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Authors	Michael R. Pakko
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Federal Reserve Bank of St. Louis, Research Division, P.O. Box 442, St. Louis, MO 63166

Substitution Elasticities and Investment Dynamics in Two-Country Business Cycle Models

1. Introduction

Two country applications of equilibrium business cycle methodology — international real business cycle (IRBC) models — have been successful in matching many features of cyclical fluctuations and comovements across countries. One-commodity, two-county models [e.g. Cantor and Mark (1988), Baxter and Crucini (1993), Backus, Kehoe and Kydland (1992), do reasonably well in matching within-country patterns of volatility, persistence and comovement among macroeconomic variables. Two-good extensions of the baseline model, as in Backus, Kehoe and Kydland (1994, 1995) [hereafter, BKK] have extended these results to replicating some of the patterns of trade flows and terms-of-trade fluctuations. For example, the baseline two-good model in BKK (1995) predicts persistence of terms-of-trade fluctuations, the correlation between the terms of trade and net exports, and the countercyclicality of net exports that are generally consistent with the data. BKK (1994) also show that the lagged cross-correlation function between the terms of trade and net exports displays a "J-curve" relationship that is similar to that seen in the data.

Table 1 summarizes some of the empirical regularities that have been the focus of the IRBC literature. For example, domestic output, consumption and investment are positively correlated, and show a consistent pattern of relative variability. Fluctuations in net exports are consistently countercyclical and generally negatively correlated with the terms of trade. IRBC models have been successful at matching these general features of the data.

Table 1 also shows properties of international business cycles which have been more difficult to generate in typical IRBC models. BKK (1995) refer to two of these anomalies as the "quantity puzzle" and the "price puzzle". First, models tend to predict very high cross-country consumption correlations, whereas the data in Table 1 show that consumption correlations tend to be lower than output correlations.[1] The price puzzle refers to the variability of the terms of trade. Models tend to predict a standard deviation for the terms of trade that is much lower than in the data.

An additional discrepancy—the "international comovement puzzle" (Baxter, 1995)—refers to the cross-country correlations of factor inputs. In the data, investment and employment are positively correlated across countries, whereas models tend to imply negative correlations. The data in Table 1 show that for each of the countries considered, domestic investment is positively correlated with investment in the rest of the OECD. Table 2A illustrates the robustness of this empirical regularity, showing bilateral cross country investment correlations. Only two of the bilateral correlations in Table 2A have a negative sign, and in each case the magnitude is insignificantly different from zero. Table 2B shows that the corresponding bilateral correlations for employment also display a marked tendency toward positive comovement. However, IRBC models driven by shocks to relative productivity tend to predict negative correlations for these variables.

In this paper, I address the international comovement puzzle of cross-country investment correlations directly by introducing investment adjustment costs, and in so doing, identify an additional anomaly that is related to a basic dynamic property of typical

[1]Pakko (1998) suggests that comparing the correlations of consumption with domestic output to correlations of consumption with world output (as in Lewis, 1996) provides a more robust characterization of the quantity puzzle. The conventional characterization will be considered in this paper, however.

models: The model dynamics that generate countercyclical net exports and negative co-movement between net exports and the terms of trade – as seen in the data – are also related to the counterfactual prediction of negative cross-country investment and employment correlations. When investment adjustment costs are introduced to reverse the cross-country investment correlation, the implications for net exports and the terms of trade cyclicality are reversed, and the J-curve pattern is no longer a feature of the simulated dynamics. In this sense, the ability of standard models to replicate key empirical regularities is shown to be fragile for typical calibrations.

An important parameter for generating more robust implications of the model is the elasticity of substitution between foreign and domestic goods. If the two types of goods are compliments instead of being substitutes, productivity shocks are associated with demands for domestic goods and imports being tied more tightly to relative shares. This magnifies the positive response of import demand when consumption rises following a positive productivity shock, enhancing the tendency of the model to predict countercyclical trade balance dynamics. Assuming a low substitution elasticity, the model with investment adjustment costs is shown to be capable of generating positive cross-country correlations of investment and work effort, as well as countercyclical net exports and a negative correlation between net exports and the terms of trade— retaining the J-curve pattern. This specification moves the model closer toward more realistic implications with regard to the quantity and price puzzles as well.

The outline of the paper's exposition is as follows: Section 2 describes a baseline model and shows how the introduction of investment adjustment costs affects cross-country investment correlations and the dynamics of the terms of trade and net exports. Section 3 explores the sensitivity of these results to the elasticity of substitution between foreign and domestic goods, showing that an assumption of complementarity provides a more robust fit between the model and the data. Section 4 presents some basic empirical estimates of the relevant elasticity parameter to support the relevance of this finding. Section 5 concludes.

