The Dynamics of the Trade Balance and the Real Exchange Rate: The J Curve and Trade Costs?*

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Abstract
We show that flexible and sticky price multi-country models generate a counterfactual comovement between the trade balance and the real exchange rate and that the dynamics of the US trade balance since 1980 are mostly attributed to declines in trade costs and a gradual response of trade flows to past movements in the real exchange rate. We develop a theoretical model with heterogenous producers, a dynamic export participation decision, pricing to market, and declining trade costs to address these properties of the trade balance. With temporary and permanent shocks to trade costs leading to fluctuations in trade and the observed increases in trade, the model can capture the dynamics of the trade balance and the real exchange rate. With these movements in the trade balance, business cycles are substantially more synchronized and there is much less consumption risk sharing.

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1. Introduction

In a famous paper, Backus, Kehoe and Kydland (1994) show that the tendency for the trade balance to increase following a depreciation of the real exchange rate[1] is well-described by a two country dynamic stochastic general equilibrium model with productivity shocks and capital accumulation.[2,3] In that model a positive productivity shock leads both to a depreciation of the real exchange rate and a trade deficit as the cross country productivity gap temporarily stimulates investment leading to a trade deficit. In this paper we show that this mechanism is actually not at the heart of the dynamic comovement between the trade balance and the real exchange. Instead, the dynamics of the trade balance and the real exchange are related to the slow adjustment of trade to movements in relative prices and substantial changes in the costs of trade at business cycle and lower frequencies.

The apparent success of the two country RBC model in explaining the comovement between the trade balance and the real exchange rate is actually rooted in its two well-known failures: the quantity and price puzzles. The quantity puzzle is the inability of the model to generate synchronized business cycles. The price puzzle is the inability of the model to generate large enough relative price movements.

To see how these failures drive the model's main success consider the ratio of exports to imports as our measure of trade balance. In nearly all international macro models in which home and foreign goods are imperfect substitutes this ratio is described by the following

[1] BKK focus on the dynamics between the trade balance and the terms of trade not the real exchange rate. However, in their framework the terms of trade and real exchange rate are perfectly correlated.

[2] Raffo (2008) points out that in the BKK model that real trade balance to gdp ratio and nominal trade balance to gdp are negatively correlated when investment is constrained to match the observed pattern in the data while in the data they are quite positively correlated. By making consumption more volatile he can fix this problem.

[3] Heathcoate and Perri (2014) use this model as the benchmark for international business cycles in the recent handbook of international economics chapter.

structural relationship

$$\text{(1)} \quad \ln(EX/M) = -\rho\left[\ln\left(p_{ex}(1+\tau^*)/P^*\right) - \ln\left(p_m(1+\tau)/P\right)\right] + \ln\left(D^*/D\right),$$

where ρ is the elasticity of substitution between home and foreign goods, τ, τ^* are trade costs/taste shifters, p_{ex} and p_m are the export and import prices, P,P* are the home and foreign price levels, D, D^* denote home and foreign domestic absorption. The first term shows how changes in relative prices induce substitution between home and foreign goods. Whenever the real exchange rate depreciates, say from an increase in productivity, this makes the ratio of exports to imports increase. To generate a trade deficit with a depreciation then requires the second term, which is the difference in foreign and domestic expenditures, to respond strongly to offset the substitution effect. Taken together the quantity and price puzzles make the expenditure effect quite strong and the substitution effect weak. With a strong but temporary gap in cross country expenditures the ratio of expenditures will move from deficit to surplus over time explaining .

By controlling for movements in final expenditures it is straightforward to see that

$$\text{(2)} \quad \ln(EX/M) - \ln\left(D^*/D\right) = -\rho\left[\ln\left(p_{ex}(1+\tau^*)/P^*\right) - \ln\left(p_m(1+\tau)/P\right)\right],$$

With this in hand, it is clear that once one controls for movements in absorption all that is left is the substitution effect and so a depreciation will always lead to a surplus in this alternative measure of the net trade flows and correlations of the left hand side with lags of the real exchange rate

