivity Shock (A^{NT})

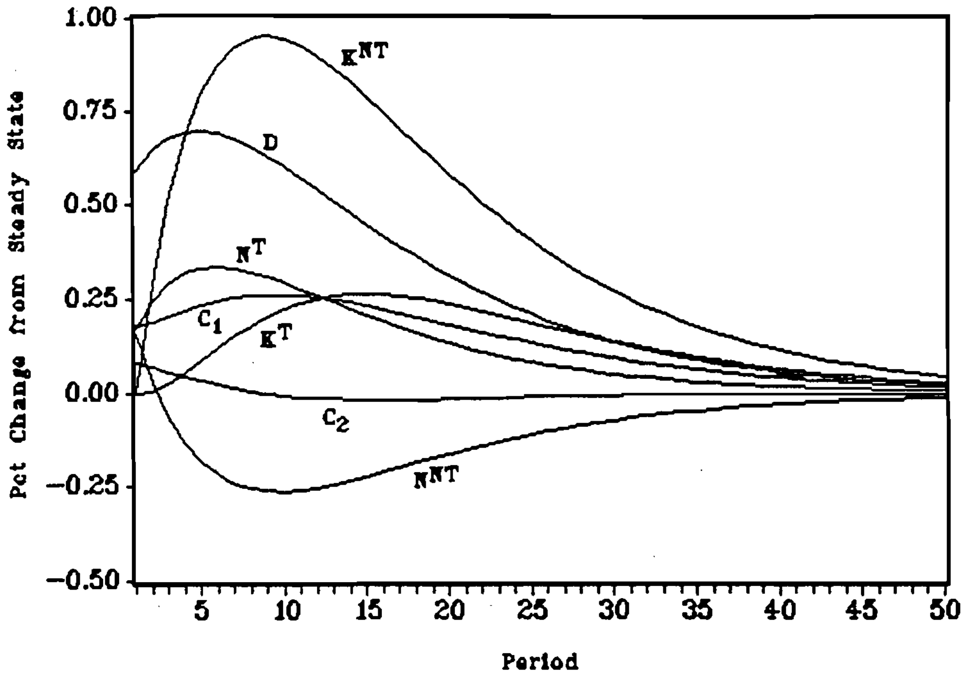
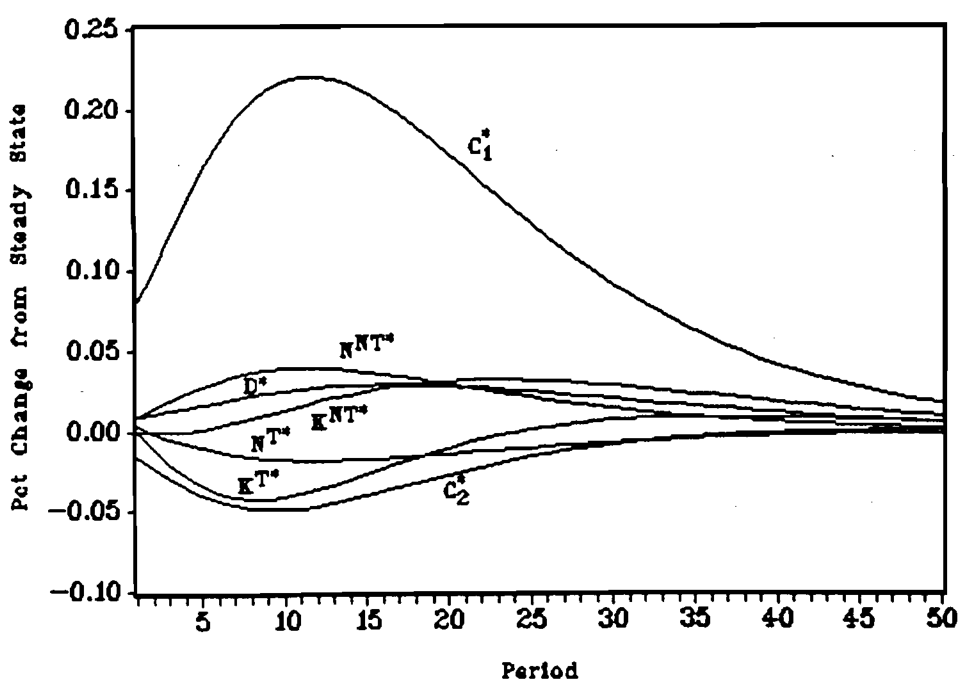


Figure 4b: Foreign-Country Response to Nontraded–Good Productivity Shock (A^{NT})



Source: Authors' calculations.

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Figure 3a: Home-Country Response to Traded–Good Productivity Shock (A^T)

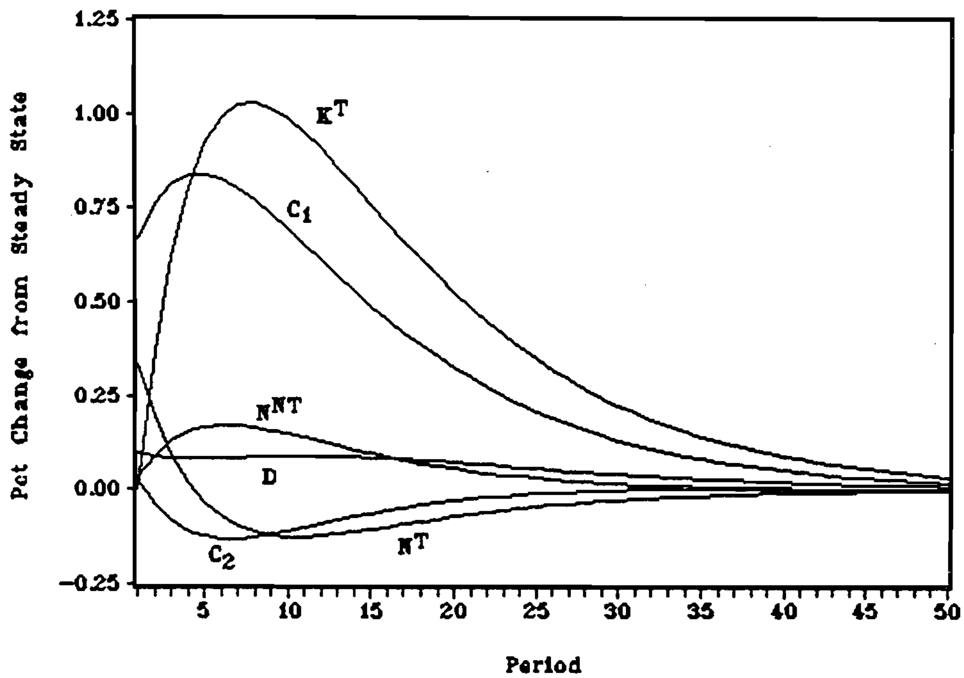
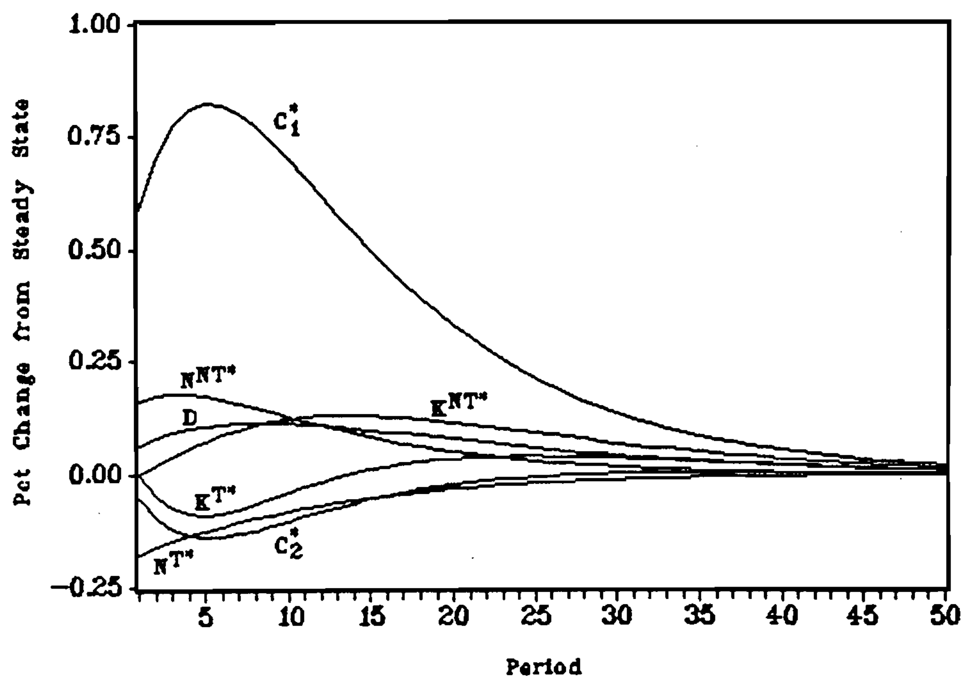


Figure 3b: Foreign-Country Response to Traded–Good Productivity Shock (A^T)



Source: Authors' calculations.

