Trade Adjustment and the Composition of Trade

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Motivation

- Substantial interest in assessing the economic forces that might induce U.S. trade adjustment, and in the implications for imports, exports, and the exchange rate.

- Considerable discussion of appropriate policy response:
  - U.S. fiscal consolidation (IMF)
  - Stimulate consumption abroad (U.S. Treasury)

- We show that taking appropriate account of the high investment content of U.S. trade is critical for assessing how different shocks/policy choices affect trade and the real exchange rate.

Background

- U.S. Imports and Exports are heavily concentrated in capital goods and consumer durables.
  - About 3/4 of nonfuel imports and exports fall under these two categories, while their share of total absorption is around 1/4.

Non-Energy Merchandise Trade and Expenditure Components

	Percent of imports	Percent of exports	Percent of GDP
1. **Consumer Nondurables**	28	25	61
2. **Consumer Durables**	32	16	8
3. **Producer Durables**	30	45	8
4. **Non-energy industrial supplies used in producing durables**	10	14	
TOTAL	100	100	77

Background (con't)

- Empirical studies using aggregate trade data usually ignore differences; typically imports depend on GDP or absorption.
  - Some exceptions: Burda and Gerlach (1992); Warner (1994).
- Open economy DSGE models typically ignore compositional differences; imports depend on absorption.
  - e.g.: Backus, Kehoe, Kydland (1994); Chari, Kehoe and McGrattan (2002).
  - Exceptions: Arvanitis and Mikkola (1996), Boileau (2002).

Methodology

We embed two alternative trade specifications in an open economy DSGE model (SIGMA):

1) Absorption-based trade (AT) specification

- final consumption and investment goods have same import intensity.

- activity variable driving imports puts a weight of about 1/4 on investment (its share in domestic expenditure).

2) Disaggregated trade (DT) specification

- allows for investment goods to be much more import-intensive than consumption goods.

- activity variable driving imports puts a weight of about 3/4 on investment (its share in imports)

Key Findings

- DT specification provides a better fit of observed U.S. import behavior given theoretical constraints of our DSGE framework.

- Under AT specification, shocks that affect foreign consumption or investment have similar effects on U.S. trade and the exchange rate.

- Under DT specification, foreign investment shocks much stronger catalyst for trade adjustment, while implying much smaller movement in exchange rates.

Key Findings (con't)

- Similarly, shocks that reduce domestic investment can provide a stronger catalyst for trade adjustment than consumption shocks, with smaller exchange rate depreciation.

- Overall, our analysis suggests that movements in the interest-sensitive components of domestic expenditure may play a significant role in trade adjustment.

- Emphasis on investment changes as a catalyst for trade adjustment consistent with empirical work of Freund (2000) and Croke, Kamin, and LeDuc (2005).

Structure of SIGMA

- DSGE model with two countries; each produces a single final good by aggregating a continuum of domestically-produced intermediate goods.

- Nominal and Real Rigidities:
  - staggered wage and price contracts
  - habit persistence in consumption
  - investment adjustment costs
  - costs of adjusting import shares

- Exports are priced in the currency of the buyer (local currency pricing).

Optimizing Households

- Maximize an intertemporal utility functional; the period utility function depends on a composite consumption good, leisure, and real balances.
- Accumulate capital by purchasing a composite investment good.
- Monopolistically competitive sellers of differentiated labor services.
- Face shocks to the return to capital, and taste shocks to aggregate consumption.
- The consumption and investment goods are a composite of the domestically-produced good and the imported good (possibly in different proportions).

Optimizing Households

Period utility:

$$\frac{1}{1-\sigma}\left(C_t(h) - \varkappa\frac{C_{Ot-1}}{\zeta} - \varphi_{Ct}\right)^{1-\sigma} + \frac{\chi_0}{1-\chi}(1-N_t(h))^{1-\chi} + \frac{\mu_0}{1-\mu}\left(\frac{MB_{t+1}(h)}{P_{Ct}}\right)^{1-\mu}$$

Budget constraint:

$$P_{Ct}C_t(h) + P_{It}I_t(h) + MB_{t+1}(h) - MB_t(h) + \int_s \xi_{t,t+1}B_{Dt+1}(h) - B_{D,t}(h) +$$
$$P_{Bt}B_{Gt+1} - B_{Gt} + \frac{e_t P^*_{Bt}B_{Ft+1}(h)}{\phi_{bt}} - e_t B_{Ft}(h) = W_t(h)\,N_t(h)$$
$$+(1-\tau_{Kt})R_{Kt}K_t(h) + TR_t(h) - T_t(h) - \phi_{It}(h)$$

Costs of adjustments

Intermediation costs for foreign bonds

$$\phi_{bt} = exp\left(-\phi_b\left(\frac{e_t B_{Ft+1}}{P_t Y_t}\right) + \varphi_{bt}\right)$$

Costs of adjustment for capital

$$\phi_{It}(h) = \frac{1}{2}\phi_I P_{Dt}\frac{(I_t(h) - \mu_z I_{t-1}(h))^2}{I_{t-1}(h)}$$

Wage Setting

Wages determined by Calvo contracts (allow for dynamic wage indexation, log-linearized FOC):

$$\widehat{\pi}_{wt} = (1 - \lambda_w)\widehat{\pi}_{wt-1} + \lambda_w \widehat{\pi}_{wt+1|t} + \kappa_w (m\widehat{r}s_t - \widehat{w}_{ct})$$

Full backward indexation: $\lambda_w = \frac{\beta}{1+\beta}$.

"Hand-to-Mouth" Agents

Fraction of households purely "Keynesian":

$$P_{C,t}C_t(h) = (1-\tau_{Nt})W_t(h)\,N_t(h) + TR_t(h) - T_t(h)$$

"Hand-to-Mouth" agents set their wage at the average wage of optimizing households.