In the next section, we reconsider the dynamics of the trade balance using our theoretically consistent measure. We highlight three features that have not featured prominently in the literature. First, fluctuations in the trade balance and real exchange rate are much larger and more persistent than previously thought. Much of the volatility of the trade balance and real exchange rate has been ignored by the quantitative macro literature because these series tend to be detrended using an hp filter for reasons of stationarity. However, there is no need to hp-filter our measure of the trade balance since it is stationary. Doing so, we find that the raw fluctuations in the trade balance (and real exchange rate) are 5 (2.2) times as large as the detrended fluctuations and 15 (10) percentage points more persistent. Thus, quantitative macro literature has concerned itself with explaining less than 20 percent of net flows. Second, temporary and permanent changes in trade costs account for a substantial share of the fluctuations in the US trade balance. Indeed, our theoretical measure of the trade balance accounts for less than 1/3 of the fluctuations in the trade balance and there are persistent departures from the predictions of the theory. And third, the trade balance gradually responds to changes in trade costs and relative prices. A simple way of seeing this is to estimate an error correction model of our structural equation as this yields short-run and long-run elasticities. These types of statistical models have been frequently used to estimate import demand or export supply equations (see Hooper, Marquez, and Johnson 2000). Depending on our level of aggregation we find that the short-run elasticity of substitution is quite low, around 0.25 at the quarter level, but rises to between 1.5 and 3 in the long-run with only about 8 percent of the gap closed each quarter.

To address the features of the trade balance and international business cycles we build on the heterogeneous producer model of Alessandria and Choi (2007). This is a variation of the BKK model with heterogenous producers subject to idiosyncratic productivity shocks and a sunk and fixed cost of exporting. The heterogeneity and dynamic exporting decision leads the exporters to respond gradually to aggregate shocks. We extend the model along two dimensions. First, we introduce pricing-to-market by allowing the trade elasticity in foreign markets to be variable. Pricing-to-market is crucial to explain the persistent deviations from the law of one price across countries and to get the real exchange rate to be more volatile than the data (see Alessandria 2009). Additionally, pricing-to-market leads US firms to raise their markups when the US real exchange rate depreciates. These higher markups lead to a stronger expansion of US exporters than in the constant markup. Second, we introduce persistent and temporary shocks to the costs of trade. The persistent component of trade costs is chosen to match the more than doubling of US trade-to-GDP ratio from the 80s. The temporary shocks to trade costs are chosen to capture the highly cyclical nature of trade, particularly around turning points of the economy.

With temporary and permanent shocks to trade costs leading to fluctuations in trade and the observed increases in trade, the model can capture the dynamics of the trade balance and the real exchange rate. Indeed, we find that more than half of the variance of net trade flows can be attributed to the shocks to trade costs. With these movements in the trade balance, business cycles are substantially more synchronized and there is much less consumption risk sharing.

This paper is related to models of international transmission with flexible and sticky prices such as Backus, Kehoe and Kydland (1994), Chari, Kehoe and McGrattan (2002) and Corsetti, Dedola and Leduc (2008). The paper is most closely related to models with a different short-run and long-run trade response (Alessandria and Choi (2007), Drozd and Nosal (2011), Engel and Wang (2012), Alessandria, Pratap and Yue (2011) and Imura (2013). This paper is also related to models that consider trade costs in aggregate fluctuations (Stockman and Tesar, 1995, Levchenko, Lewis, and Tesar, 2010, Alessandria, Kaboski and Midrigan, 2010, 2011, 2013).

The paper is organized as follows. The next section derives a structural relationship between the ratio of exports to imports (what we redefine as the trade balance), relative prices, and relative absorption and uses it to highlight three features of the trade balance that have received little attention. First, fluctuations in the trade balance and real exchange rate are much larger and more persistent than previously thought. Second, temporary and permanent changes in trade costs account for a substantial share of the fluctuations in the US trade balance. And third, the trade balance gradually responds to changes in trade costs and relative prices. In section 3 we develop a two-country dynamic general equilibrium model with a dynamic exporting decision. Section 4 discusses the calibration of the model. Section 5 uses the model to decompose source of the dynamics of the trade balance and real exchange rates. Section 6 concludes.

2. Evidence

In this section we present evidence on the cyclical properties of net and gross trade flows and the real exchange rate for the United States. In the data, the trade balance and real exchange fluctuations are large and persistent. Yet most analyses of international business cycles focus on explaining deviations of these variables from a trend. Figure 1 shows that these fluctuations of the RER and NX (scaled by trade) around their trend are relatively small and transitory compared to the trends in these variables. Indeed, the fluctuations in the raw series are 2 to 4 times as large as in the detrended series and the series mean revert almost 5 to 10 times slower (autocorrelations of detrended series are 0.80 to 0.90 while the raw series are 0.98 to 0.99). It is clear that most of the action is in the trends not the deviations from the trends.