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Figure 6a: Home-Country Response to Nontraded–Good Taste Shock (τ_3)

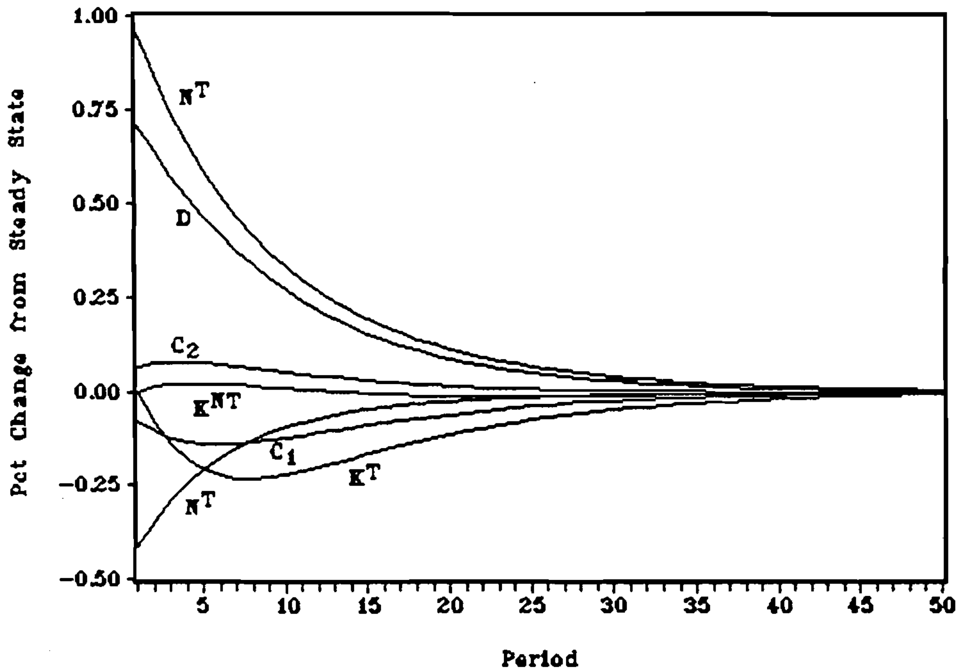
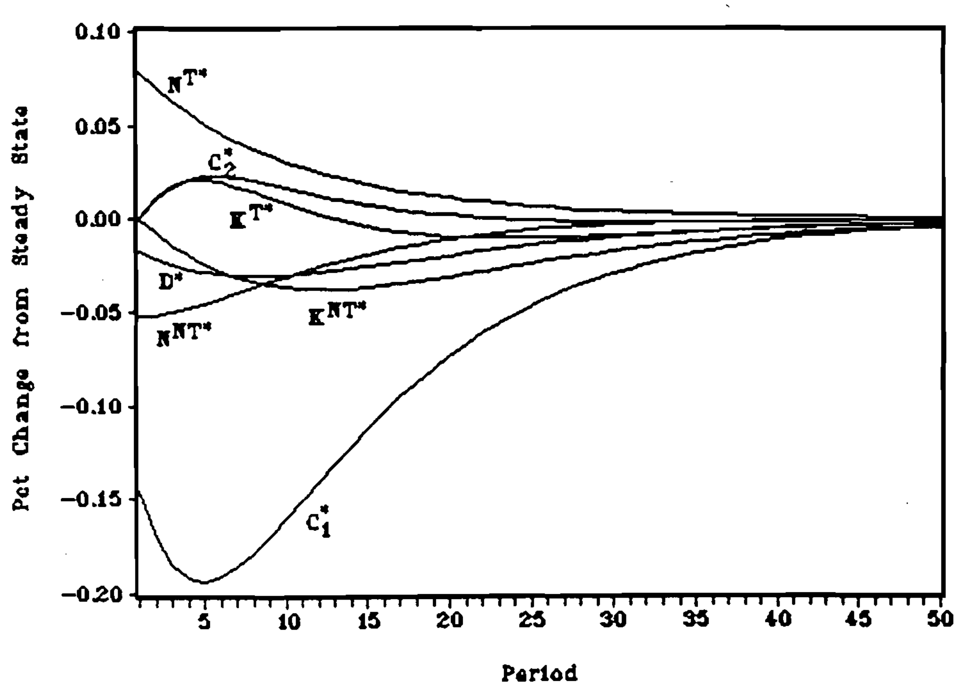


Figure 6b: Foreign-Country Response to Nontraded–Good Taste Shock (τ_3)



Source: Authors' calculations.

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Figure 5a: Home-Country Response to Traded–Good Taste Shock (τ_1)

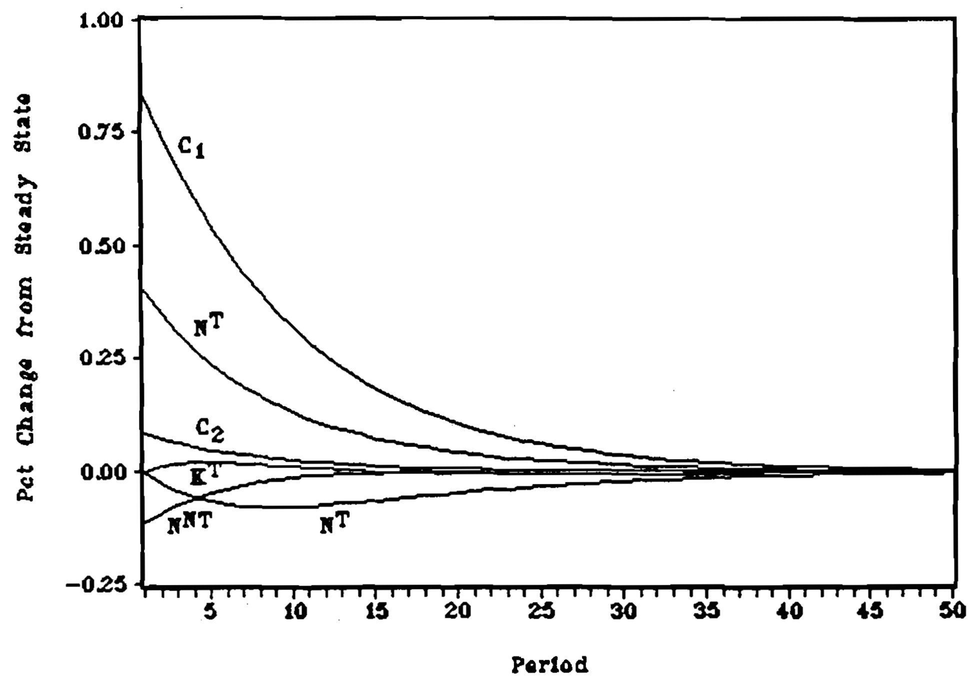
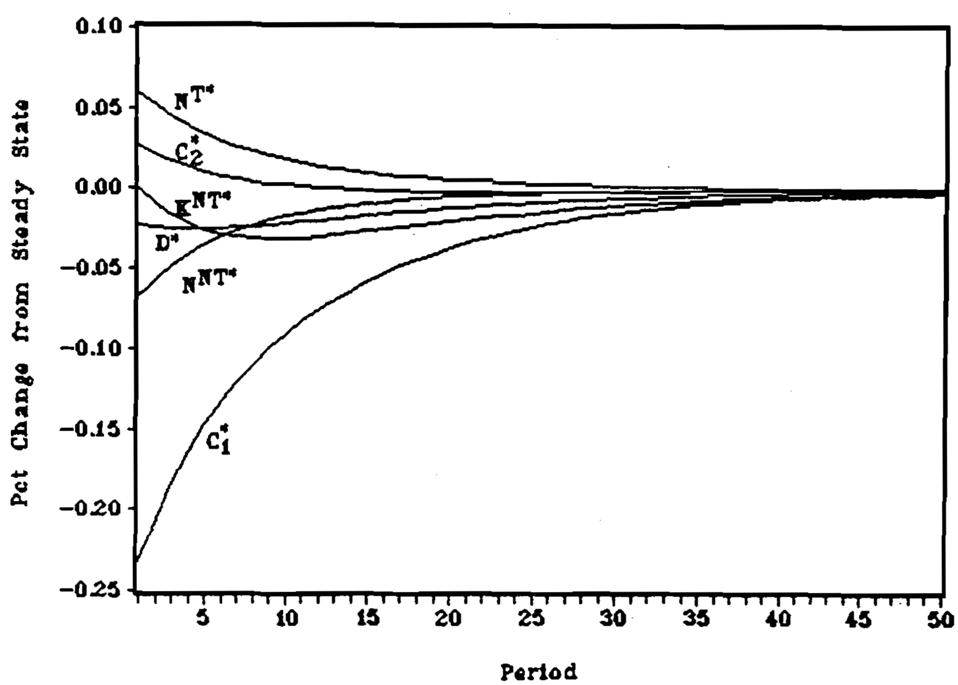


Figure 5b: Foreign-Country Response to Traded–Good Taste Shock (τ_1)



Source: Authors' calculations.

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Table 1: Cross–Country Correlations of Output and Productivity

A. Correlations of Output (1971–1988)

	CANADA	JAPAN	GERMANY	ITALY
USA				
Agg	.679	.525	.858	.571
T	.737	.379	.839	.479
NT	.318	.530	.713	.623
CANADA				
Agg		.437	.694	.711
T		.468	.604	.563
NT		.363	.492	.645
JAPAN				
Agg			.618	.477
T			.344	.409
NT			.859	.501
GERMANY				
Agg				.835
T				.809
NT				.795

B. Correlations of Solow Residuals (1971–1984)

	CANADA	JAPAN	GERMANY	ITALY
USA				
Agg	.718	.441	.570	.454
T	.770	.092	.346	.193
NT	.546	–.212	.299	.704
CANADA				
Agg		–.017	.238	.329
T		.088	.245	.193
NT		.040	.304	.644
JAPAN				
Agg			.473	–.249
T			.275	.129
NT			.688	–.435
GERMANY				
Agg				.352
T				.417
NT				–.095

Source: Output and Solow residuals from OECD International Sectoral Data Base. All data are detrended using the Hodrick–Prescott filter.