2. Baseline Economy

2.1 Preferences and Technology

The baseline model economy is that used by BKK (1994, 1995). It consists of two countries, each of which is inhabited by an infinitely-lived representative agent. Both agents have expected utility functions of the form

$$E_t \sum_{t=0}^{\infty} \beta^t U(C_t, 1-N_t)$$

where C_t and N_t are consumption and work effort, and $U(C_t,1\text{-}N_t)=[C_t^{\theta}\,(1\text{-}N_t)^{1\text{-}\theta}]^{1\text{-}\gamma}/(1\text{-}\gamma)$. Production takes place in each country using capital and labor. The home country produces X_t of the x-good while the foreign country produces Y_t of the y-good:

$$X_t = A_t F(K_t, N_t) = A_t K_t^{\alpha} N_t^{1-\alpha},$$

$$Y_t = A_t^* F(K_t^*, N_t^*) = A_t^* K_t^{*\alpha} N_t^{*1-\alpha}.$$

Consumption and investment are composites of domestic goods and imports,

$$H(x_t, y_t) = C_t + I_t \tag{1}$$

$$H^*(x_t^*, y_t^*) = C_t^* + I_t^* \tag{1*}$$

where H(x,y) and H*(x*,y*) are Armington aggregator functions of the CES form:

$$H(x_t, y_t) = [a x_t^{1-\eta} + (1-a) y_t^{1-\eta}]^{\frac{1}{1-\eta}} \qquad H^*(x_t^*, y_t^*) = [(1-a) x_t^{*1-\eta} + a y_t^{*1-\eta}]^{\frac{1}{1-\eta}}$$

The elasticity of substitution between domestic goods and imports is $1/\eta$. The parameter a determines the relative shares of domestic goods and imports in consumption and investment.

Capital stocks in the two countries evolve according to

$$K_{t+1} = (1-\delta)K_t + I_t \tag{2}$$

$$K^*_{t+1} = (1-\delta)K^*_t + I^*_t \tag{2*}$$

where δ is the depreciation rate of capital.

The equilibrium relative price of the home country's import (the terms of trade) can be computed from the marginal rate of substitution implicit in the Armington aggregator:

$$P_t = [\partial H(x_t,y_t)/\partial y_t]/[\partial H(x_t,y_t)/\partial x_t] \ ,$$

and the trade balance for the home country can be expressed in units of the domestic good as

$$NX_t = x_t* - P_t\, y_t \ .$$

The exogenous technology shock variables A and A* follow a joint AR(1) process,

$$\begin{bmatrix} A_{t+1} \\ A^*_{t+1} \end{bmatrix} = \begin{bmatrix} \rho_{xx} & \rho_{xy} \\ \rho_{yx} & \rho_{yy} \end{bmatrix} \begin{bmatrix} A_t \\ A^*_t \end{bmatrix} + \begin{bmatrix} \varepsilon_{t+1} \\ \varepsilon^*_{t+1} \end{bmatrix}.$$

International asset markets are assumed to be complete in the sense that agents have access to a complete array of state-contingent assets, so the equilibrium will be Pareto optimal and can be found as the solution to a social-planner's problem.[2] With two equal-sized countries, the social planner's objective can be represented as maximizing the simple

[2]Papers departuring from the assumption of complete asset markets include Baxter and Crucini (1995), Arvanitis and Mikkola (1996), Kollman (1996), Heathcote and Perri (2002), and Kehoe and Perri (2002).

sum of the two agents' discounted expected utility, subject to constraints (1), (1*), (2), (2*) and the resource constraints:

$$A_t F(K_t, N_t) = x_t + x_t^* \tag{3}$$

$$A_t^* F(K_t^*, N_t^*) = y_t + y_t^* \tag{3*}$$

2.2 Model Dynamics

Dynamic simulations of the model are calculated as the solution to a log-linear approximation of the nonlinear system of optimality conditions and constraints, using standard methods.[3] For all the second-moment results reported in this paper, the HP filter is applied using a frequency-domain representation of the HP filter's variance transfer function to the model's implied population moments [as in King and Rebelo (1993)].

The model is calibrated using the baseline parameter values given in Table 3, with most parameter values following those used in BKK (1995). Assuming quarterly time periods, the discount factor is consistent with a 4% real interest rate and an annual capital depreciation rate of 10%. The Cobb-Douglas parameters in utility and production are set so that the fraction of time spent working is 0.3 and that labor's share of output is 0.64. The parameters of the Armington aggregator are chosen to imply an import share of 0.15 and a baseline value for the elasticity of substitution between domestic goods and imports of 1.5. The parameters governing technology process are those estimated by BKK (1992): $\rho_{xx}=\rho_{yy}=0.906$, $\rho_{xy}=\rho_{yx}=0.088$, and var(ε)=var(ε*)=.08325.

The row labeled "baseline" in Table 4 reports some of the key implications of this specification of the model. Consumption and investment are both highly correlated with

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[3]E.g. King, Plosser and Rebelo (1988).

output, the cross-country output correlation is positive, and net exports are negatively correlated with both output and the terms of trade.[4]

The IRBC "puzzles" are also clear: Cross-country consumption correlations are higher than corresponding output correlations, the standard deviation of the terms of trade is far lower than seen in the data, and the model implies negative correlations of investment and employment across countries.

The interrelatedness of these features of the model is illustrated in Figure 1, which shows impulse-response functions for a positive technology shock to the home country's production function. The increase in the home country's marginal product of capital attracts investment, absorbing resources from abroad (hence, inducing countercyclical net exports). However, this fundamental feature of the dynamics also is responsible for the negative cross-country investment correlation. The terms of trade respond to changes in the relative supply of home- and foreign-produced goods, which is magnified by the response of work-effort to the change in the relative marginal product of labor across countries. Given the assumption of complete asset markets, consumption would co-move perfectly if not for the substitution of leisure for consumption implied by the patterns of work-effort in response to marginal products of labor. However, this feature also generates the counterfactual implication of negative co-movement of employment across countries.