The literature has generally focused on explaining the cyclical properties of the detrended ratio of net exports to GDP. This allows us to measure changes in net exports as percentage points of gdp. This is a different approach than is taken when looking at other economic variables which tend to be logged. It is done because net exports can be negative and because it allows us to consider how much more/less than income a country is saving/borrowing. A problem with this measure is that while it is possibly stationary, the growth of trade relative to GDP implies that the variance of the series is growing over time with trade (see Figure 2). Consequently the series is generally detrended using an hp filter. This filtering substantially changes the properties of net exports as a sizeable fraction of the cyclical fluctuation in net exports are attributed to the trend rather than the cycle.

An alternative and perhaps superior measure of net exports is the log of the ratio of exports to imports.

$$nxr = \log X/M = x - m$$

This is approximately equal to net exports scaled by average trade flows. This approach eliminates the role of growing trade on the size of fluctuations in net exports. Since this series is stationary there is no reason to detrend it. This is important since the standard detrending will again absorb a large fraction of the cyclical fluctuations in net exports. The following table reports how the properties of net exports are affected by the filtering. Filtering reduces net export volatility to 1/3 its level with the raw series and makes net exports considerably less persistent. This is true whether the series is measured in nominal or real terms. Finally, using the nominal trade scaled measure generates net exports that are much less countercyclical than the traditional measure (-0.26 vs -0.62) and the gap is even larger when consider the correlation with IP (-0.2 vs -0.62). Part of the weaker comovement of net export is related to the filtering as the hp filtered scaled measure is -0.39 which means the remaining part is related to the cyclicality of trade differing from GDP or IP.

This then brings up a question of what do the dynamics of gross trade flows look like over the cycle. Here we find that trade is substantially more volatile than GDP or IP and it is strongly procylical (correlation with GDP of 0.87 and with IP of 0.90). This suggests that a key reason why net exports relative to GDP appears strongly countercyclical is that in recessions trade falls substantially and this makes net exports appear to increase. This is partly a composition effect from trade being relatively intensive in highly cyclical goods such as durables and capital along with trade wedges being procyclical (see Alessandria, Kaboski and Midrigan, 2013).

Now, we can ask what explains the cyclical fluctuations in the ratio of exports to imports. Returning to equation 2 and replacing the prices with the terms of trade we have that

$$nxrip = (x - m) - (d^{*} - d) = -\gamma\,(rer + tot) + \omega^{*} - \omega,$$

where d,d* are domestic and foreign expenditures and ω, ω^{*} are shocks to taste or trade costs. Table 3 reports the results of three types of regressions. In levels, in first differences, and first differences with an error correction term. We also run the regressions allowing the coefficient on relative expenditure to differ from 1. This generally improves the fit but has a minimal impact on our estimate of the Armington elasticity. Indeed, in levels we find that the Armington elasticity is between 0.68 and 0.71. In first differences we find a much lower elasticity of about 0.18 to 0.23. With the error correction structure we find that the short run Armington elasticity is 0.15 to 0.18 while the long run is about 1.35. When we split out the relative expenditure term, proxied for by relative IP, we find a coefficient of 0.78 in levels, 0.44 in first differences, and 0.49 in the short and close to 1 in the long run.

The R$^{2\prime}s$ of the models suggest that there are substantial movements in the trade balance that are related to demand shocks/trade costs moving around. These shocks could reflect a different pace of liberalization (contemporaneous and lagged effects) or perhaps inventory type considerations. Figure 3 shows how the relative wedge evolves over this period.

A question one can ask is: Do relative prices or relative expenditures exert a stronger influence on net exports? We address this in a rudimentary way by running the same regressions but omitting either the relative price or relative expenditure term. In levels we find that slightly more of the net export fluctuations can be explained by relative price fluctuations than relative IP (R^2 of 0.29 vs 0.23). When we run the regression in first differences we find that changes in relative prices are twice as important in accounting for fluctuations in net exports (R^2 of 0.11 vs 0.06). When we include the error correction structure we find that the RER tends to explain much more of the movements in real net exports than IP (R^2 of 0.26 vs 0.05). Thus it appears that to get net export dynamics right it is crucial to relative price right.

A. Lags structure

The error correction model suggests that the Armington elasticity increases over time and it is this rising Armington elasticity that accounts for a sizeable fraction of net export dynamics. To get a sense of how fast this mechanism operates I redid the regressions using up to 6 lags of the RER in levels and first differences. In levels, we find that the Armington elasticity rises from -0.71 to -0.91 over 6 quarters and that the adjusted R^2 goes from 0.51 with the contemporaneous relative price to 0.78 with a 5 quarter lag. In first differences, the Armington elasticity rises much more modestly from -0.18 to -0.21 after 5 quarters (although I guess percentage wise the gap is not as large: 1/3 vs 1/6) and the R^2 rises from 5 percent to 8 percent. Interestingly enough including all the lags in the same regression boosts the R^2 to 23 percent even if the coefficients tend to be marginally significant.

