Dynamics of Firms and Trade in General Equilibrium

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Figure 1a. Aggregate exchange rate disconnect (levels)

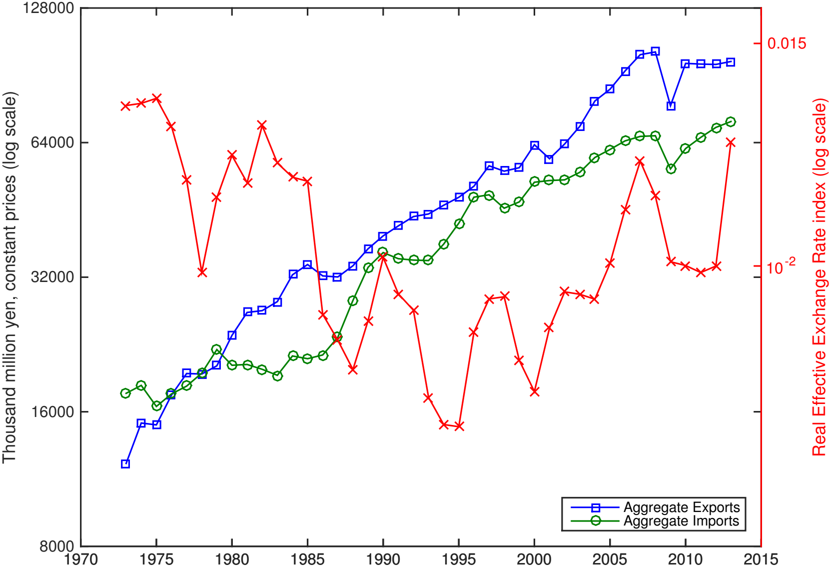
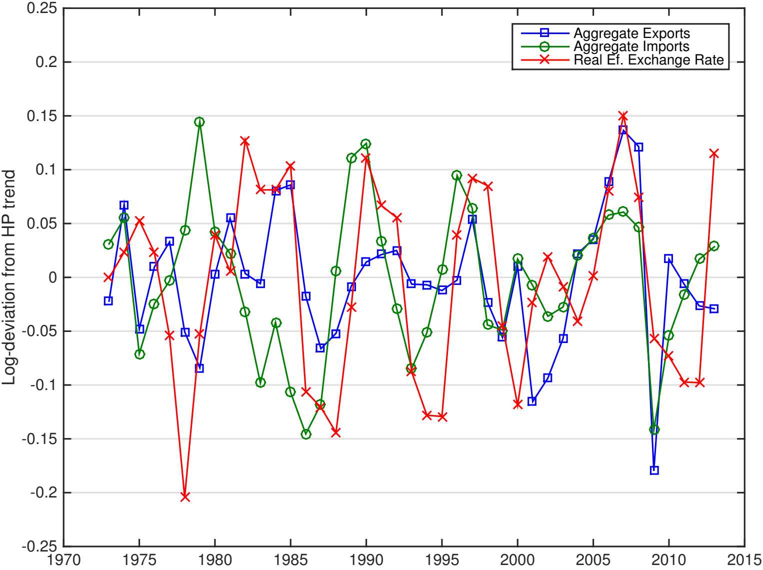


Figure 1b. Aggregate exchange rate disconnect (HP filtered)



$$\text{Corr(Exp, REER)} = \underset{(0.11)}{0.47^{***}} \qquad \text{Corr(Imp, REER)} = \underset{(0.16)}{0.19}$$

Table 1. Exports regression, Kaigin panel

	(1) All Sample	(2) High Profitability	(3) Low Profitability	(4) Big Employment	(5) Small Employment	(6) Big Sales	(7) Small Sales
log RER	0.374	0.284	0.393	0.338	0.406	0.389	0.369
	(0.049)***	(0.110)**	(0.054)***	(0.061)***	(0.068)***	(0.063)***	(0.065)***
log Y*	0.398	0.315	0.417	0.305	0.424	0.594	0.316
	(0.055)***	(0.125)**	(0.061)***	(0.072)***	(0.076)***	(0.073)***	(0.073)***
log Agg TFP	0.378	1.537	0.106	0.389	0.301	0.588	0.3
	(0.080)***	(0.181)***	-0.089	(0.104)***	(0.111)***	(0.105)***	(0.106)***
log Firm TFP	2.112	2.158	2.091	2.721	1.898	1.726	2.253
	(0.079)***	(0.169)***	(0.089)***	(0.121)***	(0.101)***	(0.111)***	(0.102)***
Cons	6.289	7.744	5.963	10.412	4.803	2.55	7.79
	(1.596)***	(3.611)**	(1.771)***	(2.083)***	(2.190)**	-2.109	(2.107)***
F-stat	325.8	118.6	228.2	250.2	152.5	171.7	196.2
Adj. R-sq.	0.042	0.122	0.029	0.171	0.002	0.126	0.022
# Obs.	9,997	2,034	7,963	3,549	6,448	3,089	6,908

Size differentiation is done by 75th percentile. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$.