Firm Behavior

- There are three types of producers in each country: intermediate-goods producers, producers of the aggregate domestic good, and distributors.

- Producers of the intermediate-goods are monopolistically competitive and set prices in both the home and foreign markets in Calvo-style contracts. They rent capital and labor from households.

- Producers of a composite domestic good bundle the continuum of intermediate goods, taking prices as given in input and product markets (similarly for the foreign intermediate goods).

- Distributors purchase both the domestically-produced good and the imported good, and resell the final consumption and investment goods to households (N.B.: these goods are identical in the AT specification).

Intermediate Goods Firms

Monopolistic competitors who hire capital and labor from households in competitive factor markets.

Technology given by:

$$Y_t(i) = \left(\omega_K^{\frac{\rho}{1+\rho}} K_t(i)^{\frac{1}{1+\rho}} + \omega_L{}^{\frac{\rho}{1+\rho}} (Z_t L_t(i))^{\frac{1}{1+\rho}}\right)^{1+\rho}$$

K-L elasticity of substitution $\frac{\rho+1}{\rho}$

Sticky domestic prices (log-linearized FOC):

$$\widehat{\pi}_t = (1-\lambda_p)\widehat{\pi}_{t-1} + \lambda_p \widehat{\pi}_{t+1|t} + \kappa_p \widehat{mc}_t$$

Local currency pricing for export prices (log-linearized FOC):

$$\widehat{\pi}^*_{Mt} = (1-\lambda_p)\widehat{\pi}^*_{Mt-1} + \lambda_p \widehat{\pi}^*_{Mt+1|t} + \kappa_{x,p}(\widehat{mc}_t - (\widehat{e}_t + \widehat{P}^*_{Mt} - \widehat{P}_t))$$

AT Distributor

Technology for production of final good ($A_t \equiv C_t + I_t$):

$$A_t = \left(\omega_A^{\frac{\rho_A}{1+\rho_A}} A_{D,t}^{\frac{1}{1+\rho_A}} + (1-\omega_A)^{\frac{\rho_A}{1+\rho_A}} (\varphi_{At} M_t)^{\frac{1}{1+\rho_A}} \right)^{1+\rho_A}$$

where the adjustment cost φ_{At} is given by:

$$\varphi_{At} = \left[1 - \frac{\varphi_{M_A}}{2} \left(\frac{\frac{M_t}{A_{D,t}}}{\frac{M_{t-1}}{A_{D,t-1}}} - 1 \right)^2 \right]$$

Distributors minimize the discounted expected cost of producing the final good (N.B.: $P_{At} = P_{Ct} = P_{It}$).

Consumption DT Distributor

Technology for production of consumption good:

$$C_t = \left(\omega_c^{\frac{\rho_A}{1+\rho_A}} C_{D,t}^{\frac{1}{1+\rho_A}} + (1-\omega_c)^{\frac{\rho_A}{1+\rho_A}} (\varphi_{ct} M_{ct})^{\frac{1}{1+\rho_A}} \right)^{1+\rho_A}$$

where the adjustment cost φ_{ct} is given by:

$$\varphi_{ct} = \left[1 - \frac{\varphi_{M_c}}{2} \left(\frac{\frac{M_{C,t}}{C_{D,t}}}{\frac{M_{C,t-1}}{C_{D,t-1}}} - 1 \right)^2 \right]$$

Distributors minimize the discounted expected cost of producing the consumption good.

Investment DT Distributor

Technology for production of investment good:

$$I_t = \left(\omega_I^{\frac{\rho_A}{1+\rho_A}} I_{D,t}^{\frac{1}{1+\rho_A}} + (1-\omega_I)^{\frac{\rho_A}{1+\rho_A}} (\varphi_{It} M_{It})^{\frac{1}{1+\rho_A}} \right)^{1+\rho_A}$$

where the adjustment cost φ_{It} is given by:

$$\varphi_{It} = \left[1 - \frac{\varphi_{M_I}}{2} \left(\frac{\frac{M_{I,t}}{I_{D,t}}}{\frac{M_{I,t-1}}{I_{D,t-1}}} - 1 \right)^2 \right]$$

Distributors minimize the discounted expected cost of producing the investment good.

Fiscal and Monetary Policy

- Govt purchases domestic goods only.
- Transfers and govt spending determined exogenously.
- Govt spending is nonproductive.
- Finances its expenditures with lump-sum taxes, seignorage, and debt issuance.
- Monetary policy follows a modified Taylor rule of the form:

$$i_t = \gamma_i i_{t-1} + \overline{r} + \overline{\pi}_t + \gamma_\pi(\pi_t^{(4)} - \overline{\pi}) + \gamma_y(y_t - y_{t-4} - g_y) + \epsilon_{it}.$$

Calibration

Home country is half as large as foreign.

κ_w and κ_p consistent with 4 quarter contracts (with full indexation); κ_x consistent with 2 quarter contracts .

Consumption elasticity $\sigma = 2$; habit persistence parameter $\varkappa = 0.8$.

Trade elasticity of substitution is 1.5 ($\rho_A = 2$).

Adjustment costs for investment set to match peak response of investment following a monetary innovation, $\phi_I = 3$, and elasticity of substitution between capital and labor in production function is 0.5.

Baseline case for interest rate rule: $\gamma_i = 0.8$, $\gamma_\pi = 0.4$, $\gamma_y = 0.28$, and $\gamma_{g_y} = 0$.

In the AT specification ω_A is set to 0.15, to be consistent with an import share of 12%.

In the DT specification ω_C is set to 0.052 and ω_I is set to 0.36. The import share remains at 12%.