Sticky prices or sticky quantities

The gradual movements in net exports could arise because relevant prices do not adjust (incomplete pass-through) or there are goods-level adjustments frictions.

In terms of pricing frictions one possibility is that movements in the terms of trade undo movements in the RER. This would occur if the tot was perfectly negatively correlated with the RER on impact so that the price of import and exports relative to local bundles do not change. This would imply that relative price movements would not be a source of net export dynamics on impact. This obviously cannot be going on since the tot and RER are highly correlated. However, it could be less correlated on impact than with a lag. Empirically, this would show up with a dynamic relationship between the tot and RER. One way of checking this is to again do the error correction model.

$$\Delta tot_t = \alpha_0 \Delta rer_t + \alpha_1 tot_{t-1} + \alpha_2 rer_{t-1} + \varepsilon_t$$

Table 7 reports the results. The terms of trade tends to move 25 percent as much as the RER on impact and in the long-run tends to move 29 percent. Most of the long run effect seems to be done by the next quarter. Of course a problem could arise if the tot is somehow mismeasured.

B. Disaggregate Results

In Table 8 we reconsider our results using more disaggregate data. Specifically, we estimate the same equation on using data on goods and goods excluding oil. We allow the income term to be different from one. As before we find a relatively low, but significant estimate for the short-run price elasticity of between 0.20 to 0.35 and a long run that ranges between 1.4 and 2.26 with about 8 percent of the adjustment to the long-run taking place per quarter. The coefficients are all quite significant.

3. Model

We now develop a two country model with heterogenous producers entering and exiting the export market. We extend the model of Alessandria and Choi (2007) to include shocks to trade costs and variables markups.

Home and foreign prices are normalized to 1: $P_t = P_t^* = 1$.

Consumers:

$$\max E_0 \sum_{t=0}^{\infty} \Theta_t U\left(C_t, L_t\right),$$

subject to

$$C_t + V_t B_t = W_t L_t + B_{t-1} + \Pi_t,$$

where $U\left(C, L\right) = \left[C^{\gamma}\left(1-L\right)^{1-\gamma}\right]^{1-\sigma} / \left(1-\sigma\right)$, Π_t is the dividend payments from home firms. In a standard model with $\Theta_t = \beta^t$, we apply small bond holding cost of $\frac{\zeta_b}{2}\left(\frac{V_t B_t}{Y_t^N}\right)$ for home with Y_t^N being nominal home GDP and $\frac{\zeta_b}{2}\left(\frac{V_t B_t^*}{q_t Y_t^{N*}}\right)$ for foreign.

The stochastic cumulative discount factor evolves as

$$\begin{aligned} \ln\left(\Theta_{t+1}/\Theta_t\right) &= \ln \beta_t \\ &= \left(1-\rho_b\right)\ln \overline{\beta} + \rho_b \ln \beta_{t-1} - \psi\left(\ln \widetilde{C}_t - \ln \overline{C}\right), \end{aligned}$$

where $\overline{\beta}$ is the steady state β, $\overline{C}$ is the steady state C, and $\widetilde{C}_t$ is the average (aggregate) consumption in the economy. Thus, the discount factor β_t is external.

Aggregation Technology or Consumption Index:

$$
\begin{aligned}
D_t &= \left(Y_{Ht}^{\frac{\rho-1}{\rho}} + a^{\frac{1}{\rho}} Y_{Ft}^{\frac{\rho-1}{\rho}}\right)^{\frac{\rho}{\rho-1}}, \\
Y_{Ht} &= \left(\int_0^1 Y_{hit}^{\frac{\theta-1}{\theta}} di\right)^{\frac{\theta}{\theta-1}}, \\
Y_{Ft} &= \left(\int_{i\in\mathcal{E}_t^*} Y_{fit}^{\frac{\theta_t-1}{\theta_t}} di\right)^{\frac{\theta_t}{\theta_t-1}}.
\end{aligned}
$$

Note that the elasticity of substitution for imported goods is time varying, $\theta_t = \theta q_t^{\zeta}$ with q_t being the real exchange rate in terms of home aggregate (a rise in q means real depreciation of home). The price indices for the aggregates are

$$
\begin{aligned}
P_{Ht} &= \left(\int P_{hit}^{1-\theta} di\right)^{\frac{1}{1-\theta}}, \\
P_{Ft} &= \left(\int_{i\in\mathcal{E}_t^*} P_{fit}^{1-\theta_t} di\right)^{\frac{1}{1-\theta_t}}, \\
P_t &= \left(P_{Ht}^{1-\rho} + a P_{Ft}^{1-\rho}\right)^{\frac{1}{1-\rho}} = 1.
\end{aligned}
$$

In equilibrium $D_t = C_t$.