In Kaigin data, the average total sales of exporters is twice as large as non-exporters $\longrightarrow$ Consistent with Melitz (2003)

But

Correlation between firm size and export dummy is weak 0.09

Correlation between firm size and export share of exporters is even weaker 0.03

Many firms have negative profit, 8% in total and 11% among exporters

$\longrightarrow$ We consider heterogeneous productivity of each product and each firm produces multiple products

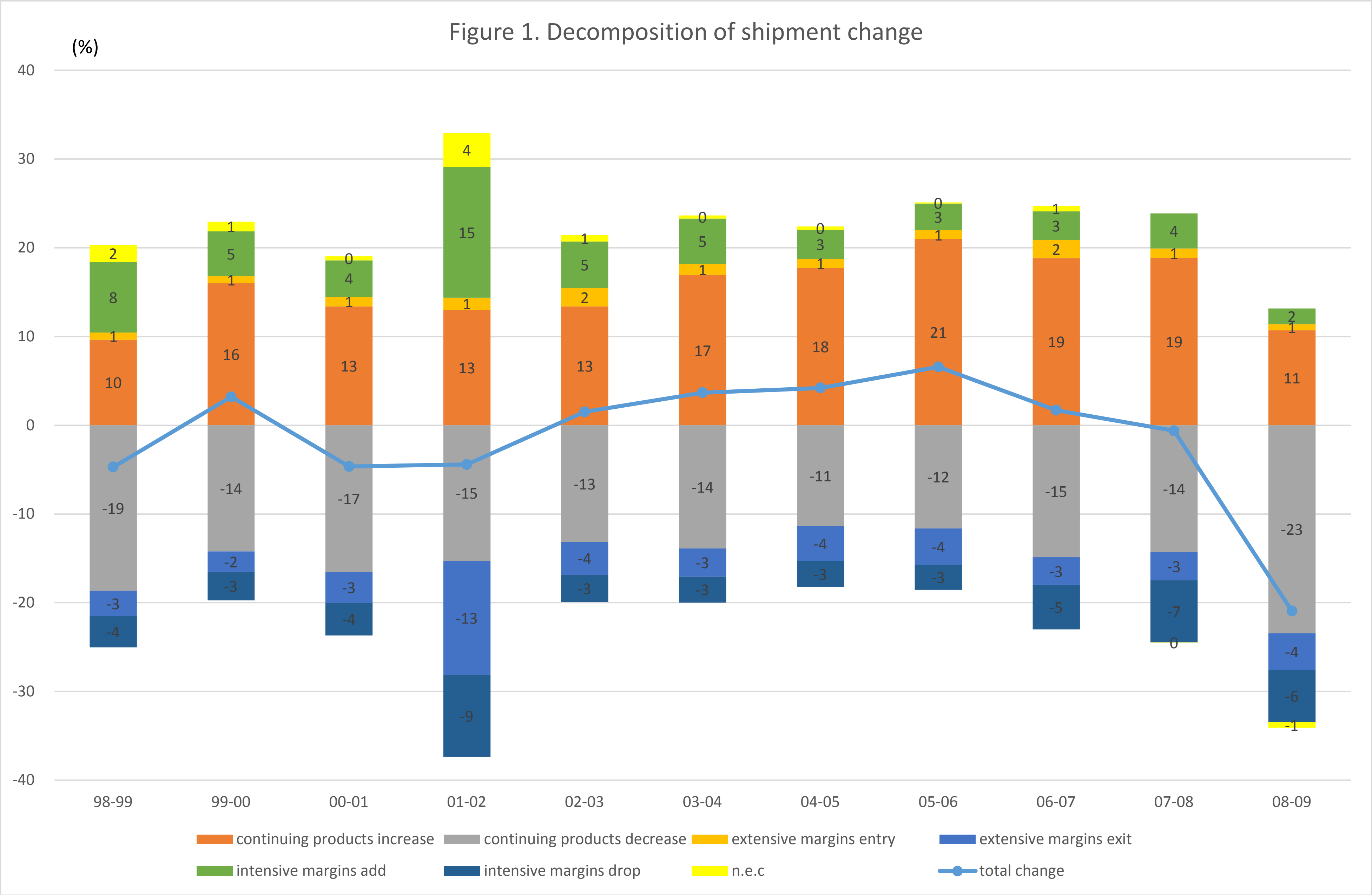


Figure 1. Decomposition of shipment change
(%)
40
30
20
10
0
-10
-20
-30
-40
98-99
99-00
00-01
01-02
02-03
03-04
04-05
05-06
06-07
07-08
08-09
continuing products increase
continuing products decrease
extensive margins entry
extensive margins exit
intensive margins add
intensive margins drop
n.e.c
total change