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Table 2: Cross–Country Correlations in Consumption

A. Correlations of Aggregate Consumption (1970–1988)

	CANADA	FRANCE	ITALY	U.K.
USA	.442	.103	–.581	.533
CANADA		.751	–.233	.295
FRANCE			.001	.025
ITALY				–.003

B. Correlations of Aggregate, Private Final Consumption and Consumption of Traded and Nontraded Goods (1971–1987)

	CANADA	FRANCE	JAPAN	U.K.
USA				
	.348	.028	.235	.534
	.531	.359	.458	.595
	.417	.204	.140	.625
	.753	.503	.197	.412
CANADA				
		.754	.625	.485
		.744	.501	.329
		.614	.488	.476
		.624	.193	.075
FRANCE				
			.822	.419
			.808	.375
			.562	.458
			.412	–.079
JAPAN				
				.724
				.701
				.265
				–.067

Source: Part A is based on IFS annual data. Part B is based on data from the OECD Quarterly Accounts, which are annualized by averaging. All data are detrended using the Hodrick-Prescott filter.

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Table 3: Average Labor Shares

(Standard deviations in parentheses)

	Period	Aggregate	Traded	Nontraded
CANADA	1970–1984	.650 (.018)	.633 (.023)	.670 (.024)
FRANCE	1977–1989	.570 (.006)	.646 (.011)	.496 (.007)
GERMANY	1970–1985	.593 (.014)	.641 (.022)	.533 (.026)
ITALY	1960–1985	.500 (.047)	.482 (.061)	.529 (.027)
JAPAN	1970–1985	.530 (.038)	.544 (.044)	.513 (.033)
UNITED KINGDOM	1970–1985	.645 (.025)	.680[a] (.040)	.604 (.012)
UNITED STATES	1960–1985	.631 (.013)	.661 (.012)	.597 (.022)

a. Average for the period 1960–1985.

Source: OECD International Sectoral Data Base.

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Table 4: Correlations between Savings, Investment, Trade Balance, Current Account and Output

	$Corr(\hat{S},\hat{I})$	$Corr(\hat{TB},\hat{Y})$	$Corr(\hat{CA},\hat{Y})$	Corr(TOT[a],Y)	Corr(TOT[a],TB)
CANADA					
60–88	.889	–.647	–.500	.298	.092
70–88	.896	–.714	–.547	–.315	.038
FRANCE[b]					
60–88	.860	.062	.080	–.384	–.335
70–88	.871	.208	.163	–.391	–.646
ITALY					
61–87	.472	–.444	–.787	.214	–.379
70–87	.430	–.257	–.719	.160	–.390
UNITED KINGDOM					
60–88	.669	–.515	–.537	.093	–.680
70–88	.630	–.523	–.540	.143	–.757
UNITED STATES					
60–88	.904	–.379	–.510	–.412	.589
70–88	.893	–.392	–.522	–.372	.588

a. Terms of trade data available through 1987.
b. Savings for France is measured as GDP less aggregate consumption, since annual GNP data were not reported in the IFS.

Source: Columns 1, 2 and 3 are from IFS annual data. Terms of trade is defined as the ratio of the import deflator to the export deflator. Terms of trade data are taken from the OECD Main Economic Indicators. All series are detrended using the Hodrick-Prescott filter.

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Table 5: Correlations of Output, Consumption and the Trade Balance with the Real Exchange Rate, 1970–1987

A. Output

GDP	CAN	FRA	ITA	GBR	USA
CAN	–	.584	.256	–.112	–.445
FRA	–.687	–	–.548	–.530	–.769
ITA	–.431	.348	–	–.340	–.571
GBR	.528	.677	.643	–	.457
USA	.256	.480	.448	.018	–

B. Consumption

Cons	CAN	FRA	ITA	GBR	USA
CAN	–	.551	.210	.037	–.555
FRA	–.533	–	–.746	–.317	–.616
ITA	–.236	.112	–	–.426	–.116
GBR	.726	.671	.683	–	.582
USA	.357	.380	.415	.076	–

C. Trade Balance

TB	CAN	FRA	ITA	GBR	USA
CAN	–	–.551	–.388	.212	.487
FRA	–.030	–	.280	.078	.009
ITA	–.146	.051	–	.062	.087
GBR	–.338	–.186	–.189	–	–.123
USA	.061	.332	.165	–.236	–

Source: IFS annual data, 1970-1988. Output, consumption and the real exchange rate are Hodrick-Prescott filtered. The trade balance is measured as exports less imports, where both series are Hodrick-Prescott filtered. The real exchange rate is defined as the ratio of the domestic Consumer Price Index to the exchange-rate-adjusted foreign Consumer Price Index.

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Table 6: Standard Deviations of International Variables

Country	Time Period	TOT	CPI	TB	CA
CANADA					
	60–88	3.27	5.05	4.71	4.54
	70–88	3.94	5.59	5.41	4.86
FRANCE					
	60–88	4.87	5.77	4.64	3.55
	70–88	5.83	6.43	4.31	3.93
ITALY					
	61–87	5.80	9.43	8.86	10.17
	70–87	6.91	10.21	8.44	9.35
UNITED KINGDOM					
	60–88	4.48	9.36	5.86	6.85
	70–88	5.43	10.49	6.96	8.19
UNITED STATES					
	60–88	5.36	5.21	6.95	3.49
	70–88	6.19	5.60	8.02	4.02

Source: Column 1 is taken from the OECD Main Economic Indicators. Columns 2 through 4 are taken from IFS. All data are detrended using the Hodrick-Prescott filter.

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Table 7: Shares of GDP by Sector, 1984

	CAN	FRA	GER	ITA	JAPAN	U.K.	U.S.
Agriculture	.03	.04	.02	.05	.03	.02	.02
Manufacturing	.19	.25	.33	.27	.29	.23	.21
Mining	.06	n.a.	.01	n.a.	.0	.08	.03
Retail[a]	.13	.14	.11	.15	.14	.12	.17
Transportation[b]	.07	.05	.06	.07	.06	.07	.06
Traded	.50	.48	.53	.54	.53	.52	.50
Electricity, Gas and Water	.03	.05	.03	.05	.03	.03	.03
Construction	.06	.06	.06	.08	.07	.06	.05
Finance, Insurance and Real Estate	.19	.19	.13	n.a.	.15	.19	.22
Private Services[c]	.05	.09	.13	.19	.13	.05	.09
Gov't. Services	.16	.13	.12	.14	.08	.15	.12
Nontraded	.50	.52	.47	.46	.47	.48	.50

a. Includes wholesale and retail trade, restaurants and hotels.
b. Includes transport, storage and communication.
c. Includes community, social and personal services.
Source: OECD International Sectoral Data Base.

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Table 8: Volatility of Macroeconomic Variables

A. Standard Deviations of Annual Time Series (1970-1986)

	Output	Solow Residuals[a]	Capital	Labor	Investment
CANADA					
Agg	3.35	3.15	3.36	2.57	7.29
T	5.00	3.92	2.55	3.32	9.74
NT	2.73	2.29	3.72	2.14	5.98
GERMANY					
Agg	1.95	1.50	2.79	1.60	5.25
T	2.24	1.64	2.79	1.77	6.51
NT	1.93	1.73	3.15	1.52	5.59
ITALY					
Agg	2.37	2.60	2.58	1.01	5.28
T	3.03	2.69	2.01	1.73	6.18
NT	1.55	2.90	3.82	.66	6.19
JAPAN					
Agg	2.29	2.07	3.27	.90	3.67
T	3.00	2.70	3.40	1.30	5.08
NT	2.40	2.05	3.42	1.20	5.95
U.S.					
Agg	2.69	1.60	2.82	1.96	6.18
T	3.99	2.74	1.76	2.72	7.59
NT	1.47	1.94	4.07	1.26	8.83
5-COUNTRY AVERAGE					
Agg	2.53	2.18	2.96	1.61	5.53
T	3.45	2.74	2.50	2.17	7.02
NT	2.02	2.18	3.64	1.36	6.26

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Table 8: Volatility of Macroeconomic Variables (cont.)

B. Ratio of Standard Deviations of Variables to the Standard Deviations of Output

	Solow Residuals[a]	Capital	Labor	Investment
CANADA				
Agg	.94	1.00	.77	2.18
T	.78	.51	.66	1.95
NT	.84	1.36	.78	2.19
GERMANY				
Agg	.77	1.43	.82	2.69
T	.73	1.25	.79	2.91
NT	.90	1.63	.79	2.90
ITALY				
Agg	1.09	1.09	.43	2.23
T	.89	.66	.57	2.04
NT	1.87	2.46	.43	3.99
JAPAN				
Agg	.90	1.43	.39	1.60
T	.90	1.13	.43	1.69
NT	.85	1.43	.50	2.98
U.S.				
Agg	.59	1.05	.73	2.30
T	.69	.44	.68	1.90
NT	1.32	2.77	.86	5.16

a. The Solow residuals are estimated from capital, labor and output data, which are detrended using the Hodrick-Prescott filter.

Source: OECD International Sectoral Data Base. Data are detrended using the Hodrick-Prescott filter. Standard deviations are calculated over the period from 1970 to the last available observation.