Firms: The production function of a firm is given by

$$
Y_{it} = e^{Z_t + \eta_{it}} L_{it},
$$

where Z_t is the country-wide productivity, η_{it} is the firm specific productivity with $\eta_{it} \overset{iid}{\sim} N\left(0, \sigma_\eta^2\right)$. The country productivity follows

$$
\begin{bmatrix} Z_t \\ Z_t^* \end{bmatrix} = A_z \begin{bmatrix} Z_{t-1} \\ Z_{t-1}^* \end{bmatrix} + \begin{bmatrix} \varepsilon_{Zt} \\ \varepsilon_{Zt}^* \end{bmatrix}, \qquad \begin{bmatrix} \varepsilon_{Zt} \\ \varepsilon_{Zt}^* \end{bmatrix} \overset{iid}{\sim} N\left(0, \Sigma_Z\right)
$$

Exporting costs are given by $W_t f_0$ for starters, and $W_t f_1$ for continuing exporters. The (gross) marginal trade cost is given by ξ_t^* for home exporters, and ξ_t for foreign exporters.

The resource constraint for each good is given by

$$Y_{it} = Y_{hit} + m_{it}\xi_t^* Y_{hit}^*,$$

where m_{it} is the exporting status of firm i. The marginal trade cost is stochastic with

$$\begin{bmatrix} \ln \xi_t \\ \\ \ln \xi_t^* \end{bmatrix} = A_\xi \begin{bmatrix} \ln \xi_{t-1} \\ \\ \ln \xi_{t-1}^* \end{bmatrix} + \begin{bmatrix} \varepsilon_{\xi t} \\ \\ \varepsilon_{\xi t}^* \end{bmatrix}, \qquad \begin{bmatrix} \varepsilon_{\xi t} \\ \\ \varepsilon_{\xi t}^* \end{bmatrix} \overset{iid}{\sim} N\left(0, \Sigma_\xi\right)$$

Aggregate Variables: The nominal output (GDP) is given by

$$Y_t^N = \int \left(P_{hit} Y_{Hit} + q_t P_{hit}^* Y_{Hit}^*\right) di.$$

The real GDP is given by

$$Y_t^R = \frac{Y_t^N}{P_{Ht}}.$$

The nominal export is given by

$$\begin{aligned} EX_t^N &= \int q_t P_{hit}^* Y_{hit}^* di \\ &= a q_t P_{Ht}^{*1-\rho} D_t^*. \end{aligned}$$

The export price index is given by

$$P_{Xt} = \frac{q_t P_{Ht}^*}{\xi_t^*}.$$

The real export is given by

$$\begin{aligned} EX_t^R &= \frac{EX_t^N}{P_{Xt}} \\ &= a \xi_t^{*1-\rho} q_t^\rho P_{Xt}^{-\rho} D_t^*. \end{aligned}$$

The nominal import is given by

$$
\begin{aligned}
IM_t^N &= \int P_{fit} Y_{fit} di \\
&= a P_{Ft}^{1-\rho} D_t.
\end{aligned}
$$

The import price index is given by

$$P_{Mt} = \frac{P_{Ft}}{\xi_t}.$$

The real import is given by

$$
\begin{aligned}
IM_t^R &= \frac{IM_t^N}{P_{Mt}} \\
&= a \xi_t^{1-\rho} P_{Mt}^{-\rho} D_t.
\end{aligned}
$$

We define the terms of trade as

$$TOT_t = \frac{P_{Mt}}{P_{Xt}}.$$

So, we have

$$\ln \left(EX_t^R / IM_t^R \right) = (\rho - 1) \ln \left(\xi_t / \xi_t^* \right) + \rho \left(\ln q_t + \ln TOT_t \right) + \ln \left(D_t^* / D_t \right).$$

The trade balance to GDP ratio is given by

$$NXY_t = \frac{EX_t^N - IM_t^N}{Y_t^N}.$$

4. Calibration

[to be completed]

5. Results

[to be completed]

6. Conclusions

We highlight some key features of the trade balance and the real exchange rate that have been hidden in plain sight by the reliance on a non-theoretical measure of the trade balance and a reliance on particular filtering techniques. We show that the dynamics of the trade balance are mostly explained by changes in trade costs the gradual response of trade to aggregate shocks.