Small Open Economy Model

A continuum of home firm $h \in \mathcal{H}_t$. Firm h produces I_{ht} number of differentiated products for home and export market

$$q_{hit}^{H} = a_{hit} Z_t \left(\frac{l_{hit}^{H}}{\gamma_L}\right)^{\gamma_L} \left(\frac{m_{hit}^{*H}}{1-\gamma_L}\right)^{1-\gamma_L}, \text{ for } i = 1, 2, .., I_{ht}$$

$$q_{hit}^{F} = a_{hit} Z_t \left[\left(\frac{l_{hit}^{F}}{\gamma_L}\right)^{\gamma_L} \left(\frac{m_{hit}^{*F}}{1-\gamma_L}\right)^{1-\gamma_L} - \phi\right], \text{ for } i = 1, 2, ..I_{ht}$$

Home output for home and export markets are produced as

$$Q_t^H = \left[\int_{h\in\mathcal{H}_t} \left(\sum_{i=1}^{I_{ht}} q_{hit}^{H\,\frac{\theta-1}{\theta}}\right) dh\right]^{\frac{\theta}{\theta-1}}$$

$$Q_t^F = \left[\int_{h\in\mathcal{H}_t} \left(\sum_{i=1}^{I_{ht}} q_{hit}^{F\,\frac{\theta-1}{\theta}}\right) dh\right]^{\frac{\theta}{\theta-1}}$$

A new entrant who pays a sunk cost κ_{Et} at date t draws an opportunity of producing a new products from date t+1 with probability λ_E. The productivity of the new product is distributed as

$$\text{Prob}\left(a_{hit} \leq a\right) = F(a) = 1 - a^{-\alpha}, \text{ for } a \in [1, \infty)$$

where $\alpha > 1$ and $\alpha > \theta - 1$.

A firm must pay the fixed maintenance cost κ for each product in order to produce and maintain its productivity

$$a_{hit+1} = \begin{cases} a_{hit}, \text{with probability } 1 - \delta \\ 0, \text{with probability } \delta \end{cases}$$

In addition, each maintained product yields an opportunity to produce another new product with probability $\lambda\delta < \delta$ with the same Pareto distribution.

Each firm can produce many products. Each product multiplies and dies like "amoeba."

Home final goods market

$$Q_t^H = C_t + \kappa_{Et} N_{Et} + \kappa N_t$$

N_{Et} is measure of entering firms, N_t is measure of differentiated products maintained, and

$$\kappa_{Et} = \kappa_E \left(\frac{N_{Et}}{N_E} \right)^{\eta}, \ \eta > 0 \tag{1}$$

The representative household supplies labor L_t, consumes final goods C_t and holds home and foreign real bonds D_t and D_t^* to maximize its expected utility

$$U_0 = E_0 \sum_{t=0}^{\infty} \beta^t \left(\ln C_t - \psi_0 \frac{L_t^{1+1/\psi}}{1+1/\psi} + \xi_t^* \ln D_t^* \right)$$

subject to the budget constraint

$$\begin{aligned} & C_t + \kappa_E N_{Et} + \kappa N_t + D_t + \epsilon_t D_t^* \\ = \; & w_{Lt} L_t + \Pi_t + R_{t-1} D_{t-1} + \epsilon_t R_{t-1}^* D_{t-1}^* \end{aligned}$$

ξ_t^* : utility (liquidity) shock to foreign bond holding

Foreigners do not hold home bond $\rightarrow D_t = 0$

Foreign bond holding of home household

$$D_t^* = R_{t-1}^* D_{t-1}^* + p_t^F Q_t^F - M_t^{*H}$$

where M_t^{*H} is total import of intermediate input

Foreign aggregate demand for home exports are given by

$$Q_t^F = (p_t^F)^{-\varphi} Y_t^*$$

where Y_t^* is an exogenous foreign demand

Competitive Equilibrium

All firms choose to pay the fixed maintenance cost

$$N_{t+1} = (1 - \delta + \delta\lambda)\, N_t + \lambda_E N_{Et} \tag{2}$$

Price of differentiated goods is a mark-up over the unit cost and the price index of home final goods at home is

$$1 = p_t^H = \left[\int_{h\in\mathcal{H}_t} \left(\sum_{i=1}^{I_{ht}} p_{hit}^{H\ 1-\theta}\right) dh\right]^{\frac{1}{1-\theta}} = \frac{\theta}{\theta\text{-}1}\frac{w_t}{\overline{a}N_t^{\frac{1}{\theta-1}}Z_t} \tag{3}$$

$$w_t = (w_{Lt})^{\gamma_L}\epsilon_t^{1-\gamma_L},\ \overline{a} \equiv \left[\int_1^\infty a^{\theta-1}dF(a)\right]^{\frac{1}{\theta-1}} = \left(\frac{\alpha}{\alpha+1-\theta}\right)^{\frac{1}{\theta-1}}$$