Table 9: Shares of Nontraded Goods in Consumption

A. Services as a Share of Private Final Consumption

	60:1–69:4	70:1–79:4	80:1–88:4
CANADA	.379	.415	.455
FRANCE	.379	n.a.	.386
ITALY	n.a.	n.a.	.328
JAPAN[a]	n.a.	.450[b]	.497
UNITED KINGDOM	.294	.334	.398
UNITED STATES	.421	.455	.508
UNITED STATES[c]	n.a.	.523	.558

B. Expenditure on Nontradables[d] as a Share of Private Final Consumption

	60:1–69:4	70:1–79:4	80:1–88:4
CANADA	n.a.	n.a.	n.a.
FRANCE	.225[e]	n.a.	.350
ITALY	n.a.	n.a.	.271
JAPAN	n.a.	.249	.280
UNITED KINGDOM	.189	.223	.259
UNITED STATES[f]	.363	.392	.443

a. Private final consumption includes net direct purchases abroad and gifts.
b. Average for the period 1975:1-1979:4.
c. Data from Citibase; expenditure on services (private plus government) as a share of total consumption.
d. Expenditure on "rent, fuel and power" and "transportation and communication" used as proxies for expenditure on nontradables.
e. Average for the period 1966:1-1974:4.
f. Based on Citibase data. Calculated as the share of clothing and shoe repair, personal care (barbershops, etc.), housing, household utilities, medical care, personal business, auto repair, local and intercity public transportation, and education expenditures in total personal consumption expenditures.

Source: OECD Quarterly Accounts.

Table 10: Standard Deviations of Consumption

Country	Time Period	Aggregate	Private Final Consumption	Traded	Nontraded
CANADA	60–88	2.34	2.07	4.10	2.88
	70–88	2.71	1.83	4.97	3.38
FRANCE	60–88	1.62	n.a.	n.a.	1.81
	70–88	1.59	1.47	2.12	1.89
ITALY	60–87	2.13	n.a.	n.a.	n.a.
	81–87	1.20	1.38	1.64	0.87
JAPAN	61–88	2.74	n.a.	n.a.	3.06
	71–87	2.91	1.94	3.07	3.27
GREAT BRITAIN	60–88	2.05	n.a.	n.a.	2.71
	70–88	2.48	3.72	3.35	3.31
UNITED STATES	60–88	2.24	1.16	2.80	1.91
	70–88	1.95	1.21	3.10	2.06

Source: OECD Quarterly Accounts. U.S. data from Citibase. Data are converted from quarterly to annual time series by taking annual averages. The annual data are detrended using the Hodrick-Prescott filter.

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Table 11: Long–run Shares of Investment, Consumption and Trade in GDP

	I/GDP	C/GDP	Trade/GDP
CANADA			
60–88	.229	.763	.227
70–88	.226	.763	.245
FRANCE			
60–88	.237	.759	.176
70–88	.232	.766	.203
ITALY			
60–88	.244	.786	.183
70–88	.245	.757	.202
UNITED KINGDOM			
60–88	.187	.817	.239
70–88	.185	.817	.260
UNITED STATES			
60–88	.190	.817	.071
70–88	.189	.823	.084
Five-Country Avg.			
60–88	.217	.788	.179
70–88	.215	.785	.209
Model			
$\Theta = \Theta^* = 0.5$	.263	.737	.188
$\Theta = .2, \Theta^* = .8$	.263	.737	.075
$\Theta = .8, \Theta^* = .2$	.263	.737	.301

Source: IFS annual data. Trade (column 3) is defined as the average of nominal exports plus nominal imports.

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Table 12: Correlations Between Prices and Quantities

	(C_T, C_{NT})	(Y_T, Y_{NT})	$(\frac{P_N}{P_T}, \frac{C_N}{C_T})$	$(\frac{P_N}{P_T}, \frac{Y_N}{Y_T})$
CANADA[a]				
60–88	.462	.176	–.504	.378
70–88	.620	.620	–.585	.440
FRANCE[b]				
70–88	.832	.833	–.484	.197
GERMANY[c]				
70–88	n.a.	.609	n.a.	.498
ITALY[c]				
60–87	n.a.	.863	n.a.	.069
70–87	n.a.	.862	n.a.	.040
80–87	.864	–	–.650	–
JAPAN[a]				
70–87	.909	.492	.034	.032
UNITED KINGDOM[a]				
62–88	.739	n.a.	–.348	n.a.
70–88	.773	.914	–.302	.199
UNITED STATES[a]				
60–88	.759	1.0	–.685	.488
70–88	.724	1.0	–.739	.537

a. Output data available through 1986.
b. Output data available through 1984.
c. Output data available through 1985.
Source: Columns 1 and 2 are from the OECD Quarterly Accounts. Columns 2 and 4 are from the OECD Intersectoral Data Base. All series are detrended using the Hodrick-Prescott filter.

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Table 13: Parameter Values

Technology

$\gamma = 2.73$	Rate of technical progress (percent per annum)
$\delta = .10$	Depreciation rate
$s^T (= s^{NT}) = 0.5$	Share of production of traded (and nontraded) goods in total output
$\alpha^T = 0.61$	Labor share in traded–good industry
$\alpha^{NT} = 0.56$	Labor share in nontraded–good industry
$\nu^T = 0.521$	Share of work effort allocated to traded–good production
$\nu^{NT} = 0.479$	Share of work effort allocated to nontraded–good production
$1/a = -3.173$	Intertemporal elasticity of substitution in leisure

Preferences

$\Phi = 0.5$	Home country's share of world wealth
$\beta = 0.96$	Rate of time preference
$1/\sigma = 0.5$	Intertemporal elasticity of substitution
$1/1+\mu = 0.44$	Elasticity of substitution between traded and nontraded goods
$\theta = 0.5$	Share of domestically produced goods in consumer's bundle of traded goods

Source: Authors.

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TABLE 14: SIMULATION RESULTS

Standard Deviations:

Variable	Data:		Case 1 Model:	Case 2 Model:	Case 3 Model:	Case 4 Model:
Aggregate:						
Output:	2.53	(2.00, 3.06)	2.58	2.60	2.70	2.60
Capital:	2.96	(2.62, 3.30)	2.73	2.99	3.09	2.88
Labor:	1.61	(0.92, 2.30)	1.90	2.28	2.47	1.99
Investment:	5.53	(4.20, 6.86)	5.84	5.85	5.88	6.01
Consumption:	2.03	(1.04, 3.02)	1.54	1.81	1.86	1.69
Traded-Good Sector:						
Output:	3.45	(2.38, 4.52)	3.21	3.37	3.62	3.24
Capital:	2.50	(1.85, 3.15)	2.57	2.57	3.06	2.62
Labor:	2.17	(1.34, 3.00)	1.78	2.41	2.46	1.86
Investment:	7.02	(5.26, 8.78)	9.22	9.22	9.37	9.28
Consumption:	3.32	(2.29, 4.35)	1.08	3.17	2.96	1.12
Nontraded-Good Sector:						
Output:	2.02	(1.48, 2.56)	2.86	2.89	2.87	2.91
Capital:	3.64	(3.28, 4.00)	2.97	3.03	2.97	3.10
Labor:	1.36	(0.82, 1.90)	1.12	1.20	1.13	1.59
Investment:	6.51	(5.20, 7.82)	6.13	6.19	6.13	6.41
Consumption:	2.78	(2.04, 3.52)	1.86	1.89	1.87	2.35
Domestic Correlations:						
Corr(C,Y):	0.88*	(0.82, 0.95)	0.92	0.89	0.91	0.86
Corr(I,Y):	0.87	(0.83, 0.90)	0.95	0.92	0.93	0.91
Corr(CT,CNT):	0.77*	(0.66, 0.88)	0.83	0.38	0.39	0.64
Corr(YT,YNT):	0.70	(0.41, 1.00)	0.45	0.38	0.37	0.42
Corr(APL,Y):	0.76	(0.63, 0.90)	0.69	0.54	0.45	0.72
Corr(N,Y):	0.69	(0.55, 0.83)	0.85	0.77	0.81	0.80
Domestic Price–Quantity Correlations:						
Corr(PN/PT,CN/CT):	–0.42*	(–.71, –.12)	–1.00	–0.45	–0.54	–0.30
Corr(PN/PT,YN/YT):	0.28	(.07, .49)	–0.70	–0.52	–0.61	–0.56
International Variables:						
Correlations:						
Corr(Y,Y*)	0.64	(0.49, 0.78)	0.64	0.53	0.52	0.63
Corr(C,C*)	0.50	(0.25, 0.75)	0.78	0.39	0.42	0.63
Corr(S,I)	0.74*	(0.54, 0.95)	0.89	0.77	0.75	0.89
Corr(TB,Y)	–0.47*	(–.67, –.28)	–0.42	–0.47	–0.48	–0.42
Corr(CA,Y)	–0.58*	(–.67, –.49)	–0.30	–0.38	–0.40	–0.29
Standard Deviations:						
s.d.(TOT)	5.66	(4.56, 6.76)	2.05	2.56	2.26	2.13
s.d.(TB)	6.63	(4.88, 8.38)	0.45	0.57	0.61	.46
s.d.(CA)	6.07	(3.55, 8.59)	2.61	3.88	4.06	2.62

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TABLE 14: SIMULATION RESULTS (cont.)