We develop a theoretical model with heterogenous producers, a dynamic export participation decision, pricing to market, and declining trade costs to address these properties of the trade balance. With temporary and permanent shocks to trade costs leading to fluctuations in trade and the observed increases in trade, the model can capture the dynamics of the trade balance and the real exchange rate. With these movements in the trade balance, business cycles are substantially more synchronized and there is much less consumption risk sharing.

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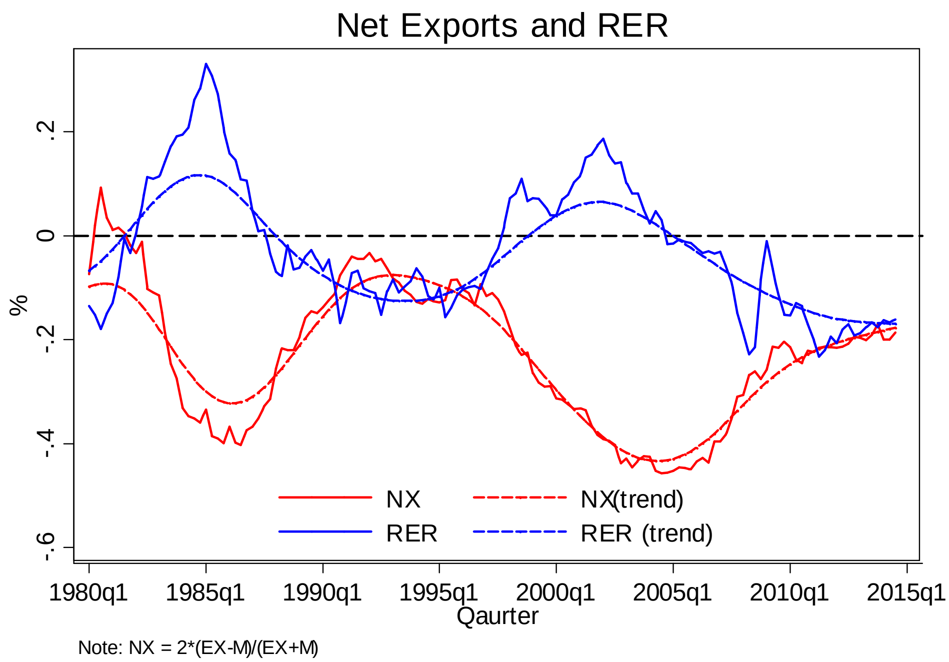
Figure 1



Net Exports and RER
.2
0
-.2
-.4
-.6
%
NX
NX(trend)
RER
RER (trend)
1980q1
1985q1
1990q1
1995q1
2000q1
2005q1
2010q1
2015q1
Qaurter
Note: NX = 2*(EX-M)/(EX+M)

Figure 2:

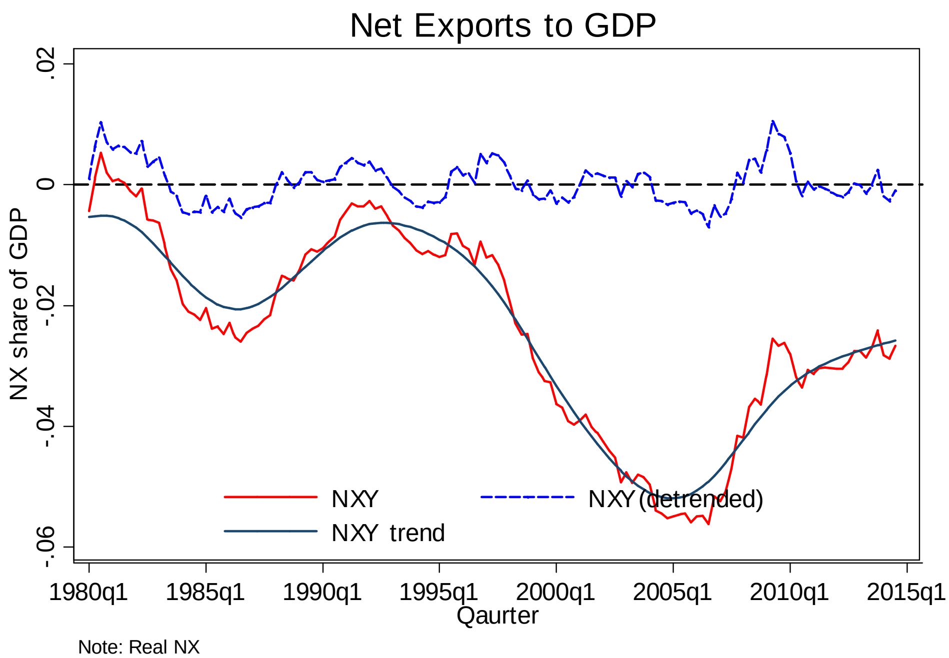


Figure 3:

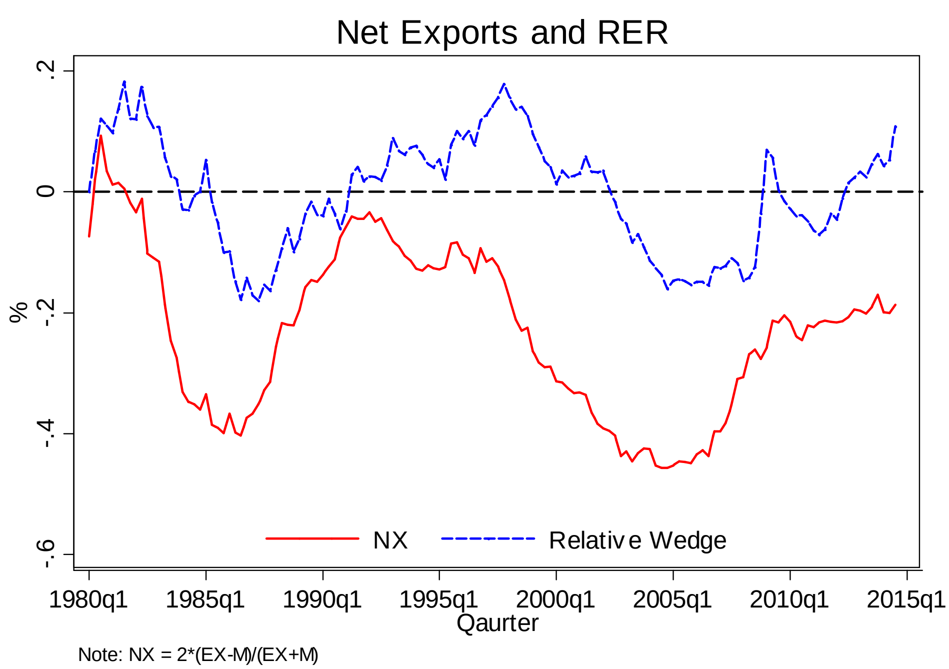


TABLE 2: CYCLICALITY OF US NET EXPORTS					
	Absolute Volatlity		Autocorrelation	Correlation with	
GDP	1.34		0.88	Y	IP
	Volatility relative to GDP	Volatility relative to HP filtered series			
				1.00	
IP	2.1		0.90	0.89	1.00
NX/GDP (hp)	0.3		0.86	-0.48	-0.45
NX/SALES (hp)	0.3		0.84	-0.44	-0.38
NX/TRADE (hp)	3.4		0.89	-0.31	-0.21
RER (hp)	2.7		0.81	-0.14	-0.23
TOT(hp)	1.6		0.81	-0.14	-0.21
NX/GDP	1.2	4.64	0.99	-0.25	-0.19
NX/SALES	1.3	4.85	0.99	-0.23	-0.17
NX/TRADE	10.2	2.99	0.98	-0.26	-0.17
RER	7.6	2.81	0.97	-0.05	-0.08
TOT	2.5	1.50	0.91	-0.04	-0.09
Nominal ratios					
NX/GDP (hp)	0.3		0.79	**-0.59**	**-0.61**
NX/SALES (hp)	0.3		0.78	-0.54	-0.54
NX/TRADE (hp)	2.8		0.81	-0.46	-0.38
NX/GDP	1.2	3.55	0.99	**-0.31**	**-0.26**
NX/SALES	1.3	4.48	0.99	-0.26	-0.20
NX/TRADE	9.0	3.26	0.98	-0.30	-0.21
Based on US data from 1980q1 to 2014q3.					