The initial responses of investment and work-effort to productivity shocks dominate the dynamics summarized by the cross-country correlations shown in Table 4. Nevertheless, the impulse-response functions in Figure 1 show that the longer-run dynamics of these variables are characterized by positive comovement. As the direct effects of the productivity

[4]Table 1 shows that the U.S. is the exception to the general regularity that net exports and the terms of trade are negatively correlated.

shock dissipate, accumulated capital is optimally shared more equally across countries giving rise to a longer-run component of dynamics associated with a positive cross-country investment correlation. Moreover, the effect of these capital-stock dynamics on the marginal product of labor also imply a longer-run positive comovement of work-effort across countries. The introduction of a friction to dampen the initial impact-responses of investment and work effort to relative productivity shocks should therefore work toward generating positive (or at least, less negative) cross-country correlations of these variables. One direct approach to dampening the initial response of investment is the introduction of investment adjustment costs.

2.3 Investment Adjustment Costs

Investment adjustment costs are modeled as a friction that reduces the effectiveness of investment in proportion to deviations from the steady-state path. In particular I employ the specification for investment adjustment costs used by Baxter and Crucini (1993, 1995), modifying the capital accumulation equations to:

$$K_{t+1} = (1-\delta)K_t + \varphi(I_t/K_t)K_t \tag{2a}$$

$$K^*_{t+1} = (1-\delta)K^*_t + \varphi(I^*_t/K^*_t)K^*_t \tag{2a*}$$

where the adjustment cost function has the properties $\varphi(\cdot)>0$, $\varphi'(\cdot)>0$, $\varphi''(\cdot)<0$. The function $\varphi(\cdot)$ is calibrated so that the steady state investment/capital ratio is the same as in the model without adjustment costs and the steady-state value of Tobin's q is 1, leaving one free parameter, which can be described as the elasticity of the investment/capital ratio with respect to Tobin's q, $\zeta=[\varphi'(\cdot)/\varphi''(\cdot)](I/K)$. The results reported below use an elasticity value of ζ=-4, which is sufficient to generate positive cross-country investment correlations with all other parameters unchanged from the baseline case.

The second row of figures in Table 4 report the implied moments of the model with investment adjustment costs. Note that this added friction has the intended result: The volatility of investment is lower and the cross-country correlation of investment spending is now positive. The addition of investment adjustment costs also raises the variability of the terms of trade and lowers that of output. Moreover, cross country-consumption correlations are lower and cross-country output correlations are higher in the adjustment-cost economy. These modifications work in the direction of resolving both the quantity puzzle and the price puzzle. However, net exports are now significantly procyclical, and the terms of trade covaries positively with net exports. A small dampening of the investment-flow channel of the model results in a complete reversal of the cyclical behavior of these two variables.

Figures 2 and 3 illustrates how the introduction of investment adjustment costs alters the dynamic response of the model. A positive productivity shock in the home country gives rise to a much smaller increase in investment (as expected). Net exports now rise, rather than fall as an immediate consequence of the shock. Moreover, note that the J-curve pattern observed in the impulse-response function for the terms of trade in the baseline case is no longer a feature of the simulation with investment adjustment costs.

3. The Role of the Substitution Elasticity

An important parameter governing the model's implied dynamics is the elasticity of substitution between foreign and domestic goods. The sensitivity of model dynamics to changes in the substitution elasticity has been noted in the literature. For example, the role of this elasticity parameter in endowment economies has been considered by Hagiwara (1994) [terms of trade fluctuations] and Pakko (1997) [the quantity puzzle]. BKK (1995) conduct a sensitivity analysis of the substitution elasticity in regard to both the quantity and price puzzles, and Heathcote and Perri (2002) found it to be an important parameter in their investigation of international comovements in environments with limited asset-trade.

Lowering the elasticity of substitution has the effect of increasing the volatility of the terms of trade—directly addressing the price puzzle. And because lower substitutability between domestic goods and imports reduces incentives to substitute production locations, cross-country correlations of output are higher, as are cross-country correlations of investment and labor—addressing both the quantity puzzle and the international comovement puzzle.

The rows of Table 4 labeled "unit elasticity" and "low elasticity" correspond to simulations of the model for values of $1/\eta=1$ and 2/3, respectively. The baseline versions of these case is similar are many respects to the high-elasticity version already considered. The performance of the model is improved marginally along the lines found by BKK, but their puzzles remain. Other implied second moments are roughly the same.

After introducing investment adjustment costs, there are some striking differences between the high-elasticity and lower-elasticity economies. It is still true that adjustment costs lower the volatility of investment and can reverse the negative cross-country correlation between investment levels. In the lower elasticity cases, however, net exports remain countercyclical and continue to covary negatively with the terms of trade. Figure 4 illustrates the trade dynamics in response to a home-country productivity shock for the low elasticity case. The non-monotonic path for net exports is retained in this case, even after the introduction of investment adjustment costs. Hence, the model continues to generate the J-curve relationship between net exports and the terms of trade.