Standard Deviations:

Variable	Data:		Case 1 Model:	Case 5 Model:	Case 6 Model:	Case 7 Model:
Aggregate:						
Output:	2.53	(2.00, 3.06)	2.58	2.62	2.61	2.65
Capital:	2.96	(2.62, 3.30)	2.73	3.13	3.29	2.97
Labor:	1.61	(0.92, 2.30)	1.90	2.35	2.49	2.29
Investment:	5.53	(4.20, 6.86)	5.84	6.03	6.06	5.87
Consumption:	2.03	(1.04, 3.02)	1.54	1.94	2.05	1.73
Traded-Good Sector:						
Output:	3.45	(2.38, 4.52)	3.21	3.40	3.33	3.31
Capital:	2.50	(1.85, 3.15)	2.57	2.62	2.62	2.68
Labor:	2.17	(1.34, 3.00)	1.78	2.47	2.31	1.96
Investment:	7.02	(5.26, 8.78)	9.22	9.27	9.26	9.25
Consumption:	3.32	(2.29, 4.35)	1.08	3.18	3.30	1.70
Nontraded-Good Sector:						
Output:	2.02	(1.48, 2.56)	2.86	2.94	2.94	3.14
Capital:	3.64	(3.28, 4.00)	2.97	3.16	3.24	3.21
Labor:	1.36	(0.82, 1.90)	1.12	1.64	1.52	1.76
Investment:	6.51	(5.20, 7.82)	6.13	6.47	6.57	6.26
Consumption:	2.78	(2.04, 3.52)	1.86	2.37	2.37	2.28
Domestic Correlations:						
Corr(C,Y):	0.88*	(0.82, 0.95)	0.92	0.85	0.84	0.91
Corr(I,Y):	0.87	(0.83, 0.90)	0.95	0.88	0.86	0.94
Corr(CT,CNT):	0.77*	(0.66, 0.88)	0.83	0.31	0.47	0.54
Corr(YT,YNT):	0.70	(0.41, 1.00)	0.45	0.36	0.39	0.35
Corr(APL,Y):	0.76	(0.63, 0.90)	0.69	0.56	0.45	0.56
Corr(N,Y):	0.69	(0.55, 0.83)	0.85	0.74	0.70	0.81
Domestic Price–Quantity Correlations:						
Corr(PN/PT,CN/CT):	–0.42*	(–.71, –.12)	–1.00	–0.21	–0.43	–0.50
Corr(PN/PT,YN/YT):	0.28	(.07, .49)	–0.70	–0.42	–0.54	–0.60
International Variables:						
Correlations:						
Corr(Y,Y*)	0.64	(0.49, 0.78)	0.64	0.53	0.52	0.56
Corr(C,C*)	0.50	(0.25, 0.75)	0.78	0.33	0.25	0.54
Corr(S,I)	0.74*	(0.54, 0.95)	0.89	0.78	0.79	0.86
Corr(TB,Y)	–0.47*	(–.67, –.28)	–0.42	–0.47	–0.48	–0.46
Corr(CA,Y)	–0.58*	(–.67, –.49)	–0.30	–0.38	–0.39	–0.33
Standard Deviations:						
s.d.(TOT)	5.66	(4.56, 6.76)	2.05	2.62	2.78	2.18
s.d.(TB)	6.63	(4.88, 8.38)	0.45	0.58	0.60	.54
s.d.(CA)	6.07	(3.55, 8.59)	2.61	3.88	3.85	2.96

Source: Authors' calculations.

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Table 15: Technology and Taste Shocks Used in Simulations

Case 1: Solow Residuals only:

Variance–Covariance Matrix of Productivity Shocks:

3.62	1.23	1.21	0.51
1.23	1.99	0.51	0.27
1.21	0.51	3.62	1.23
0.51	0.27	1.23	1.99

Autocorrelation Matrix of Productivity Shocks:

0.154	0.040	–0.199	0.262
–0.015	0.632	–0.110	0.125
–0.199	0.262	0.154	0.040
–0.110	0.125	–0.015	0.632

Case 2: Taste Shocks for Home–Produced Traded Good:

Variance–Covariance Matrix of Preference Shocks:

3.60	0.00	0.00
0.00	0.00	0.00
0.00	0.00	0.00

Autocorrelation Matrix of Preference Shocks:

0.900	0.000	0.000
0.000	0.900	0.000
0.000	0.000	0.900

Case 3: Small Taste Shocks for Home–Produced Traded Good:

Variance–Covariance Matrix of Preference Shocks:

0.036	0.000	0.000
0.000	0.000	0.000
0.000	0.000	0.000

Autocorrelation Matrix of Preference Shocks:

0.999	0.000	0.000
0.000	0.999	0.000
0.000	0.000	0.999

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Table 15: Technology and Taste Shocks Used in Simulations (cont.)

Case 4: *Taste Shocks for Nontraded Goods*:

Variance–Covariance Matrix of Preference Shocks:

$$\begin{vmatrix} 0.000 & 0.000 & 0.000 \\ 0.000 & 0.000 & 0.000 \\ 0.000 & 0.000 & 2.000 \end{vmatrix}$$

Autocorrelation Matrix of Preference Shocks:

$$\begin{vmatrix} 0.632 & 0.000 & 0.000 \\ 0.000 & 0.632 & 0.000 \\ 0.000 & 0.000 & 0.632 \end{vmatrix}$$

Case 5: *Taste Shocks to Home–Produced Goods*:

Variance–Covariance Matrix of Preference Shocks:

$$\begin{vmatrix} 3.600 & 0.000 & 0.000 \\ 0.000 & 0.000 & 0.000 \\ 0.000 & 0.000 & 2.000 \end{vmatrix}$$

Autocorrelation Matrix of Preference Shocks:

$$\begin{vmatrix} 0.900 & 0.000 & 0.000 \\ 0.000 & 0.900 & 0.000 \\ 0.000 & 0.000 & 0.630 \end{vmatrix}$$

Case 6: *Taste Shock to Home–Produced Goods, Correlated across Goods*:

Variance–Covariance Matrix of Preference Shocks:

$$\begin{vmatrix} 3.600 & 0.000 & 1.340 \\ 0.000 & 0.000 & 0.000 \\ 1.340 & 0.000 & 3.600 \end{vmatrix}$$

Autocorrelation Matrix of Preference Shocks:

$$\begin{vmatrix} 0.900 & 0.000 & 0.000 \\ 0.000 & 0.900 & 0.000 \\ 0.000 & 0.000 & 0.630 \end{vmatrix}$$

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Table 15: Technology and Taste Shocks Used in Simulations (cont.)

Case 7: Small Taste Shocks to Home–Produced Goods:

Variance–Covariance Matrix of Preference Shocks:

$$\begin{vmatrix} 0.036 & 0.000 & 0.000 \\ 0.000 & 0.000 & 0.000 \\ 0.000 & 0.000 & 0.020 \end{vmatrix}$$

Autocorrelation Matrix of Preference Shocks:

$$\begin{vmatrix} 0.995 & 0.000 & 0.000 \\ 0.000 & 0.995 & 0.000 \\ 0.000 & 0.000 & 0.995 \end{vmatrix}$$

Source: Authors' calculations.

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APPENDIX A: Description of the Data Sources

The International Sectoral Data Base compiled by the OECD provides time-series data on output, employment, investment, capital stocks and factor payments by sectors for 13 OECD countries. The sector classification is based on the ISIC. Gross capital stocks are estimated from investment data, allowing for varying rates of depreciation across countries and across sectors. For a detailed description of the estimation procedure, see Meyer-zu-Schloctern (1988, pp. 2-6). We construct time series for productivity growth in the traded- and nontraded-goods-producing sectors from constant-price, domestic-currency series of output, capital, compensation of employees and total number of employees.

We take consumption data from the OECD Quarterly Accounts. We decompose private final consumption of commodities by type (durables, semidurables, nondurables and services) and by object (food, beverages and tobacco; clothing and footwear; gross rent, fuel and power; transportation and communication; furniture and household operations; and other goods and services). We use two proxies for consumption of nontradables: services from the classification by type; and gross rent, fuel and power plus transportation and communication from the classification by object. U.S. data for these categories are taken from the Citibase database. We construct the relative prices of nontradables in each of the countries from the price deflators of the service and nonservice components of consumption. Deseasonalized quarterly data from the OECD are annualized by averaging.

We take data on aggregate output, investment, savings, net foreign investment, exports and imports from the International Financial Statistics of the IMF. We deflate production data using the GNP (GDP) deflator and

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consumption data using the Consumer Price Index. In some cases, data for the United States are taken from Citibase. The export and import price deflators used to calculate the terms of trade are taken from the OECD Main Economic Indicators.

Unless otherwise noted, empirical results cited in the body of the paper are based on data detrended using the Hodrick-Prescott filter. Results based on data detrended by taking first differences (growth rates) appear in Appendix B.

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APPENDIX B

Table B1: Cross–Country Correlations of Output and Productivity

A. Correlations of Output (1971–1988)

	CANADA	JAPAN	GERMANY	ITALY
USA				
Agg	.693	.623	.821	.494
T	.746	.557	.811	.422
NT	–.027	.317	.601	.604
CANADA				
Agg		.518	.705	.603
T		.562	.698	.578
NT		.346	.249	.186
JAPAN				
Agg			.697	.445
T			.682	.673
NT			.642	.091
GERMANY				
Agg				.813
T				.823
NT				.682

B. Correlations of Solow Residuals (1971–1984)

	CANADA	JAPAN	GERMANY	ITALY
USA				
Agg	.659	.486	.575	.151
T	.674	.370	.381	–.070
NT	.148	–.214	.135	.553
CANADA				
Agg		.303	.518	.225
T		.317	.449	.306
NT		.175	.470	.288
JAPAN				
Agg			.540	.011
T			.579	.412
NT			.469	–.456
GERMANY				
Agg				.599
T				.627
NT				.134

Source: Output and Solow residuals from OECD International Sectoral Data Base. All data are logged and first–differenced.