Comparing Linearized Trade Specifications

AT specification:

$$\tilde{M}_t = \tilde{A}_t - \frac{\lambda}{\varphi_{M_A}(1-\beta\lambda\rho_\psi)(1-\lambda L)}\tilde{\psi}_t. \tag{1}$$

$$\tilde{A}_t \;=\; \left(\frac{C}{A}\right)\tilde{C}_t + \left(\frac{I}{A}\right)\tilde{I}_t. \tag{2}$$

DT specification:

$$\tilde{M}_t = \tilde{A}_t^{DT} - \frac{\lambda}{\varphi_{M_A}(1-\beta\lambda\rho_\psi)(1-\lambda L)}\tilde{\psi}_t^{DT}. \tag{3}$$

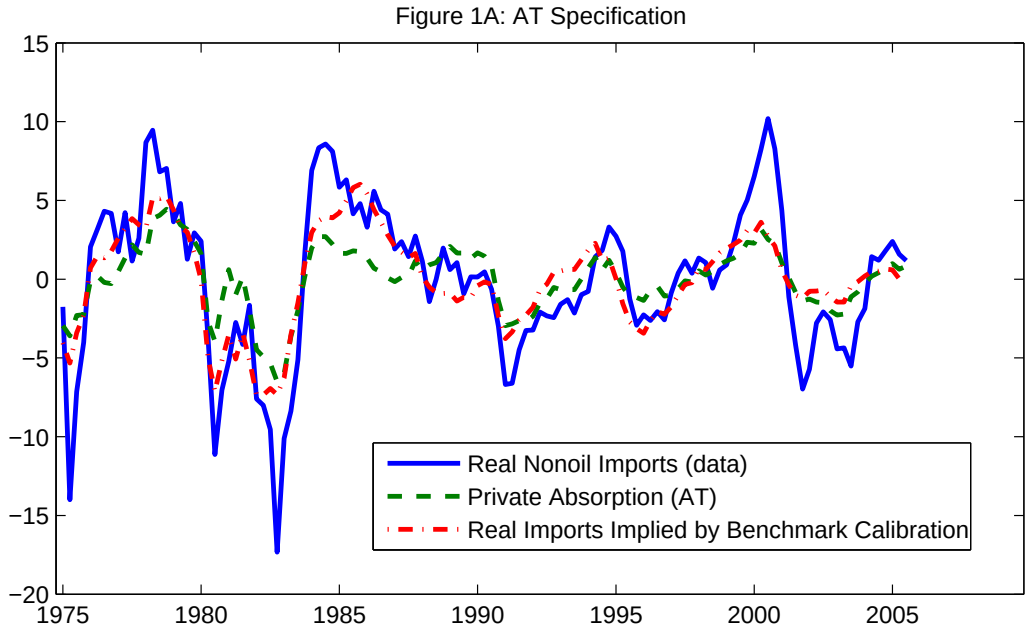
$$\tilde{A}_t^{DT} \;=\; \left(\frac{M_C}{M}\right)\tilde{C}_t + \left(\frac{M_I}{M}\right)\tilde{I}_t. \tag{4}$$

Table 4: Mean Squared Error of Predicted Imports (1975-2005)[a,b]

Experiment	AT Specification	DT Specification
1. Benchmark Calibration ($\epsilon_A = 1.5$, $\varphi_{M_A} = 15$, $\rho_\psi = 0.9$)	2.62	2.13
2. Activity Measure Only	3.07	2.45
3. Minimized MSE[c]	2.53	2.11
4. Alternative Trade-Price Elasticity[d]		
$\epsilon_A = 1$	2.68	2.11
$\epsilon_A = 3$	2.67	2.37
5. Alternative Adjustment Cost Parameter[d]		
$\varphi_{M_A} = 5$	2.98	2.34
$\varphi_{M_A} = 30$	2.59	2.14
6. Alternative Relative Import Price Persistence[d]		
$\rho_\psi = 0.75$	2.65	2.12
$\rho_\psi = 0.999$	2.74	2.30

[a]Entries report the square root of the mean squared error.
[b]AT and DT specifications refer to absorption-based and disaggregated trade specifications implied by equations (12) and (13), respectively.
[c]In this case, $\rho_\psi = 0.9$ and the parameters ϵ_A and φ_{M_A} are chosen to minimize the mean-squared error. For the AT specification, $\epsilon_A = 3.05$ and $\varphi_{M_A} = 28.44$, and for the DT specification, $\epsilon_A = 1.08$ and $\varphi_{M_A} = 15.00$.
[d]The parameter values are the same as in the benchmark calibration except for the alternative parameter under consideration.