Only products with higher than $\underline{a}_t$ productivity is exported.

$$\underline{a}_t = \left[\frac{\alpha\,(\theta-1)\,\phi}{\alpha+1-\theta}\frac{\overline{a}Z_tN_t^{\frac{\theta}{\theta-1}}}{\epsilon_t^{\varphi}Y_t^*}\right]^{\frac{\theta-1}{\alpha(\theta\text{-}1)+(\alpha+1\text{-}\theta)(1\text{-}\varphi)}} \tag{4}$$

The input composite market equilibrium is

$$X_t = \left(\frac{L_t}{\gamma_L}\right)^{\gamma_L} \left(\frac{M_t^{*H}}{1-\gamma_L}\right)^{1-\gamma_L} = \frac{1}{\gamma_L(\psi_0 C_t)^{\psi}} \left(\frac{w_t^{1-\gamma_L+\psi}}{\epsilon_t^{(1-\gamma_L)(1+\psi)}}\right)^{\frac{1}{\gamma_L}} \tag{5}$$

$$= X_t^H + \phi \frac{\theta\alpha + 1 - \theta}{\alpha + 1 - \theta} \underline{a_t}^{-\alpha} N_t \tag{6}$$

Free entry condition is

$$\kappa_{Et} = \lambda_E E_t \left(\Lambda_{t,t+1} \overline{V}_{t+1}\right) : \text{ free entry} \tag{7}$$

where the value function of the average product

$$\overline{V}_t = \overline{\pi}_t - \kappa + (1 - \delta + \delta\lambda) E_t \left(\Lambda_{t,t+1} \overline{V}_{t+1}\right) \tag{8}$$

where $\Lambda_{t,t+1} = \beta C_t / C_{t+1}$ and

$$\overline{\pi}_t = w_t \left[\frac{X_t}{(\theta - 1)N_t} - \frac{\theta}{\theta - 1} \phi \underline{a_t}^{-\alpha}\right] \tag{9}$$

The final goods market clearing implies

$$C_t + \kappa_{Et} N_{Et} + \kappa N_t = \overline{a} N_t^{\frac{1}{\theta-1}} Z_t X_t^H \tag{10}$$

Net foreign assets evolve as

$$\epsilon_t D_t^* = \epsilon_t R_{t-1}^* D_{t-1}^* + \underline{a}_t^{\frac{(\alpha+1\text{-}\theta)(1\text{-}\varphi)}{\theta-1}} \epsilon_t^{\varphi} Y_t^* - (1-\gamma_L) w_t X_t \tag{11}$$

Home demand for home bond and foreign bond imply

$$1 = R_t E_t(\Lambda_{t,t+1}) \tag{12}$$

$$\epsilon_t - R_t^* E_t \left(\Lambda_{t,t+1}\epsilon_{t+1}\right) = \xi_t^* \frac{C_t}{D_t^*} \tag{13}$$

$(1-13)$ determine $w_t, \underline{a}_t, X_t, X_t^H, C_t, \epsilon_t, R_t, \overline{V}_t, \overline{\pi}_t, \kappa_{Et}, N_{Et}$, N_{t+1} and D_t^* as a function of the state variables $\mathcal{M}_t = (N_t, D_{t-1}^*, Z_t, \xi_t^*, Y_t^*, R_t^*)$

Table 2a. Baseline parameterization

β	Discount factor	0.92
θ	Elasticity of substitution between products	4.19
ψ	Frisch elasticity of labor supply	6.02
ψ_0	Labor disutility	12.84
γ_L	Labor share	0.85
α	Productivity distribution shape parameter	3.64
φ	Elasticity of foreign demand	0.75
ϕ	Export cost	3.14
κ	Maintenance cost	16.57
κ_E	Entry cost	89.26
η	Elasticity of entry cost	0.1
δ	Probability of losing product	0.12
λ	Probability of drawing new product for incumbent	0.49
λ_E	Probability of producing new product for entrant	0.41
σ	Std. dev. of noise for sales	1.67
Z	Steady state aggregate productivity	1
Y^*	Steady state foreign demand	10^6
G/C	Steady state govt. expenditure / cons.	0.28
ξ^*	Steady state liquidity shock	0.01
R^*	Steady state foreign interest rate	1.05

Table 2b. Steady state moments (aggregate and cross-sectional)