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Table B2: Cross–Country Correlations in Consumption

A. Correlations of Aggregate Consumption (1970–1988)

	CANADA	FRANCE	ITALY	U.K.
USA	.278	.205	–.432	.321
CANADA		.451	.052	.086
FRANCE			–.007	.112
ITALY				.032

B. Correlations of Aggregate, Private Final Consumption and Consumption of Traded and Nontraded Goods (1971–1988)

	CANADA	FRANCE	JAPAN	U.K.
USA				
	.250	.017	.269	.472
	.442	.285	.494	.554
	.335	.278	.477	.589
	.501	.280	.436	.322
CANADA				
		.515	.445	.261
		.536	.412	.268
		.397	.426	.376
		.489	.161	.100
FRANCE				
			.783	.352
			.733	.261
			.668	.466
			.539	–.190
JAPAN				
				.656
				.587
				.645
				.221

Source: Part A is based on IFS annual data. Part B is based on data from the OECD Quarterly Accounts, which are annualized by averaging. All data are first-differenced.

Table B3: Correlations between Savings, Investment, Trade Balance, Current Account and Output

	$Corr(\hat{S},\hat{I})$	$Corr(\hat{TB},\hat{Y})$	$Corr(\hat{CA},\hat{Y})$	$Corr(TOT^{a},Y)$	$Corr(TOT^{a},TB)$
CANADA					
60–88	.846	–.339	–.157	–.422	.001
70–88	.861	–.365	–.178	–.517	–.052
FRANCE[b]					
60–88	.799	–.170	–.139	–.357	–.419
70–88	.753	.061	.008	–.359	–.546
ITALY					
61–87	.644	–.261	–.664	.256	–.212
70–87	.642	–.214	–.722	.293	–.258
UNITED KINGDOM					
60–88	.733	–.376	–.301	–.119	–.593
70–88	.724	–.359	–.244	–.145	–.699
UNITED STATES					
60–88	.932	–.356	–.390	–.413	.084
70–88	.933	–.376	–.433	–.392	.062

a. Terms of trade data available through 1987.
b. Savings for France is measured as GDP less aggregate consumption, since annual GNP data were not reported in the IFS.

Source: Columns 1, 2 and 3 are from IFS annual data. Terms of trade is defined as the ratio of the import deflator to the export deflator. Terms of trade data are taken from the OECD Main Economic Indicators. All series are first-differenced.

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Table B4: Correlations of Output, Consumption and the Trade Balance with the Real Exchange Rate, 1970–1987

A. Output

GDP	CAN	FRA	ITA	GBR	USA
CAN	–	.111	–.103	–.079	–.234
FRA	–.386	–	–.200	–.338	–.476
ITA	.030	.051	–	–.120	–.037
GBR	.449	.560	.485	–	.419
USA	.053	.203	.114	.057	–

B. Consumption

Cons	CAN	FRA	ITA	GBR	USA
CAN	–	.193	–.044	.083	–.334
FRA	–.254	–	–.400	–.154	–.354
ITA	–.187	.110	–	–.359	–.171
GBR	.687	.696	.661	–	.621
USA	.170	.250	.217	.098	–

C. Trade Balance

TB	CAN	FRA	ITA	GBR	USA
CAN	–	–.325	–.266	.146	.035
FRA	–.290	–	.142	–.091	–.191
ITA	–.081	–.047	–	.043	–.048
GBR	–.328	–.180	–.189	–	–.198
USA	–.121	.418	.255	–.312	–

Source: IFS annual data, 1970-1988. Output, consumption and the real exchange rate are first-differenced. The trade balance is measured as exports less imports, where both series are first-differenced. The real exchange rate is defined as the ratio of the domestic Consumer Price Index to the exchange-rate-adjusted foreign Consumer Price Index.

Table B5: Standard Deviations of International Variables

Country	Time Period	TOT	CPI	TB	CA
CANADA					
	60–88	3.19	3.20	4.84	5.20
	70–88	3.81	2.86	5.24	5.27
FRANCE					
	60–88	4.46	3.41	5.69	4.33
	70–88	5.37	3.30	6.02	5.06
ITALY					
	60–88	4.90	5.81	12.49	8.39
	70–88	5.89	5.20	12.88	8.98
UNITED KINGDOM					
	60–88	3.74	5.09	5.51	6.35
	70–88	4.53	5.11	5.91	6.82
UNITED STATES					
	60–88	4.97	3.18	8.12	3.39
	70–88	5.70	3.02	8.54	3.96

Source: Column 1 is taken from the OECD Main Economic Indicators. Columns 2 through 4 are taken from IFS. All data are detrended by first-differencing.

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Table B6: Volatility of Macroeconomic Variables

A. Standard Deviations of Annual Time Series (1970-1986)

	Output	Solow Residuals[a]	Capital	Labor	Investment
CANADA					
Agg	3.00	3.25	4.18	2.22	6.55
T	5.07	4.15	2.52	3.12	9.46
NT	2.06	2.36	5.44	1.90	4.92
GERMANY					
Agg	2.02	1.69	1.84	1.46	4.86
T	2.59	2.14	2.05	1.69	5.88
NT	1.68	1.53	2.06	1.36	5.46
ITALY					
Agg	2.68	2.91	2.24	.78	6.45
T	3.58	3.51	2.19	1.31	7.70
NT	1.48	2.42	3.25	.52	5.80
JAPAN					
Agg	2.40	2.07	2.09	0.91	3.76
T	3.36	2.98	2.29	1.24	4.58
NT	2.63	2.23	2.11	1.21	6.75
U.S.					
Agg	2.87	1.50	2.16	2.10	6.90
T	4.34	2.87	2.06	2.97	8.00
NT	1.48	1.26	2.97	1.29	7.73
5-COUNTRY AVERAGE					
Agg	2.59	2.28	2.50	1.49	5.70
T	3.79	3.13	2.22	2.07	7.13
NT	1.87	1.96	3.17	1.26	6.13

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Table B6: Volatility of Macroeconomic Variables (cont.)

B. Ratio of Standard Deviations of Variables to the Standard Deviations of Output

	Solow Residuals [a]	Capital	Labor	Investment
CANADA				
Agg	1.08	1.39	.74	2.18
T	.82	.48	.62	1.87
NT	1.15	2.64	.92	2.39
GERMANY				
Agg	.83	.91	.72	2.41
T	.83	.79	.65	2.27
NT	.91	1.23	.81	3.25
ITALY				
Agg	1.09	.84	.29	2.41
T	.98	.61	.37	2.15
NT	1.64	2.20	.35	3.92
JAPAN				
Agg	.86	.87	.38	1.57
T	.89	.68	.37	1.36
NT	.85	.80	.46	2.57
U.S.				
Agg	.52	.75	.73	2.40
T	.66	.47	.68	1.84
NT	.85	2.01	.87	5.22

a. The Solow residuals are estimated from first-differenced capital, labor and output data.

Source: OECD International Sectoral Data Base. Data are detrended by taking first differences. Standard deviations are calculated over the period from 1970 to the last available observation.

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Table B7: Standard Deviations of Consumption

Country	Time Period	Aggregate	Private Final Consumption	Traded	Nontraded
CANADA	61–88	1.64	2.08	2.85	1.79
	70–88	1.81	2.34	3.37	1.42
FRANCE	61–88	1.67	1.78	n.a.	n.a.
	70–88	1.35	1.55	1.85	1.37
ITALY	61–87	2.07	n.a.	n.a.	n.a.
	81–87	1.32	1.57	1.10	0.92
JAPAN	61–88	2.78	3.05	n.a.	n.a.
	71–87	2.26	2.45	3.10	1.91
UNITED KINGDOM	61–88	1.81	2.24	n.a.	n.a.
	70–88	2.09	2.63	2.96	2.76
UNITED STATES	61–88	1.57	1.66	2.54	1.00
	70–88	1.53	1.77	2.78	0.94

Source: OECD Quarterly Accounts. U.S. data are from Citibase. Data are converted from quarterly to annual time series by taking annual averages. The annual data are detrended by taking first differences.

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Table B8: Correlations between Prices and Quantities

	(C_T, C_{NT})	(Y_T, Y_{NT})	$(\frac{P_N}{P_T}, \frac{C_N}{C_T})$	$(\frac{P_N}{P_T}, \frac{Y_N}{Y_T})$
CANADA[a]				
61–88	.433	.356	–.295	–.192
70–88	.622	.305	–.270	–.154
FRANCE[b]				
67–88	.640	n.a.	–.587	n.a.
70–88	.681	.653	–.598	–.186
GERMANY[c]				
61–85	n.a.	.679	n.a.	–.532
70–85	n.a.	.687	n.a.	.024
ITALY[c]				
60–87	n.a.	.851	n.a.	.117
70–87	n.a.	.856	n.a.	.263
80–87	.999	–	–.550	–
JAPAN[a]				
70–87	.822	.370	.251	.084
UNITED KINGDOM[a]				
63–88	.565	n.a.	–.187	n.a.
70–88	.972	.757	–.084	–.078
UNITED STATES[a]				
61–88	.628	830	–.594	–.332
70–88	.647	874	–.700	–.373

a. Output data available through 1986.
b. Output data available through 1984.
c. Output data available through 1985.
Source: Columns 1 and 3 are from OECD Quarterly Accounts. Columns 2 and 4 are from the OECD Intersectoral Data Base. All series are detrended using the Hodrick-Prescott filter.

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Table B9: Domestic Correlations

	Hodrick-Prescott-Filtered Data		First-Differenced Data	
	(C, Y)	(I, Y)	(C, Y)	(I, Y)
CANADA				
60–88	.889	.896	.829	.859
70–88	.930	.927	.838	.882
FRANCE				
60–88	.808	.856	.835	.771
70–88	.801	.842	.793	.710
ITALY				
60–87	.320	.895	.451	.778
70–87	.371	.879	.401	.817
GREAT BRITAIN				
60–88	.846	.842	.803	.726
70–88	.866	.835	.830	.689
UNITED STATES				
60–88	.941	.845	.907	.866
70–88	.935	.849	.899	.884

Source: *IFS* annual data.