Figure 1: U.S. Real Imports of Goods and Alternative Activity Measures



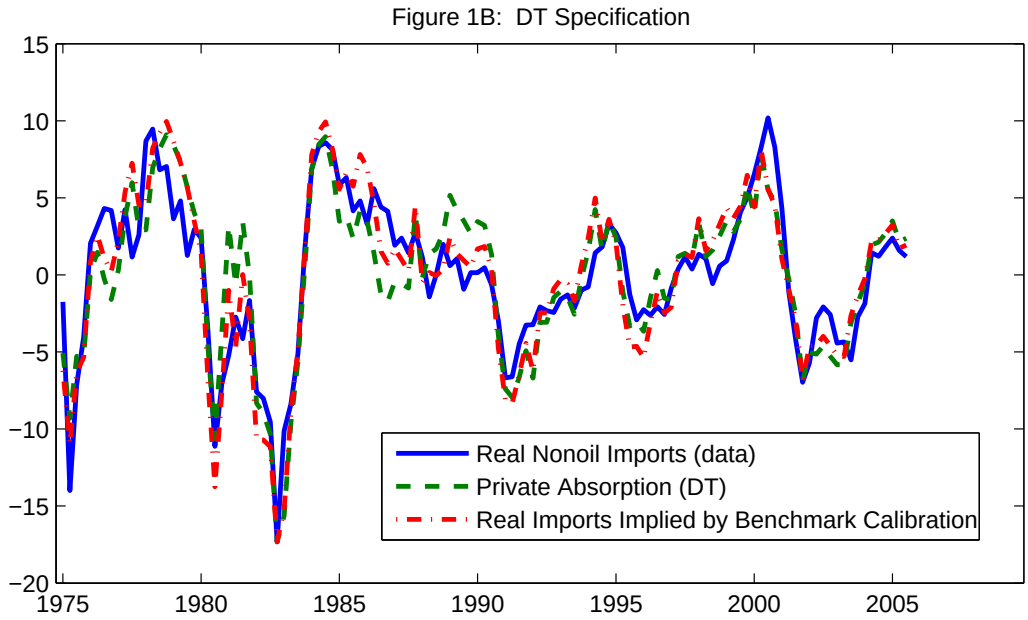
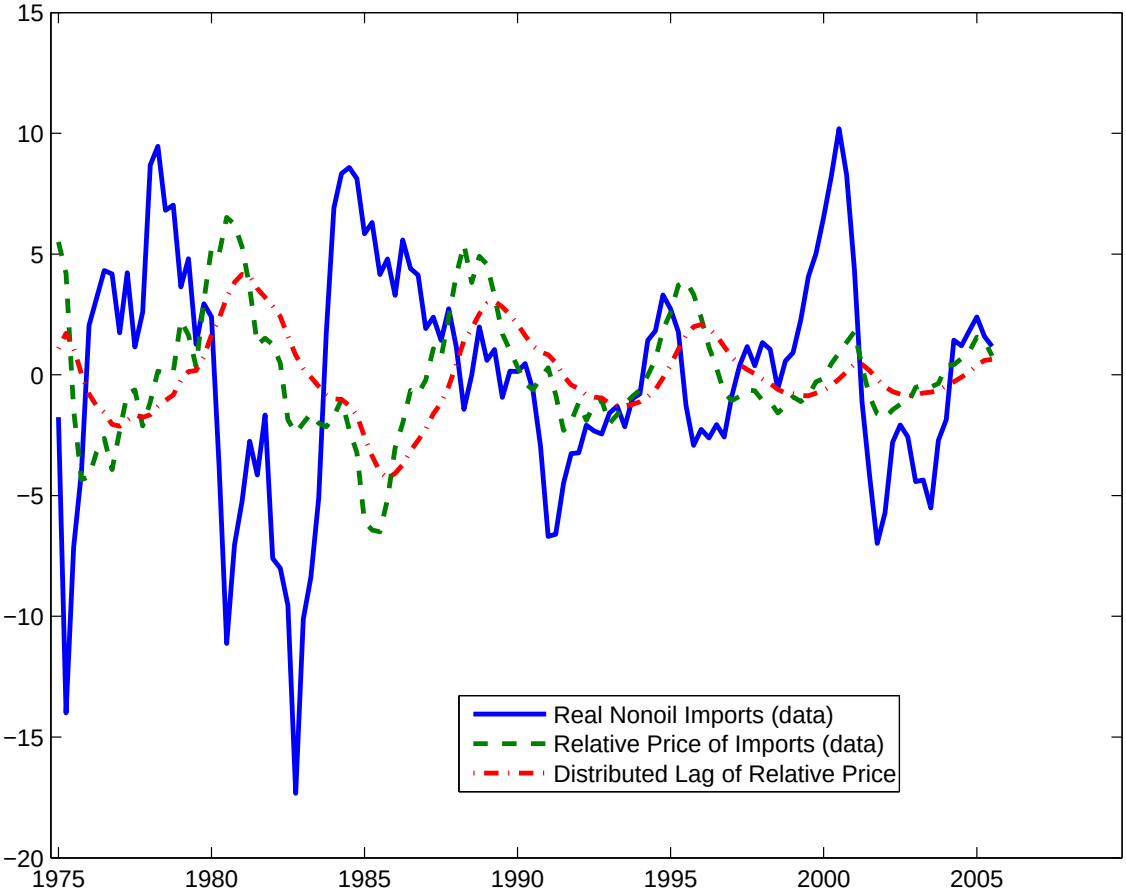