	Data	Model
C/Y	0.56	0.66
$\epsilon D^*/Y$	0.20	0.19
Exp/Y	0.12	0.12
N_E/N	0.10	0.15
Mean log Rev	17.77	17.77
SD log Rev	1.42	1.84
Mean log Dom	17.65	17.66
SD log Dom	1.41	1.84
Mean log Exp	16.03	15.58
SD log Exp	2.09	1.85
Mean PR	0.03	0.15
SD PR	0.06	0.15
$\#Exp/N$	0.39	1.00
Corr PR, log Rev	0.07	0.71
Corr ES, log Rev	0.17	0.32

Figure 3a. Cross sectional distribution of total sales by export status: Kaigin data

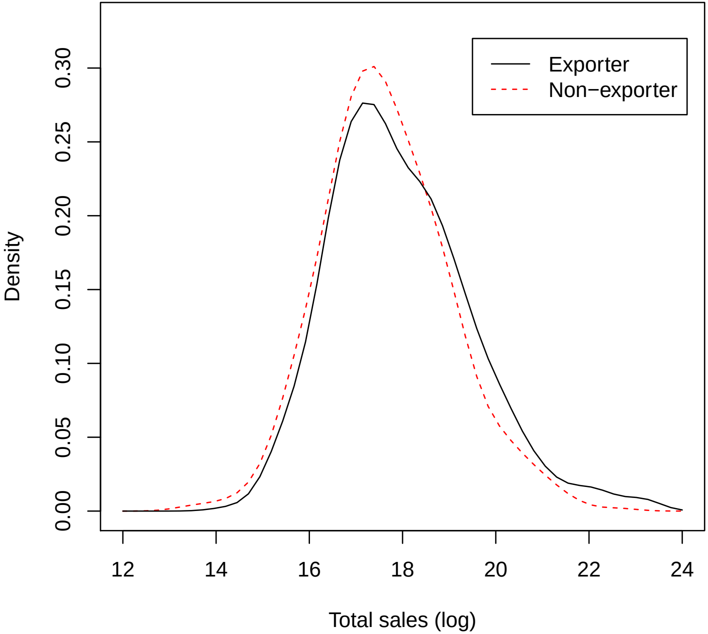


Figure 3b. Cross sectional distribution of total sales by export status: Model

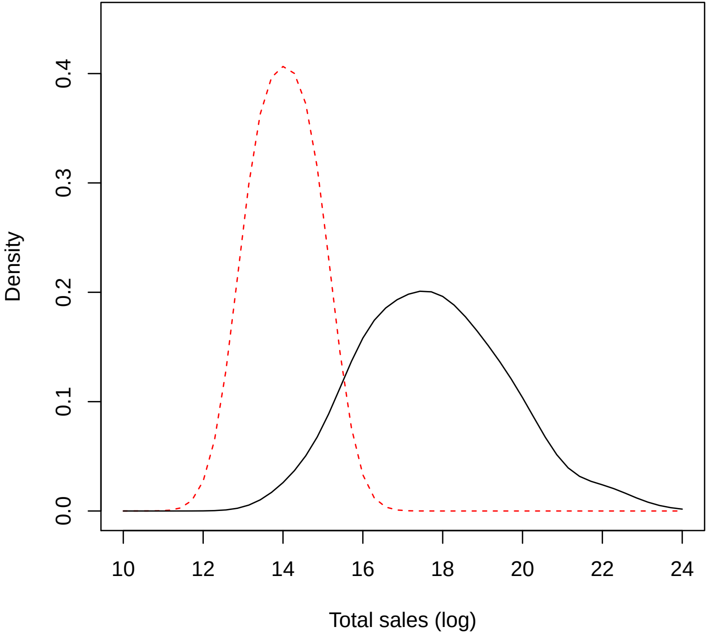


Table 3a. Calibration of stochastic processes

	Efficient	Subjective
Standard deviation		
σ_Z (%)	0.87	0.59
σ_{Y^*} (%)	1.35	5.46
σ_G (%)	0.83	0.61
σ_{ξ^*} (%)	22.05	79.16
Autocorrelation		
ρ_Z	0.55	0.73
ρ_{Y^*}	0.94	0.84
ρ_G	0.95	0.95
ρ_{ξ^*}	0.95	0.27