Note also that the introduction of investment adjustment costs tends to reinforce the low-elasticity version's ability to remedy the BKK quantity and price puzzles. Consumption correlations are higher while output correlations lower; term of trade variability is higher while output variability is lower. BKK (1995) show that lowering the elasticity of substitution can only go so far in resolving the quantity puzzle in the baseline model. In the model with investment adjustment costs, however, very low elasticity parameterizations are associated with consumption correlations that are lower than output correlations.[5]

4. Realistic Values for the Elasticity of Substitution

The low-elasticity version of the model with investment adjustment costs performs well with respect to a number of issues, but how realistic is that parameterization? There exists a large body of literature measuring import demand and export supply elasticities [e.g. Stern et al., (1976); Whalley (1985)]. This work suggests elasticities in the range of one to two, providing the baseline estimate used in standard models.

However, these measures are not conceptually identical to the substitution elasticity parameterized in the model. Empirical elasticity studies have tended to be conducted on a highly disaggregated basis, whereas the relevant empirical counterparts to the commodities represented in the model are *bundles* of goods. Some goods may be very close substitutes,

[5]For example, with an elasticity as low as 0.025, the model with investment adjustment costs generates a cross-country consumption correlation of 0.48 and a cross-country output correlation of 0.50.

other highly differentiated, some nontraded, some subject to trade distortions, etc. The relevant elasticity to consider is not a pure preference or technological parameter, but a composite that reflects a mixture of factors.[6] The appropriate elasticity might be considerably lower than the measured substitutability of specific categories of traded goods.

Table 5 presents some simple regression estimates of the substitution elasticity using aggregate OECD data. Two measures of empirical counterparts to the ratio y/x ratio (along with the associated relative prices) are used: The first is simply the ratio of imports to exports, the second is the ratio of imports to output minus net exports, as literally implied by the Armington aggregator specification in the model. The estimates are found using ordinary least-squares regression of the quantity ratio on the price ratio, in which the variables are logged and first-differenced. An AR(1) term is included to adjust for serially correlated error terms.

The elasticity estimates suggest that the low-elasticity calibration of the model is a reasonable specification. Using the import/export ratio as the relevant measure, point estimates of the substitution elasticity are uniformly less than one. Using the alternative measure of relative quantities and prices, estimates of substitution elasticities are even lower. In fact, the estimated elasticity for this specification yields estimates that are not significantly different from zero for most of the countries in the sample.

[6]In a model with nontraded goods modeled explicitly, Tesar (1993) Stockman and Tesar (1995) found that the elasticity of substitution between traded and nontraded goods was a crucial parameter, with low values generating more realistic simulation results.

5. Discussion and Conclusions

This paper has demonstrated the importance of inter-country capital flows for the dynamics of a standard two country real business cycle model, and the resulting sensitivity of the models predictions to the introduction of a friction to cross-country investment flows. The addition of investment adjustment costs to the model reverses the implied cyclical behavior of net exports and the terms of trade for a baseline parameterization. However, the model with investment adjustment costs is capable of generating countercyclical net exports and negative comovement between net exports and the terms of trade for calibrations that assume a low elasticity of substitution between foreign and domestic goods.

The introduction of investment adjustment costs is a very simple and straightforward approach to resolving the model's implications for cross-country investment correlations. Other approaches to resolving the IRBC puzzles similarly address the margin of substitutability, particularly with respect to investment. Baxter and Farr (2001) consider the role of variable factor utilization, allowing for substitutability along intensive margins to dampen substitution along extensive margins. Maffezzoli (2000) models human capital as an additional factor of production that tends to dampen cross-country fluctuations in capital accumulation. Heathcote and Perri (2002) examine a model of "portfolio autarky" that relaxes the connection between the marginal products of capital in the home and foreign countries, lowering cross-country investment correlations.

Investment adjustment costs have been introduced in this paper not necessarily as an alternative solution to the puzzles of the IRBC literature, but to illustrate a more general feature of a wide class of models than can help resolve those puzzles. That is, the assumption of complementarity between domestic goods and imports provides a more robust specification of the model which can better match the data in the adjustment-costs model, and is likely to help in other settings as well. Indeed, Heathcote and Perri (2002) found that their model of "portfolio autarky" matched the data best for values between 0.5 and 1.0, and used an estimated value of 0.9.

The model simulations and aggregate elasticity estimates presented in this paper suggest that complementary between domestic goods and imports in this range are realistic, and provide for a more parsimonious fit between model dynamics and the data.

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Table 1:
Properties of International Business Cycles [OECD Data]