Figure 2: Real Imports and the Relative Price of Imports



Model simulations

1. Rise in foreign investment share of GDP that peaks at 1 percentage point (due to lower capital tax rate abroad).

2. Rise in foreign consumption share of GDP that peaks at 1 percentage point (due to taste shock).

3. Similar shocks to domestic economy (reverse sign).

Figure 3: A Foreign Investment Demand Shock

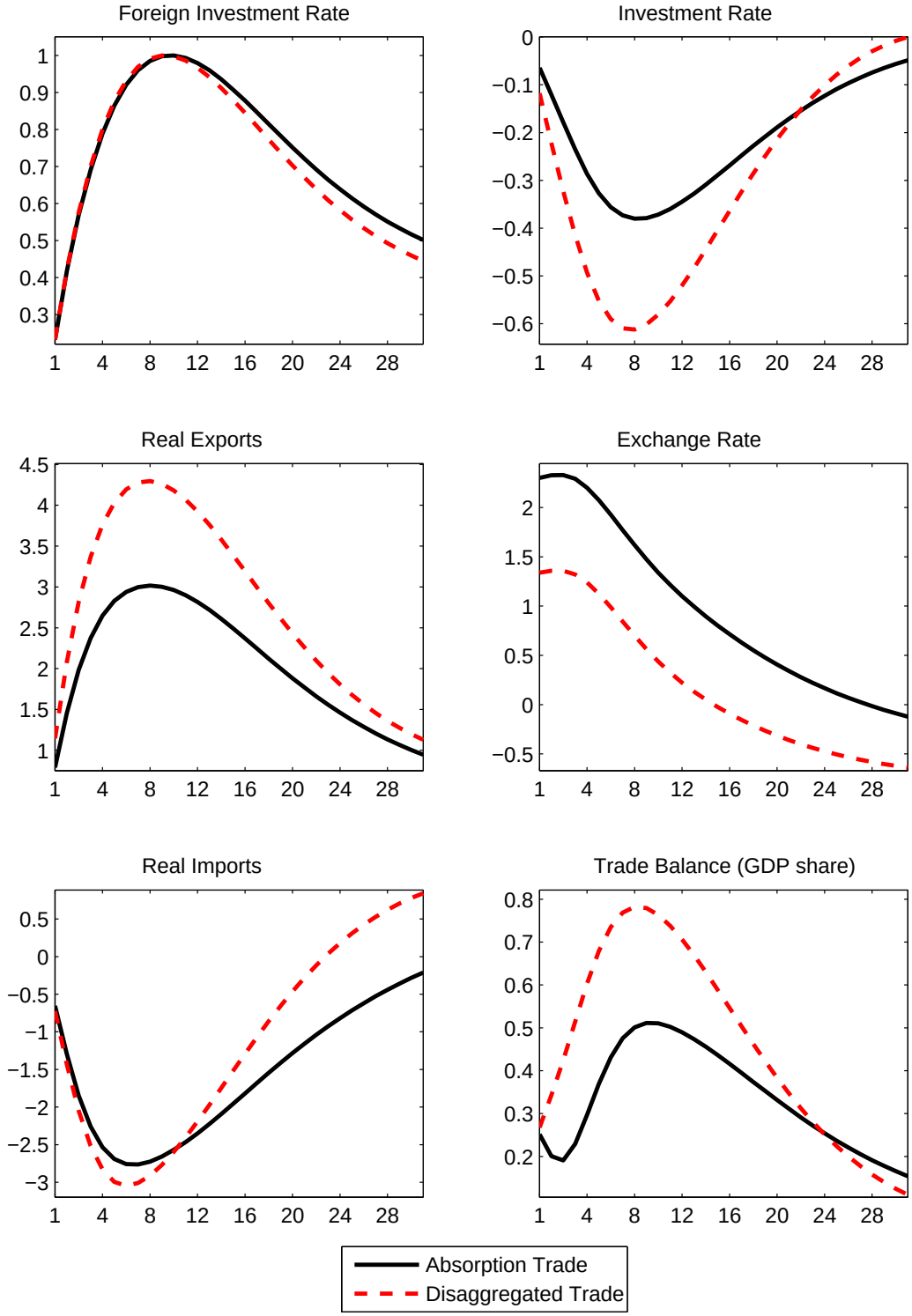


Figure 4: A Foreign Consumption Demand Shock

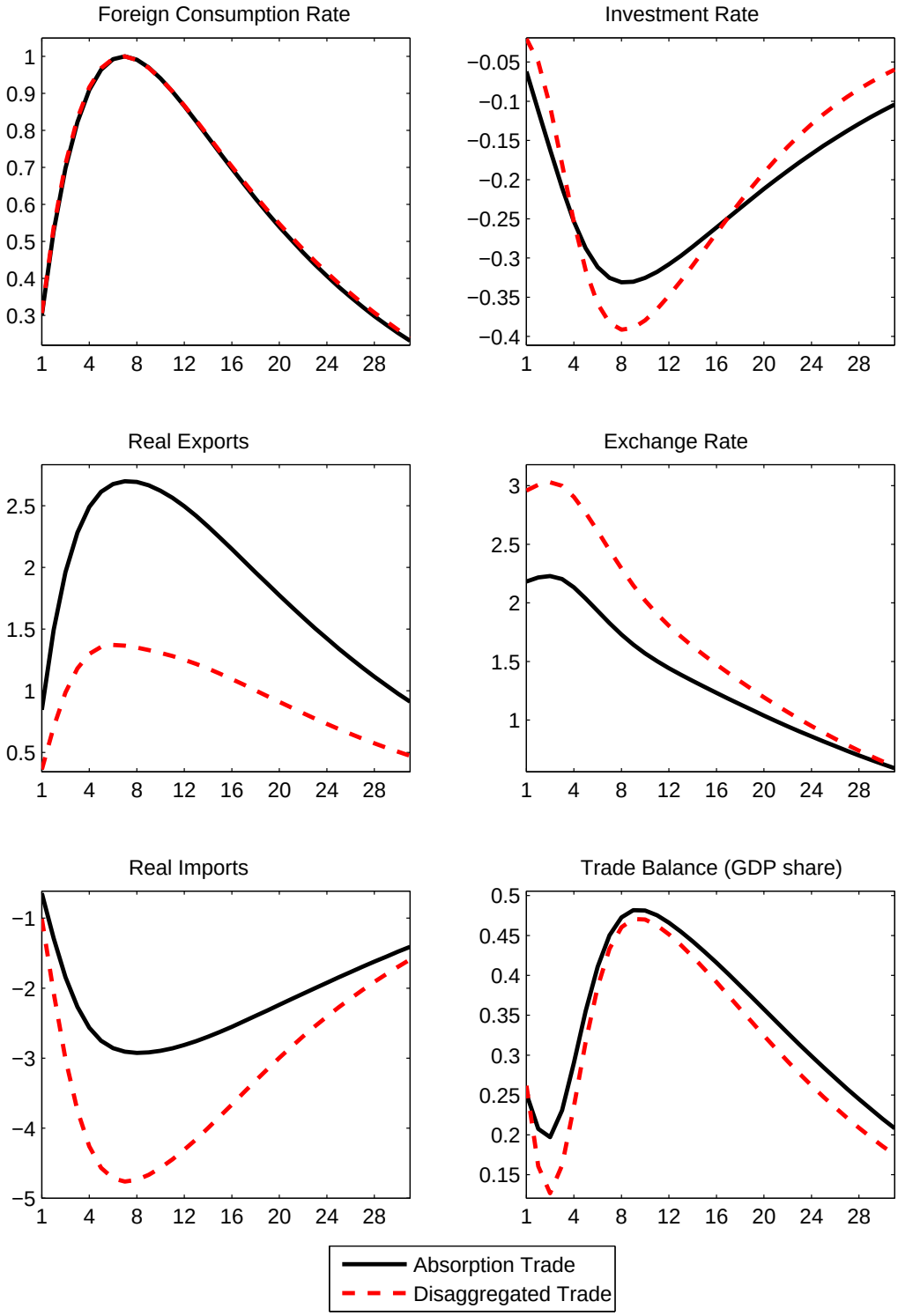


Figure 5: A Domestic Investment Demand Shock

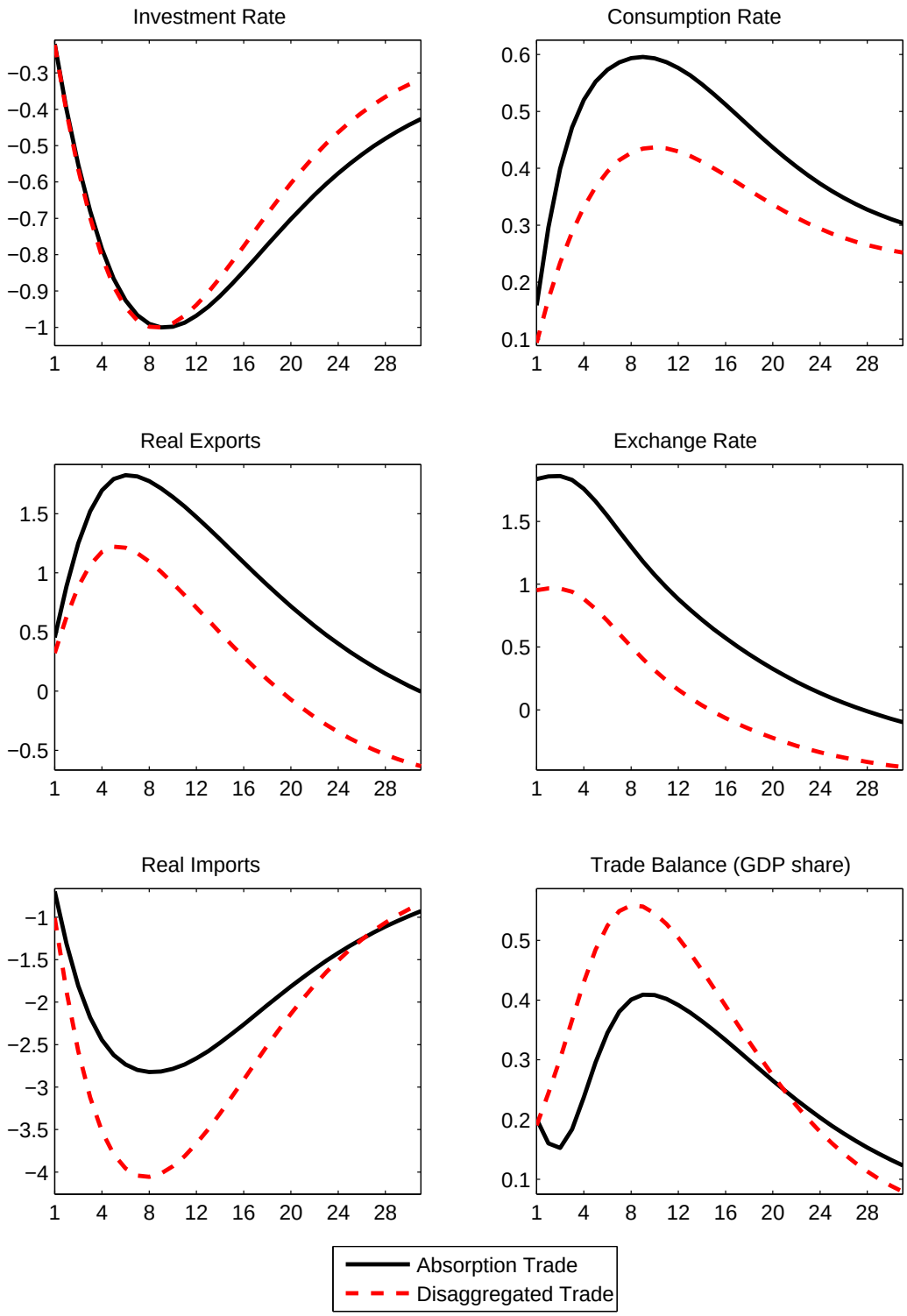


Figure 6: A Domestic Consumption Demand Shock

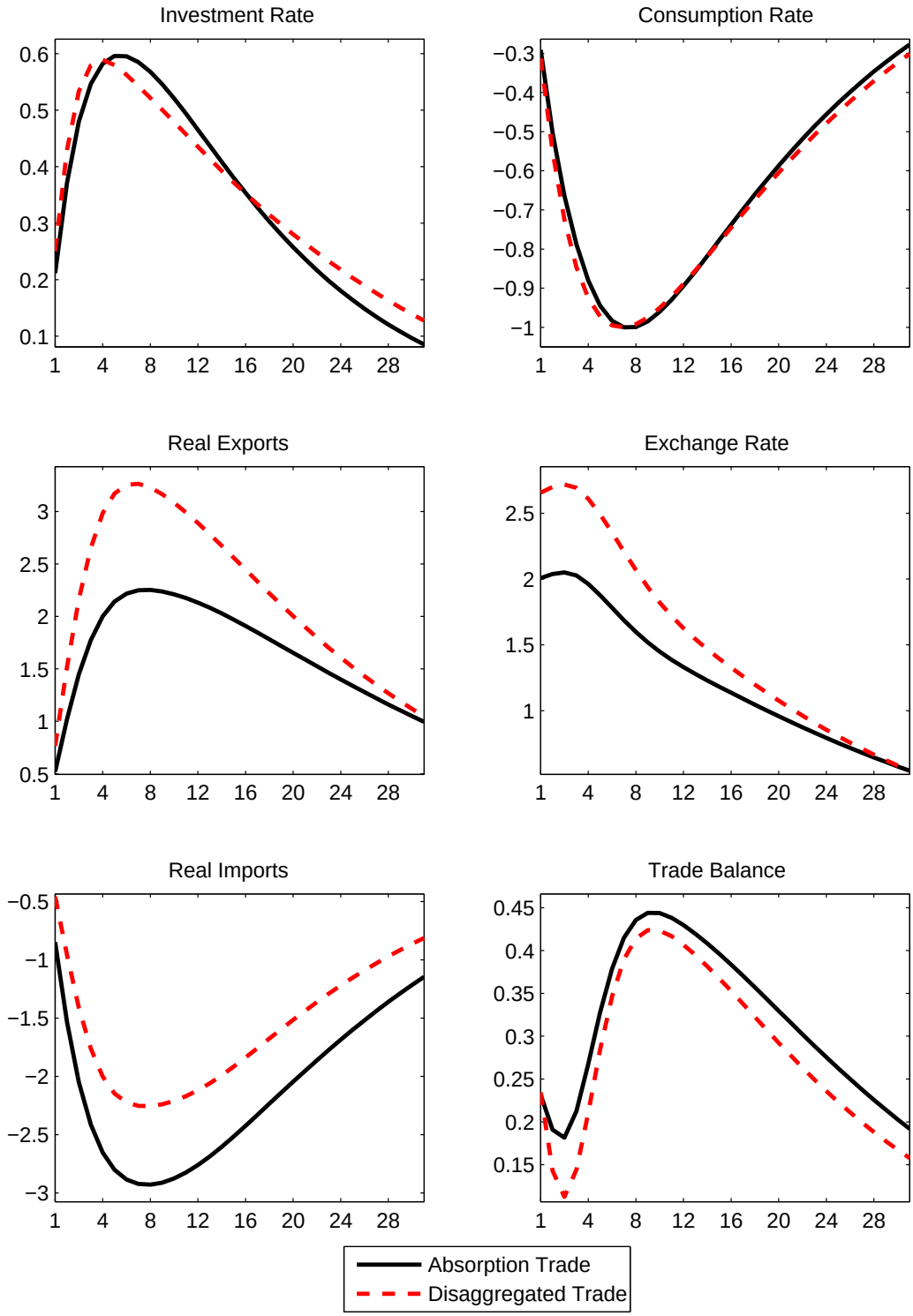


Figure 7: A Technology Shock that Boosts Real GDP by 1% in the Long Run