Table 3b. Sample and simulated moments

	Data	Efficient	Subjective
Standard deviation			
SD GDP (%)	0.88	0.93	0.96
	(0.10)		
SD Gov / SD GDP	0.63	0.83	0.59
	(0.11)		
SD Inv / SD GDP	3.13	2.80	2.47
	(0.13)		
SD Exp / SD GDP	4.63	2.41	4.24
	(0.70)		
SD RER (%)	3.52	3.07	3.57
	(0.31)		
Autocorrelation			
AC(1) GDP	0.55	0.34	0.40
	(0.15)		
AC(1) Gov	0.65	0.49	0.49
	(0.07)		
AC(1) Inv	0.58	0.30	0.23
	(0.13)		
AC(1) Exp	0.36	0.45	0.37
	(0.18)		
AC(1) RER	0.49	0.46	0.28
	(0.06)		
Correlation with GDP			
Corr Gov, GDP	0.08	0.12	0.08
	(0.19)		
Corr Inv, GDP	0.96	0.97	0.85
	(0.01)		
Corr Exp, GDP	0.55	0.08	0.53
	(0.19)		
Corr RER, GDP	0.42	-0.04	-0.59
	(0.16)		

Data and output from the model are HP filtered.

HAC robust standard errors are shown in parenthesis.