Country	Std. Dev. Relative to Output				Correlation With Output				Correlation With Foreign			
	C	*I*	*NX*	*P*	*C*	*I*	*NX*	*P*	*Y*	*C*	*I*	*Corr(P,NX)*
Australia	0.73	3.36	0.79	3.67	0.45	0.80	-0.22	-0.33	0.53	0.02	0.51	-0.11
Austria	1.09	2.74	0.62	1.39	0.45	0.55	-0.07	0.04	0.29	0.26	0.44	-0.14
Canada	0.81	2.85	0.59	1.81	0.84	0.64	-0.07	-0.17	0.69	0.53	0.40	-0.23
France	0.98	2.98	0.71	2.82	0.69	0.86	-0.34	-0.02	0.66	0.62	0.63	-0.51
Germany	0.88	2.57	0.41	1.79	0.58	0.71	-0.21	0.14	0.54	0.60	0.69	-0.35
Italy	0.99	2.25	0.94	2.64	0.66	0.72	-0.59	0.38	0.56	0.28	0.59	-0.46
Japan	0.99	2.42	0.57	4.56	0.75	0.90	-0.35	0.02	0.57	0.48	0.62	-0.51
Spain	1.04	3.52	1.00	3.67	0.76	0.83	-0.38	0.00	0.49	0.42	0.34	-0.46
Switzerland	0.69	2.40	0.64	1.57	0.75	0.77	-0.64	0.45	0.64	0.62	0.71	-0.50
U.K.	1.11	2.47	0.66	1.70	0.81	0.66	-0.35	0.12	0.69	0.65	0.49	-0.56
U.S.	0.81	2.76	0.27	1.67	0.87	0.94	-0.45	-0.18	0.64	0.49	0.44	0.11
Average	0.92	2.76	0.66	2.48	0.69	0.76	-0.33	0.04	0.57	0.45	0.53	-0.34

Notes: Statistics are based on Hodrick-Prescott filtered data. Varables are Y, real output; C, real consumption; I, real fixed investment; NX, the ratio of net exports to output (both at current prices); P, the ratio of import to export price deflators. Except for the net exports ratio, the natural logarithm has been applied to all variables before filtering. Foreign variables are defined as OECD totals minus own-country values, with own-country values converted to 1990 dollars using purchasing power parities. All data are from the OECD's *Quarterly National Accounts*. The sample period is 1970:1 through 2002:1.

Table 2A:
Cross-Country Investment Correlations

	Australia	*Austria*	*Canada*	*France*	*Germany*	*Italy*	*Japan*	*Spain*	*Sweden*	*U.K.*	*U.S.*
Australia	1.00										
Austria	0.12	1.00									
Canada	0.60	0.19	1.00								
France	0.38	0.26	0.42	1.00							
Germany	0.15	0.51	0.14	0.54	1.00						
Italy	0.18	0.29	0.36	0.72	0.45	1.00					
Japan	0.23	0.30	0.27	0.61	0.56	0.57	1.00				
Spain	0.15	0.03	0.33	0.69	0.11	0.61	0.41	1.00			
Sweden	0.46	0.38	0.43	0.77	0.55	0.60	0.56	0.44	1.00		
U.K.	0.32	-0.08	0.18	0.32	0.21	0.22	0.29	0.26	0.32	1.00	
U.S.	0.43	0.38	0.16	0.23	0.51	0.22	0.39	-0.01	0.48	0.44	1.00
Averages	0.30	0.24	0.31	0.49	0.37	0.42	0.42	0.30	0.50	0.25	0.32

***Notes*:** See Notes to Table 2.

Table 2B:

Cross-Country Employment Correlations

	Australia	*Austria*	*Canada*	*France*	*Germany*	*Italy*	*Japan*	*Spain*	*Sweden*	*U.K.*	*U.S.*
Australia	1.00										
Austria	0.07	1.00									
Canada	0.71	-0.12	1.00								
France	0.40	-0.02	0.23	1.00							
Germany	0.40	0.22	0.35	0.49	1.00						
Italy	0.02	-0.14	0.05	0.46	0.36	1.00					
Japan	-0.13	0.05	-0.11	0.23	0.33	0.29	1.00				
Spain	0.23	-0.16	0.20	0.79	0.27	0.50	0.34	1.00			
Sweden	0.47	-0.15	0.38	0.63	0.67	0.49	0.20	0.50	1.00		
U.K.	0.53	-0.08	0.62	0.34	0.18	0.10	0.14	0.41	0.12	1.00	
U.S.	0.41	0.20	0.59	0.02	0.22	-0.13	0.18	0.18	-0.09	0.70	1.00
Averages	0.31	-0.01	0.29	0.36	0.35	0.20	0.15	0.33	0.32	0.31	0.23

***Notes*:** Cross-country correlations of civilian employment from the *OECD Main Economic Indicator* database. Not seasonally adjusted data are deseasonalized using the Census X-11 procedure. Data are logged and HP-filtered. The sample period is 1970:1 to 2002:1, with the exceptions of France, Spain and Sweden, for which data start in 1978:1, 1973:1 and 1976:1, respectively.

Table 3:
Benchmark Parameter Values

	Description	Symbol	Value
Preferences	Discount factor	β	0.99
	Intertemporal substitution	γ	2.0
	Consumption share	θ	0.34
Technology	Capital's share	α	0.36
	Depreciation rate of capital	δ	0.025
Trade	Substitution Elasticity	$1/\eta$	1.50
	Import Share	$s_y = s_x^*$	0.15
Forcing Processes	AR Coefficient Matrix	A	$\begin{bmatrix} 0.906 & 0.088 \\ 0.088 & 0.906 \end{bmatrix}$
	Cross-Correlation of Shocks	σ_{XY}	0.258
	Shock Variance	σ_ε^2	0.08325

Table 4:

International Business Cycle Properties of Theoretical Economies

	Std, Dev. Relative to Output				*Correlation With Output*				*Correlation With Foreign*				
	C	*I*	*NX*	*P*	*C*	*I*	*NX*	*P*	*Y*	*C*	*I*	*N*	*Corr(P,NX)*
Data*	0.92	2.76	0.66	2.48	0.69	0.76	-0.33	0.04	0.57	0.45	0.53	0.26†	-0.34
Normal Elasticity (3/2)													
Baseline	0.48	3.28	0.30	0.34	0.90	0.93	-0.61	0.49	0.10	0.81	-0.53	-0.49	-0.37
Inv. Adj. Costs	0.67	1.62	0.07	0.81	0.96	0.99	0.61	0.63	0.22	0.72	0.19	-0.41	0.99
Unit Elasticity													
Baseline	0.49	3.24	0.31	0.42	0.91	0.93	-0.63	0.51	0.13	0.78	-0.51	-0.42	-0.59
Inv. Adj. Costs	0.69	1.72	0.06	0.98	0.97	0.99	-0.59	0.60	0.27	0.67	0.11	-0.04	-0.97
Low Elasticity (2/3)													
Baseline	0.50	3.22	0.34	0.50	0.92	0.93	-0.64	0.52	0.16	0.75	-0.48	-0.35	-0.72
Inv. Adj. Costs	0.72	1.81	0.17	1.14	0.99	0.99	-0.58	0.58	0.33	0.62	0.04	0.48	-0.99

* The "Data" row refers to averages of the statistics reported in Table 1.

† Average of bilateral correlations reported in Table 2B.

Table 5:

Estimates of Substitution Elasticities*

	Relative Quantity Definition:	
Country	IM/EX	IM/(Y-EX)
Australia	-0.68	-0.27
	(0.194)	(0.093)
Austria	-0.63	-0.35
	(0.141)	(0.122)
Canada	-0.77	-0.00
	(0.157)	(0.145)
France	-0.34	-0.08
	(0.095)	(0.060)
Germany	-0.82	-0.11
	(0.123)	(0.089)
Italy	-0.50	-0.04
	(0.139)	(0.099)
Japan	-0.38	-0.02
	(0.095)	(0.061)
Spain	-0.64	-0.33
	(0.142)	(0.073)
Switzerland	-0.55	-0.10
	(0.101)	(0.090)
U.K	-0.35	0.09
	(0.145)	(0.082)
U.S.	-0.49	-0.14
	(0.172)	(0.109)

(Standard errors in parentheses.)

*Regressions of quantity ratios on relative prices (logged first-differences), usingOLS with first-order autocorrelation adjustment.