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APPENDIX C: The Social Planner's Problem

This appendix contains a full description of the social planner's problem and the first-order conditions as they appear after linearization around the steady-state equilibrium. The social planner maximizes:

$$\max \beta^t E_t \sum_{t=0}^{\infty} [\omega\, u(c_{1t}, c_{2t}, d_t, L_t) + (1-\omega)\, u(c_{1t}^*, c_{2t}^*, d_t^*, L_t^*)] \qquad (C.1)$$

over

$$(c_{1t}, c_{2t}, d_t, L_t, N_t^T, N_t^{NT}, I_t^T, I_t^{NT}, K_{t+1}^T, K_{t+1}^{NT})$$

in the home country, and over

$$(c_{1t}^*, c_{2t}^*, d_t^*, L_t^*, N_t^{T*}, N_t^{NT*}, I_t^{T*}, I_t^{NT*})$$

in the foreign country, subject to 1) the market-clearing conditions for each of the four goods:

$$Y_t^T = c_{1t} + c_{1t}^* + I_t^T \qquad (C.2)$$

$$Y_t^{T*} = c_{2t} + c_{2t}^* + I_t^{T*} \qquad (C.3)$$

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$$Y_t^{NT} = d_t + I_t^{NT} \tag{C.4}$$

$$Y_t^{NT*} = d_t^* + I_t^{NT*}, \tag{C.5}$$

2) the four equations describing the evolution of the capital stocks:

$$I_t^T = \gamma K_{t+1}^T - (1-\delta)K_t^T \tag{C.6}$$

$$I_t^{NT} = \gamma K_{t+1}^{NT} - (1-\delta)K_t^{NT} \tag{C.7}$$

$$I_t^{T*} = \gamma K_{t+1}^{T*} - (1-\delta)K_t^{T*} \tag{C.8}$$

$$I_t^{NT*} = \gamma K_{t+1}^{NT*} - (1-\delta)K_t^{NT*}, \tag{C.9}$$

where future capital stocks are augmented by the rate of technical progress, and 3) the labor constraints in each country:

$$N_t^T + N_t^{NT} + L_t = 1 \tag{C.10}$$

$$N_t^{T*} + N_t^{NT*} + L_t^* = 1. \tag{C.11}$$

Equations (C.12) through (C.24) are the home country's first-order

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conditions for this maximization problem in linearized form. Maximizing with respect to the consumption goods and leisure in the home country, we find:

$$\epsilon_{11}\hat{c}_{1t} + \epsilon_{12}\hat{c}_{2t} + \epsilon_{13}\hat{d}_t + \epsilon_{14}\hat{L}_t = \hat{p}_t^T \tag{C.12}$$

$$\epsilon_{21}\hat{c}_{1t} + \epsilon_{22}\hat{c}_{2t} + \epsilon_{23}\hat{d}_t + \epsilon_{24}\hat{L}_t = \hat{p}_t^{T*} \tag{C.13}$$

$$\epsilon_{31}\hat{c}_{1t} + \epsilon_{32}\hat{c}_{2t} + \epsilon_{33}\hat{d}_t + \epsilon_{34}\hat{L}_t = \hat{p}_t^{NT} \tag{C.14}$$

$$\epsilon_{41}\hat{c}_{1t} + \epsilon_{42}\hat{c}_{2t} + \epsilon_{43}\hat{d}_t + \epsilon_{44}\hat{L}_t = \hat{w}_t, \tag{C.15}$$

where

$$\epsilon_{ij} = \frac{u_{ij}(-)c_j}{u_{i(-)}}.$$

The first-order conditions for work effort in the two industries are

$$\hat{p}_t^T + \hat{A}_t^T + \eta_{KN}^T\hat{K}_t^T + \eta_{NN}^T\hat{N}_t^T = \hat{w}_t \tag{C.16}$$

$$\hat{p}_t^{NT} + \hat{A}_t^{NT} + \eta_{KN}^{NT}\hat{K}_t^{NT} + \eta_{NN}^{NT}\hat{N}_t^{NT} = \hat{w}_t, \tag{C.17}$$

where eta_{ij} is the elasticity of the marginal product of factor i with respect

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to factor j.

Total differentiation of the labor constraint yields:

$$\frac{(1-N)}{N}\hat{L}_t + \nu^T\hat{N}_t^T + \nu^{NT}\hat{N}_t^N = 0, \tag{C.18}$$

where N is the (constant) fraction of time allocated to work effort and v^i is the (constant) fraction of time allocated to sector i.

The first-order conditions for choosing next period's capital stocks are

$$\hat{p}_{t+1}^T + \eta_A^T\hat{A}_{t+1}^T + \eta_{KA}^T\hat{K}_{t+1}^T + \eta_{NA}^T\hat{N}_{t+1}^T = \hat{p}_t^T \tag{C.19}$$

$$\hat{p}_{t+1}^{NT} + \eta_A^{NT}\hat{A}_{t+1}^{NT} + \eta_{KA}^{NT}\hat{K}_{t+1}^{NT} + \eta_{NA}^{NT}\hat{N}_{t+1}^{NT} = \hat{p}_t^{NT}. \tag{C.20}$$

The investment equations and budget constraints in totally differentiated form are

$$\hat{I}_t^T - \frac{\gamma}{\gamma-(1-\delta)}\hat{K}_{t+1}^T + \frac{(1-\delta)}{\gamma-(1-\delta)}\hat{K}_t^T = 0 \tag{C.21}$$

$$\hat{I}_t^{NT} - \frac{\gamma}{\gamma-(1-\delta)}\hat{K}_{t+1}^{NT} + \frac{(1-\delta)}{\gamma-(1-\delta)}\hat{K}_t^{NT} = 0 \tag{C.22}$$

$$\hat{A}_t^T + s_k^T\hat{K}_t^T + S_N^T\hat{N}_t^T - s_{c1}\hat{c}_{1t} - s_{c1}^*\hat{c}_{1t}^* - s_i^T\hat{I}_t^T = 0 \tag{C.23}$$

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$$\hat{A}_t^{NT} + s_k^{NT}\hat{K}_t^{NT} + S_N^{NT}\hat{N}_t^{NT} - s_d\hat{d}_t - s_i^{NT}\hat{I}_t^{NT} = 0. \qquad (C.24)$$

The share parameters, s_{c1} and $s_{c1}*$, denote the shares of consumption of good 1 in total output of the home-produced traded good, and s_i^T is the share of output of the home-traded good allocated to investment. Similarly, s_d and s_i^{NT} are the shares of the domestic consumption and investment of the nontraded good in total output of the nontraded good. The parameters s_K and s_N are the capital and labor shares in each industry. Symmetric equations are similarly derived for the foreign country.

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APPENDIX D: Simulation Results Based on Growth-Rate-Filtered Data

This appendix contains simulation results based on Solow residuals calculated from growth-rate-detrended (first-differenced) data. The estimated autocorrelation matrix of the Solow residuals is

$$\text{(D.1)} \qquad \Omega = \begin{vmatrix} 0.231 & -0.412 & 0.090 & -0.057 \\ -0.117 & 0.324 & -0.081 & 0.150 \\ 0.090 & -0.057 & 0.231 & -0.412 \\ -0.081 & 0.150 & -0.117 & 0.324 \end{vmatrix}$$

and the estimated variance-covariance matrix is

$$\text{(D.2)} \qquad V[\epsilon] = \begin{vmatrix} 7.06 & 2.37 & 2.47 & 0.90 \\ 2.37 & 3.30 & 0.90 & 0.34 \\ 2.48 & 0.90 & 7.06 & 2.37 \\ 0.90 & 0.34 & 2.37 & 3.30 \end{vmatrix} .$$

Table D1 shows the results of simulations based on these estimates of the Solow residuals (Case 1) and the effects of adding taste shocks (Cases 2 through 7). Table D2 provides a catalog of the various taste shocks used in the simulations.

The results based on first-differenced data are somewhat different from the Hodrick-Prescott-filtered results. The standard deviation of aggregate output is at the upper end of the two-standard-deviation band with disturbances to productivity alone, while the standard deviation of nontraded-good output is above the band. Similarly, the standard deviation of aggregate labor already exceeds the upper limit of the band. The correlations

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between relative prices and quantities are well below the data, and again, the correlation between consumptions across countries is too large.

Cases 2 through 7 consider taste shocks of roughly the same types discussed in the text. The simulation results reveal that these types of demand shocks introduce a trade-off: Taste shocks improve the correlations between prices and quantities, raise the standard deviation of consumption and reduce the cross-country consumption correlation. When the shocks are large enough to produce these effects, however, the standard deviations of labor and output exceed the two-standard-deviation band, and the correlation between quantities across sectors is too low.