Figure 4. Impulse response to TFP shock Z

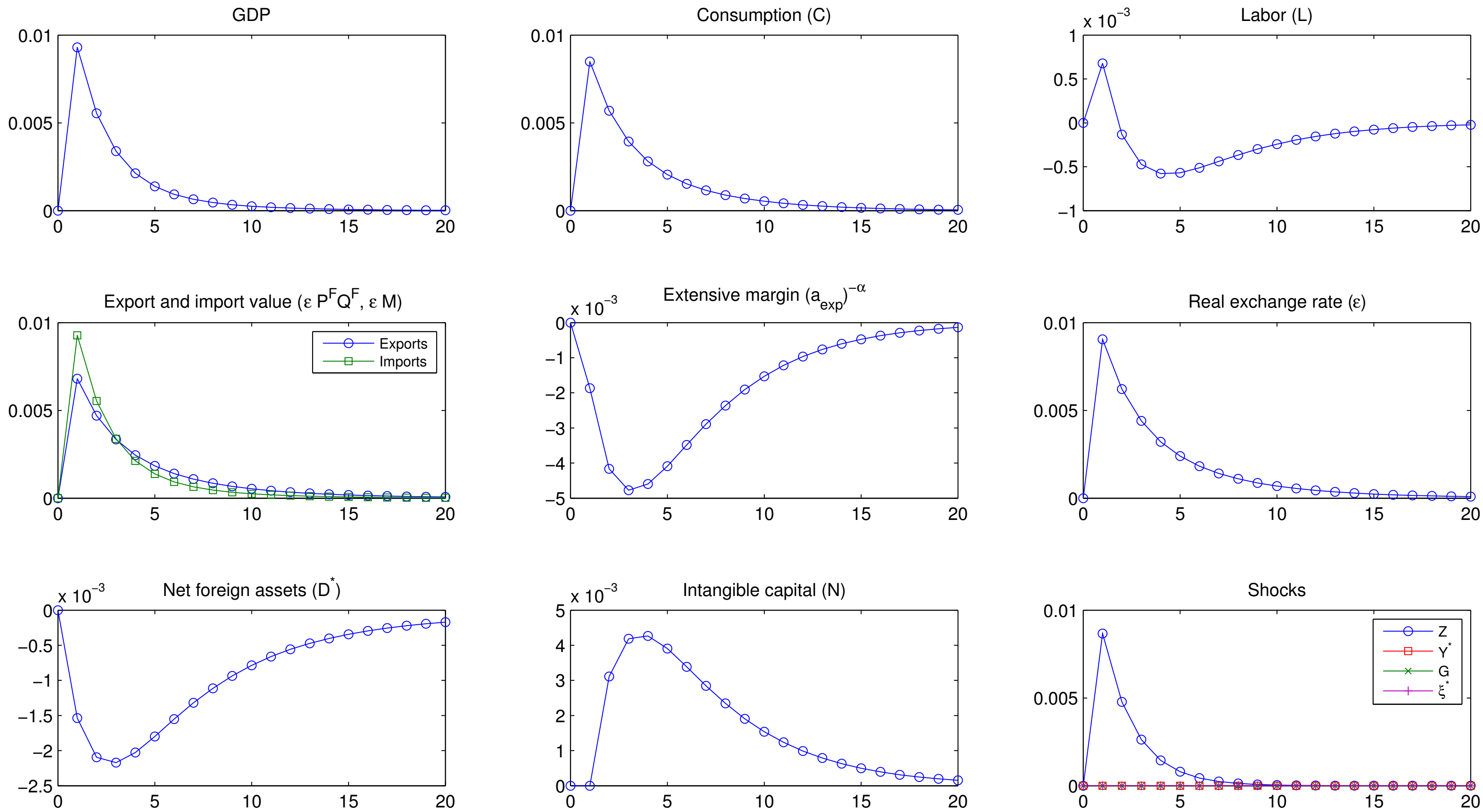


Figure 5. Impulse response to foreign demand shock Y^*

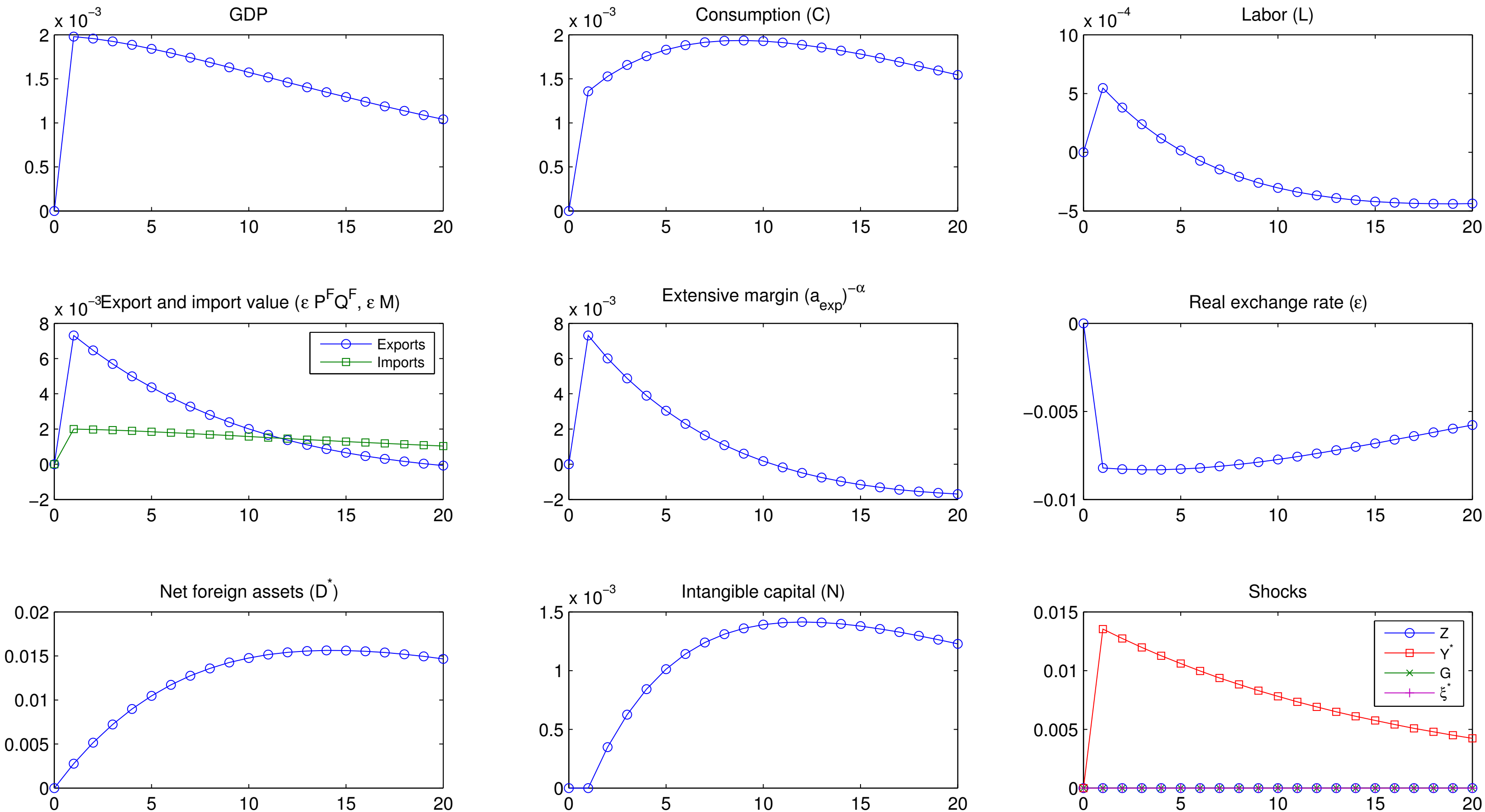


Figure 7. Impulse response to liquidity shock ξ^*

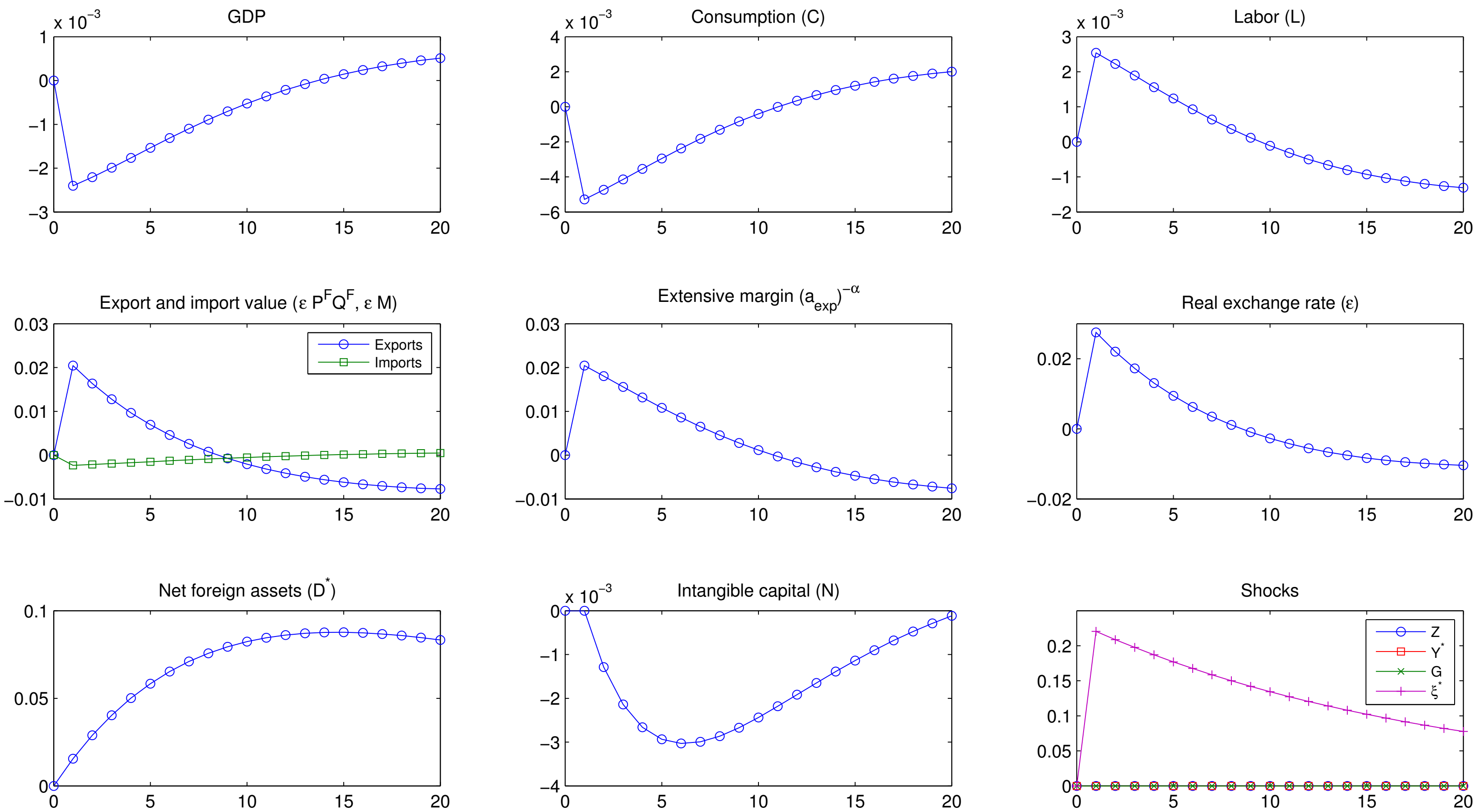


Table 6. Panel regression on simulated data: Profitability interaction

	Data	Model			
		(1)	(2)	(3)	(4)
log RER	0.527	1.95	1.95	2.00	1.65
	(0.065)***	(-7.4, 11.07)	(-0.02, 3.8)	(0.11, 3.84)	(1.18, 2.21)
log RER × PR	-1.604		-0.25	-1.81	-0.58
	(0.954)*		(-0.3, -0.23)	(-4.11, 0.56)	(-1.39, 0.27)
log Y*	0.383	2.19	2.28	2.36	2.17
	(0.055)***	(-17.9, 23.33)	(-2.06, 6.61)	(-1.88, 6.69)	(0.9, 3.29)
log Y* × PR	-0.357			-2.32	-0.83
	(0.155)**			(-5.72, 1.25)	(-2.03, 0.43)
log Agg TFP	-0.678	-0.83	-2.32	-2.64	-1.16
	(0.103)***	(-29.32, 24.36)	(-8.62, 2.99)	(-8.89, 2.21)	(-2.77, -0.17)
log Agg TFP × PR	21.09			7.76	1.16
	(1.436)***			(0.24, 16.04)	(-1.26, 3.96)
log Firm TFP	2.295				0.98
	(0.084)***				(0.97, 0.99)
Cons	7.573				
	(1.626)***				
# Obs.	9,994	26,752			
		(10536, 38688)			

For the model, 95% bootstrap confidence intervals (with 1,000 simulations) are shown in parenthesis.

Figure 8. Response of exports to the exchange rate at extensive and intensive margins