Figure 1:
Responses to a Positive Productivity Shock in the Home Country

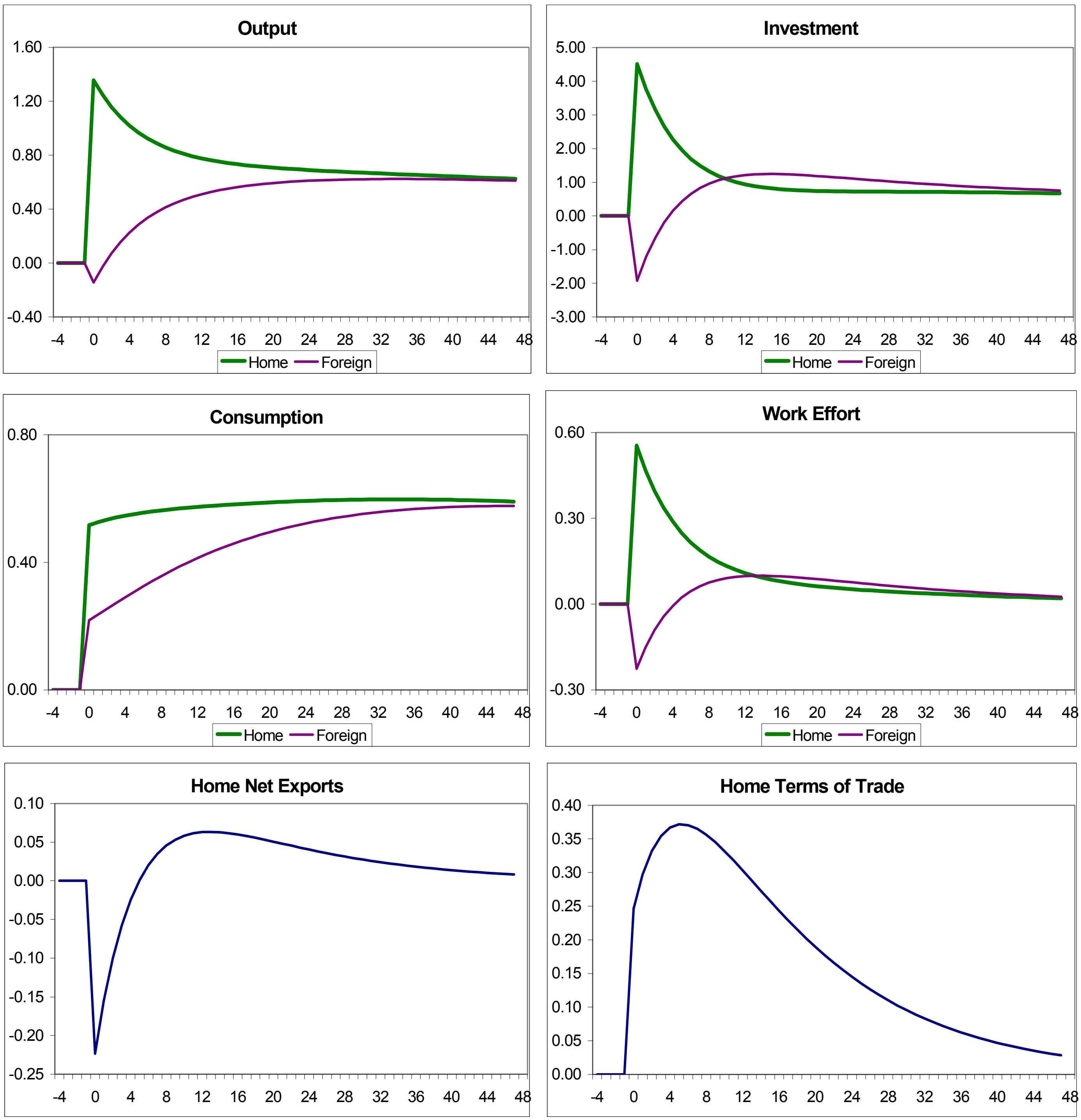


Figure 2:
Investment Dynamics with Adjustment Costs

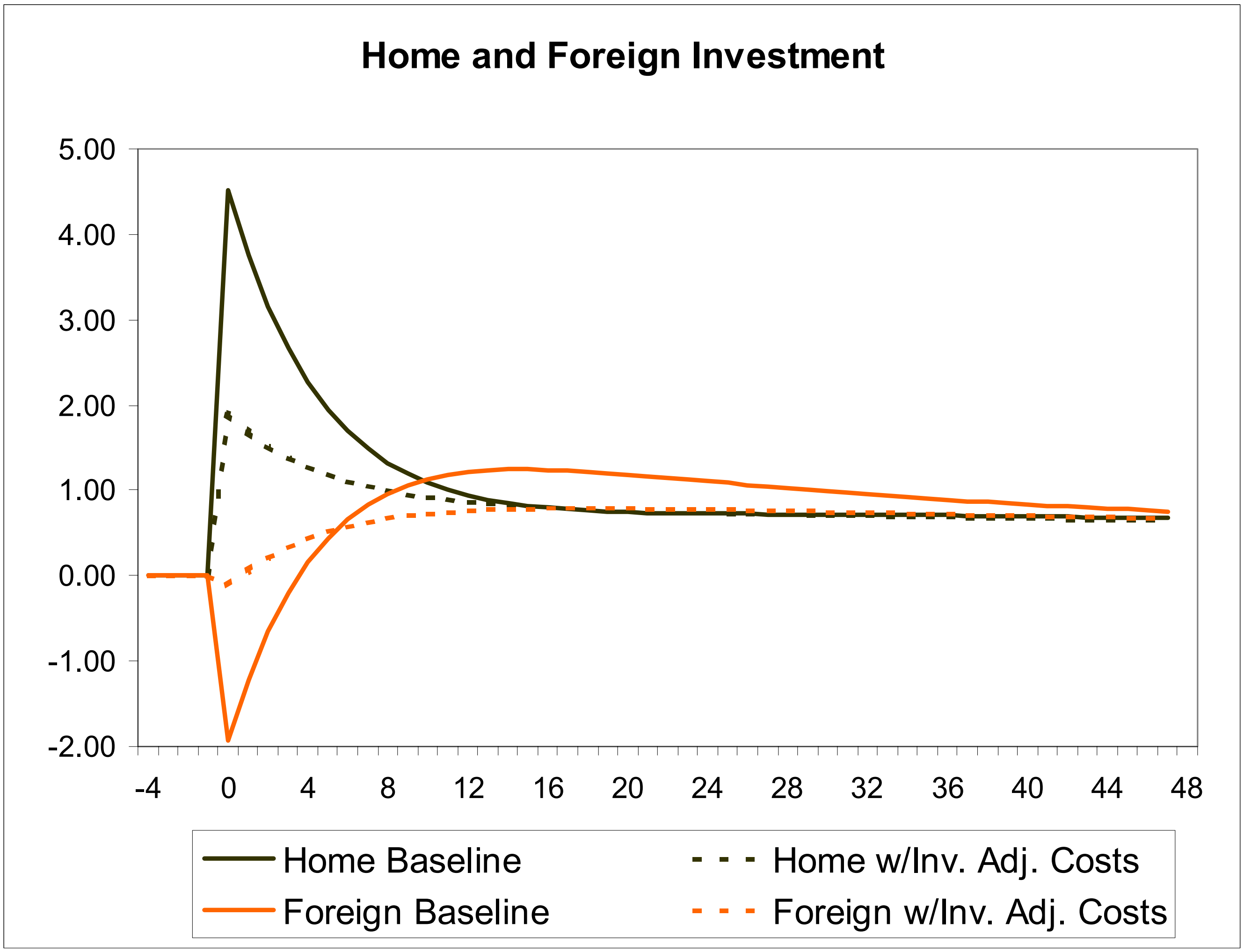
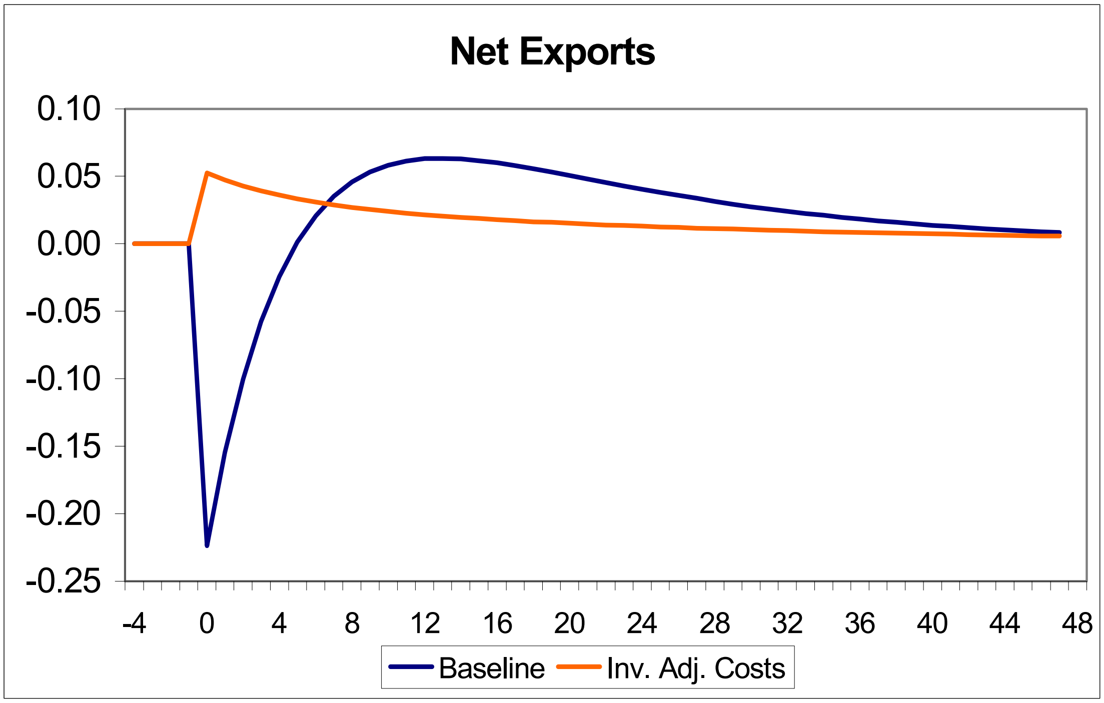