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Table D1: Simulation Results

Standard Deviations:

Variable	Data:		Case 1 Model:	Case 2 Model:	Case 3 Model:	Case 4 Model:
Aggregate:						
Output:	2.59	(2.20, 2.98)	2.84	2.86	2.88	2.86
Capital:	2.50	(1.56, 3.44)	2.28	2.49	2.44	2.41
Labor:	1.49	(0.83, 2.15)	2.61	2.75	2.79	2.64
Investment:	5.70	(4.36, 7.04)	7.55	7.63	7.56	7.79
Consumption:	2.15	(1.69, 2.61)	1.32	1.61	1.47	1.57
Traded-Good Sector:						
Output:	3.79	(2.84, 4.74)	4.19	4.25	4.31	4.21
Capital:	2.22	(2.03, 2.41)	3.38	3.46	3.52	3.41
Labor:	2.07	(1.16, 2.98)	2.28	2.61	2.52	2.32
Investment:	7.13	(5.21, 9.05)	12.49	12.55	12.53	12.51
Consumption:	2.81	(2.23, 3.39)	1.55	3.06	2.33	1.56
Nontraded-Good Sector:						
Output:	1.87	(1.38, 2.36)	2.77	2.80	2.77	2.81
Capital:	3.17	(1.80, 4.54)	2.48	2.54	2.48	2.67
Labor:	1.26	(0.77, 1.75)	1.49	1.56	1.50	1.71
Investment:	6.13	(5.02, 7.24)	6.80	6.86	6.80	7.40
Consumption:	1.68	(0.99, 2.37)	1.50	1.52	1.50	2.25
Domestic Correlations:						
Corr(C,Y):	0.84*	(0.80, 0.88)	0.89	0.82	0.87	0.78
Corr(I,Y):	0.80	(0.70, 0.89)	0.97	0.94	0.96	0.93
Corr(CT,CNT):	0.75	(0.60, 0.90)	0.40	0.23	0.28	0.27
Corr(YT,YNT):	0.64	(0.42, 0.87)	0.30	0.28	0.29	0.30
Corr(APL,Y):	0.70	(0.53, 0.77)	0.25	0.23	0.20	0.27
Corr(N,Y):	0.67	(0.52, 0.82)	0.92	0.88	0.91	0.90
Domestic Price–Quantity Correlations:						
Corr(PN/PT,CN/CT):	–0.28*	(–.67, 0.11)	–1.00	–0.64	–0.81	–0.62
Corr(PN/PT,YN/YT):	–0.07	(–.27, 0.14)	–0.77	–0.70	–0.74	–0.73
International Variables:						
Correlations:						
Corr(Y,Y*)	0.64	(0.51, 0.77)	0.51	0.47	0.48	0.51
Corr(C,C*)	0.40	(0.18, 0.62)	0.71	0.33	0.50	0.50
Corr(S,I)	0.78	(0.67, 0.90)	0.87	0.83	0.83	0.88
Corr(TB,Y)	–0.25	(–.44, –.06)	–0.49	–0.51	–0.51	–0.49
Corr(CA,Y)	–0.31*	(–.59, –.04)	–0.40	–0.42	–0.42	–0.40
Standard Deviations:						
s.d.(TOT)	5.06	(4.19, 5.93)	2.05	2.66	2.35	2.31
s.d.(TB)	7.72	(4.57, 10.87)	0.62	0.67	0.66	0.62
s.d.(CA)	6.02	(4.08, 7.96)	3.69	4.29	4.18	3.70

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Table D1: **Simulation Results** (cont.)

Standard Deviations:

Variable	Data:		Case 1 Model:	Case 5 Model:	Case 6 Model:	Case 7 Model:
Aggregate:						
Output:	2.59	(2.20, 2.98)	2.84	2.87	2.88	2.95
Capital:	2.50	(1.56, 3.44)	2.28	2.56	2.67	2.75
Labor:	1.49	(0.83, 2.15)	2.61	2.71	2.75	3.10
Investment:	5.70	(4.36, 7.04)	7.55	7.88	8.03	7.59
Consumption:	2.15	(1.69, 2.61)	1.32	1.75	1.93	1.70
Traded-Good Sector:						
Output:	3.79	(2.84, 4.74)	4.19	4.24	4.23	4.34
Capital:	2.22	(2.03, 2.41)	3.38	3.51	3.56	3.55
Labor:	2.07	(1.16, 2.98)	2.28	2.46	2.38	2.55
Investment:	7.13	(5.21, 9.05)	12.49	12.69	12.77	12.54
Consumption:	2.81	(2.23, 3.39)	1.55	2.44	2.52	2.39
Nontraded-Good Sector:						
Output:	1.87	(1.38, 2.36)	2.77	2.84	2.83	3.23
Capital:	3.17	(1.80, 4.54)	2.48	2.73	2.79	2.95
Labor:	1.26	(0.77, 1.75)	1.49	1.89	1.81	2.30
Investment:	6.13	(5.02, 7.24)	6.80	7.34	7.44	6.99
Consumption:	1.68	(0.99, 2.37)	1.50	2.30	2.31	2.25
Domestic Correlations:						
Corr(C,Y):	0.84*	(0.80, 0.88)	0.89	0.74	0.71	0.87
Corr(I,Y):	0.80	(0.70, 0.89)	0.97	0.90	0.87	0.95
Corr(CT,CNT):	0.75	(0.60, 0.90)	0.40	0.20	0.44	0.19
Corr(YT,YNT):	0.64	(0.42, 0.87)	0.30	0.28	0.30	0.20
Corr(APL,Y):	0.70	(0.53, 0.77)	0.25	0.27	0.26	0.11
Corr(N,Y):	0.67	(0.52, 0.82)	0.92	0.88	0.86	0.89
Domestic Price–Quantity Correlations:						
Corr(PN/PT,CN/CT):	−0.28*	(−.67, 0.11)	−1.00	−0.46	−0.63	−0.60
Corr(PN/PT,YN/YT):	−0.07	(−.27, 0.14)	−0.77	−0.68	−0.71	−0.66
International Variables:						
Correlations:						
Corr(Y,Y*)	0.64	(0.51, 0.77)	0.51	0.50	0.50	0.42
Corr(C,C*)	0.40	(0.18, 0.62)	0.71	0.34	0.26	0.29
Corr(S,I)	0.78	(0.67, 0.90)	0.87	0.86	0.87	0.83
Corr(TB,Y)	−0.25	(−.44, −.06)	−0.49	−0.49	−0.50	−0.53
Corr(CA,Y)	−0.31*	(−.59, −.04)	−0.40	−0.40	−0.41	−0.42
Standard Deviations:						
s.d.(TOT)	5.06	(4.19, 5.93)	2.05	2.51	2.60	2.47
s.d.(TB)	7.72	(4.57, 10.87)	0.62	0.64	0.65	0.73
s.d.(CA)	6.02	(4.08, 7.96)	3.69	3.90	3.87	4.18

Source: Authors' calculations.

Table D2: Technology and Taste Shocks Used in Simulations (First–Differenced Data)

Case 1: Solow Residuals only:

Variance–Covariance Matrix of Productivity Shocks:

7.06	2.37	2.48	0.90
2.37	3.30	0.90	0.34
2.48	0.90	7.06	2.37
0.90	0.34	2.37	3.30

Autocorrelation Matrix of Productivity Shocks:

0.231	–0.412	0.090	–0.057
–0.117	0.324	–0.081	0.150
0.090	–0.057	0.231	–0.412
–0.081	0.150	–0.117	0.324

Case 2: Taste Shocks for Home–Produced Traded Good:

Variance–Covariance Matrix of Preference Shocks:

7.06	0.00	0.00
0.00	0.00	0.00
0.00	0.00	0.00

Autocorrelation Matrix of Preference Shocks:

0.750	0.000	0.000
0.000	0.750	0.000
0.000	0.000	0.750

Case 3: Small Taste Shocks for Home–Produced Traded Good:

Variance–Covariance Matrix of Preference Shocks:

0.071	0.000	0.000
0.000	0.000	0.000
0.000	0.000	0.000

Autocorrelation Matrix of Preference Shocks:

0.995	0.000	0.000
0.000	0.995	0.000
0.000	0.000	0.995

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Table D2: Technology and Taste Shocks Used in Simulations (cont.)
(First-Differenced Data)

Case 4: Taste Shocks for Nontraded Goods:

Variance–Covariance Matrix of Preference Shocks:

$$\begin{vmatrix} 0.000 & 0.000 & 0.000 \\ 0.000 & 0.000 & 0.000 \\ 0.000 & 0.000 & 3.300 \end{vmatrix}$$

Autocorrelation Matrix of Preference Shocks:

$$\begin{vmatrix} 0.000 & 0.000 & 0.000 \\ 0.000 & 0.000 & 0.000 \\ 0.000 & 0.000 & 0.324 \end{vmatrix}$$

Case 5: Taste Shocks to Home–Produced Goods:

Variance–Covariance Matrix of Preference Shocks:

$$\begin{vmatrix} 7.055 & 0.000 & 0.000 \\ 0.000 & 0.000 & 0.000 \\ 0.000 & 0.000 & 3.300 \end{vmatrix}$$

Autocorrelation Matrix of Preference Shocks:

$$\begin{vmatrix} 0.500 & 0.000 & 0.000 \\ 0.000 & 0.500 & 0.000 \\ 0.000 & 0.000 & 0.500 \end{vmatrix}$$

Case 6: Taste Shock to Home–Produced Goods, Correlated across Goods:

Variance–Covariance Matrix of Preference Shocks:

$$\begin{vmatrix} 7.055 & 0.000 & 2.411 \\ 0.000 & 0.000 & 0.000 \\ 2.411 & 0.000 & 7.055 \end{vmatrix}$$

Autocorrelation Matrix of Preference Shocks:

$$\begin{vmatrix} 0.500 & 0.000 & 0.000 \\ 0.000 & 0.500 & 0.000 \\ 0.000 & 0.000 & 0.500 \end{vmatrix}$$

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Table D2: Technology and Taste Shocks Used in Simulations (cont.)
(First-Differenced Data)

Case 7: Small Taste Shocks to Home–Produced Goods:

Variance–Covariance Matrix of Preference Shocks:

0.071	0.000	0.000
0.000	0.000	0.000
0.000	0.000	0.033

Autocorrelation Matrix of Preference Shocks:

0.995	0.000	0.000
0.000	0.995	0.000
0.000	0.000	0.995

Source: Authors' calculations.