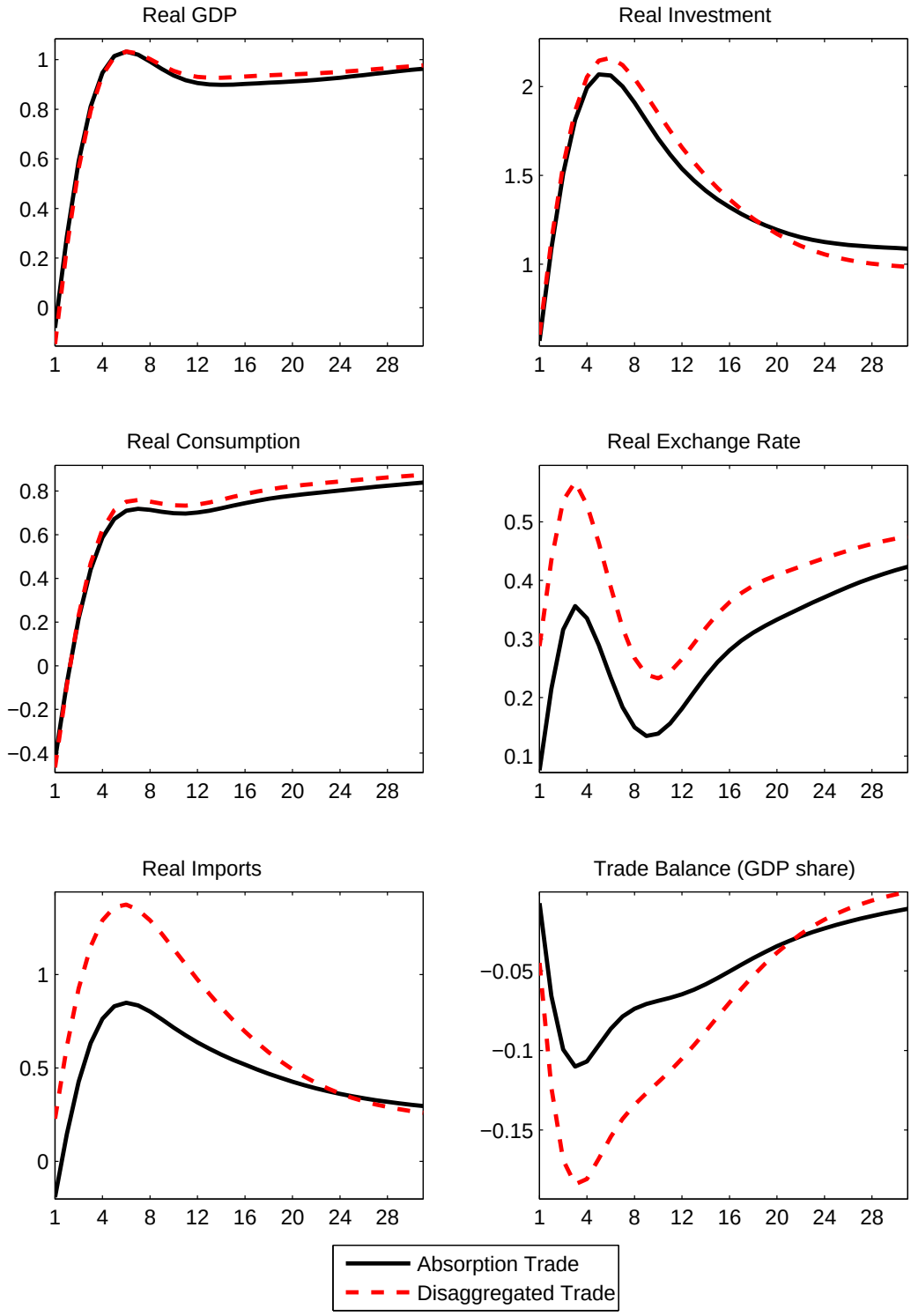
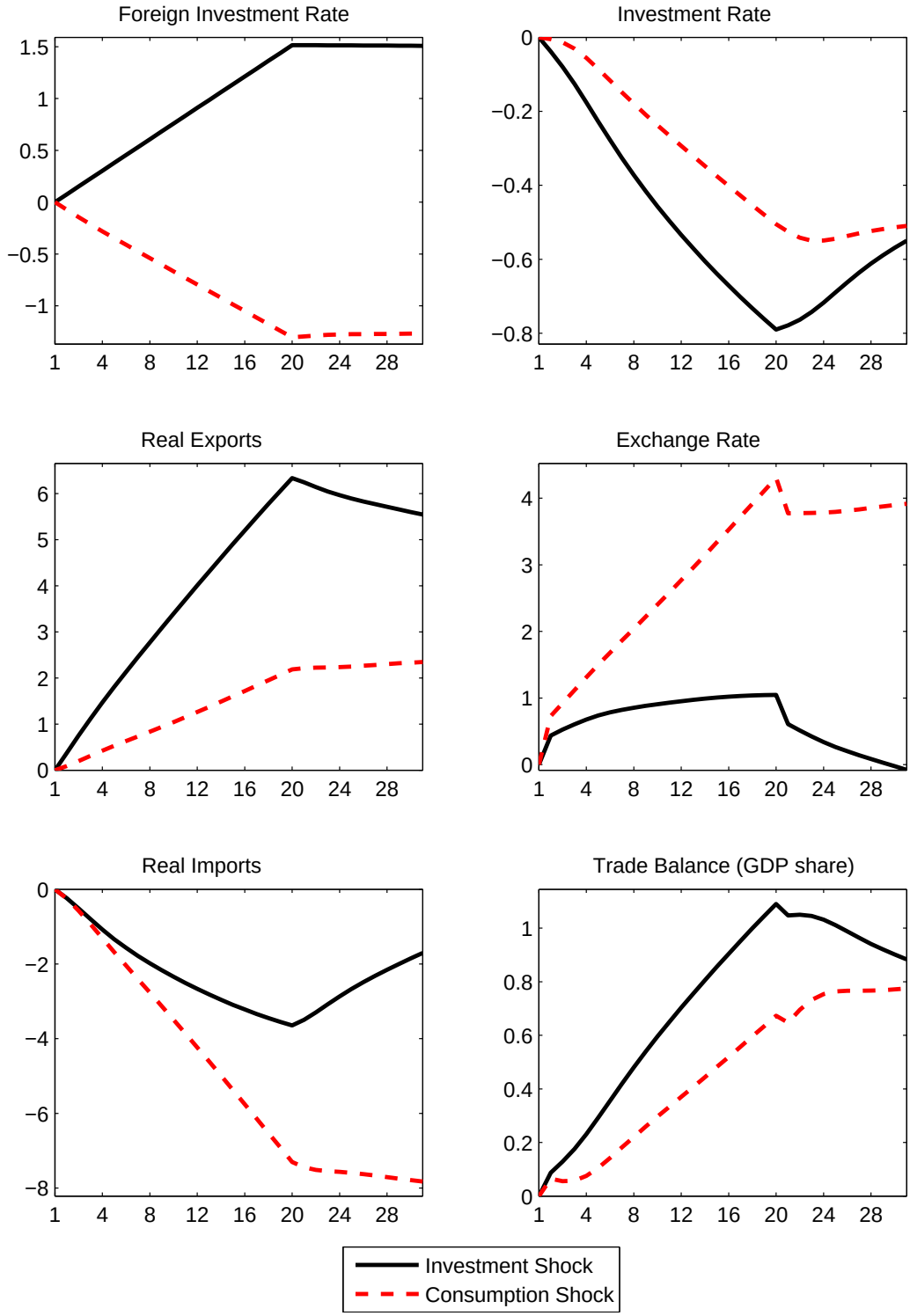


Figure 8: A Persistent Increase in Foreign Demand (Disaggregated Trade Specification)



Conclusions

- Investment shocks may serve as catalyst for trade adjustment with minimal exchange rate movement.

- Changes that boost investment abroad could improve trade balance by stimulating exports directly.

- Changes that boost consumption abroad would have smaller effects on the trade balance, and mainly operate through domestic currency depreciation.

Future Work

1. Introduce features that allow for low long-run passthrough from exchange rates to import prices.

2. Estimate model using full information maximum likelihood.