Figure 3:

Trade Patterns in the Investment-Adjustment Cost Economy



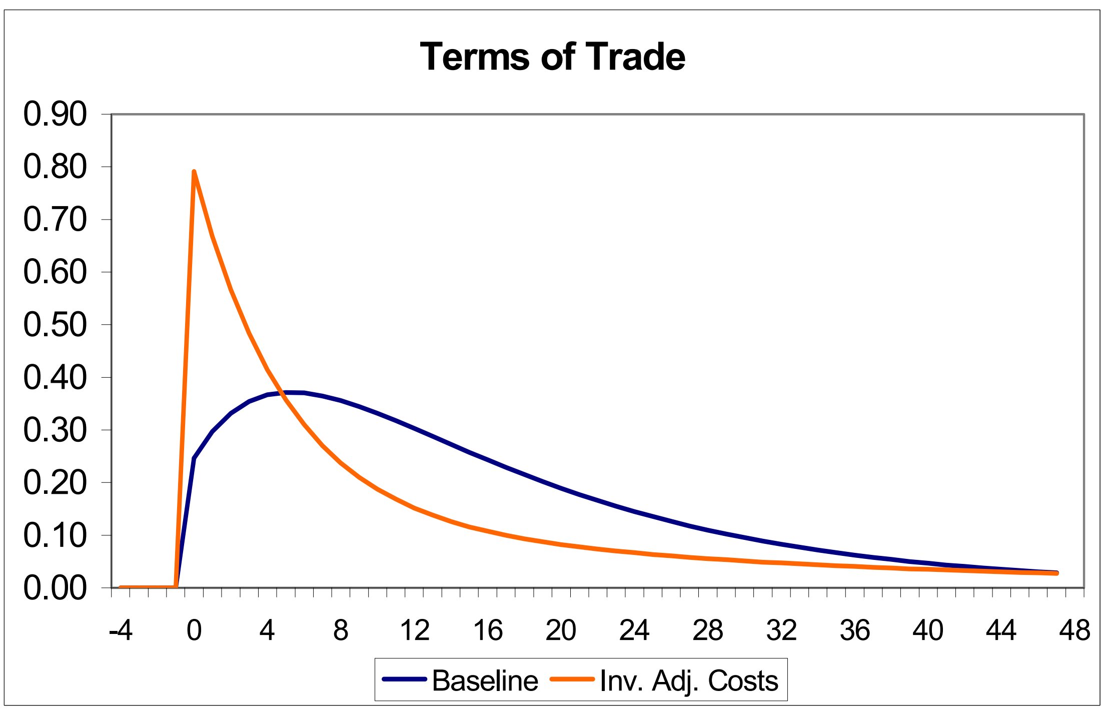


Figure 4:
Trade Patterns in the Investment-Adjustment Cost Economy (Low Elasticity Case)