Table 3: Export-Import ratio and relative prices and relative expenditures

Table 3: Export-Import ratio and relative prices and relative expenditures

Variable	nxr_ip	nxr	dnxr_ip	dnxr_ip2	dnxr	dnxr2
totq	-0.71***	-0.68***				
r_ip		-0.78***				
dtotq			-0.18**	-0.15*	-0.23***	-0.18**
nxr_ip						
L1.				-0.11***		
totq						
L1.				-0.15***		-0.15***
dr_ip					-0.44*	-0.49**
nxr						
L1.						-0.11***
r_ip						
L1.						-0.10***
_cons	-0.41***	-0.38***	0.00	-0.04***	-0.00	-0.05***
N	132	132	132	132	132	132
r2_a	0.51	0.61	0.05	0.32	0.14	0.38

legend: * p<0.05; ** p<0.01; *** p<0.001

Table 4: Export-Import ratio and relative prices or relative expenditures

Variable	nxr	nxr2	dnxr	dnxr2	dnxr3	dnxr4
totq	-0.59***					
r_ip		-0.66***				
dtotq			-0.26***		-0.24***	
dr_ip				-0.62**		-0.60**
nxr						
L1.					-0.05**	-0.02
totq						
L1.					-0.10***	
r_ip						
L1.						-0.01
_cons	-0.25***	-0.34***	-0.00	0.00	-0.02**	-0.00
N	132	132	132	132	132	132
r2_a	0.29	0.23	0.11	0.06	0.26	0.05

legend: * p<0.05; ** p<0.01; *** p<0.001

Note: totq = tot +rer, r_ip = IP US - IP(advanced economies),

d for differences, nxr =(x-m)-r_ip

Table 5: Export-Import ratio and lagged relative prices

(Levels)

Variable	nxr_ip	nxr_ip1	nxr_ip2	nxr_ip3	nxr_ip4	nxr_ip5	nxr_ip6	nxr_ip7
totq								
--.	-0.71***							0.04
L1.		-0.77***						-0.14
L2.			-0.82***					-0.10
L3.				-0.86***				-0.06
L4.					-0.89***			-0.20
L5.						-0.91***		0.03
L6.							-0.91***	-0.55***
_cons	-0.41***	-0.42***	-0.42***	-0.42***	-0.42***	-0.41***	-0.41***	-0.42***
N	132	132	132	132	132	132	132	132
r2_a	0.51	0.59	0.67	0.72	0.76	0.78	0.76	0.81

legend: * p<0.05; ** p<0.01; *** p<0.001

(First Differences)

Variable	dnxrip0	dnxrip1	dnxrip2	dnxrip3	dnxrip4	dnxrip5	dnxrip6	dnxrip7
dtotq								
--.	-0.18**							-0.16*
L1.		-0.16*						-0.06
L2.			-0.18**					-0.13*
L3.				-0.16*				-0.08
L4.					-0.20**			-0.13*
L5.						-0.21***		-0.14*
L6.							-0.16*	-0.10
_cons	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
N	132	132	132	132	132	132	132	132
r2_a	0.05	0.04	0.05	0.04	0.07	0.08	0.04	0.23

legend: * p<0.05; ** p<0.01; *** p<0.001

Table 6: Export-Import ratio and lagged relative prices (first differences)

Variable	nxr	nxr1	nxr2	nxr3	nxr4	nxr5	nxr6	nxr7
totq								
--.	-0.59***							0.25
L1.		-0.66***						-0.34
L2.			-0.71***					-0.05
L3.				-0.75***				0.01
L4.					-0.79***			-0.25
L5.						-0.81***		0.14
L6.							-0.82***	-0.61*
_cons	-0.25***	-0.25***	-0.25***	-0.25***	-0.25***	-0.25***	-0.25***	-0.25***
N	132	132	132	132	132	132	132	132
r2_a	0.29	0.35	0.41	0.45	0.49	0.50	0.51	0.51

legend: * p<0.05; ** p<0.01; *** p<0.001

Variable	nxr	nxr1	nxr2	nxr3	nxr4	nxr5	nxr6	nxr7
r_ip								
--.	-0.66***							0.73
L1.		-0.68***						-0.47
L2.			-0.69***					-0.22
L3.				-0.70***				-0.13
L4.					-0.71***			-0.21
L5.						-0.71***		-0.19
L6.							-0.71***	-0.22
_cons	-0.34***	-0.34***	-0.35***	-0.35***	-0.35***	-0.36***	-0.36***	-0.36***
N	132	132	132	132	132	132	132	132
r2_a	0.23	0.24	0.25	0.25	0.26	0.26	0.26	0.23

legend: * p<0.05; ** p<0.01; *** p<0.001

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Variable	nxr	nxr1	nxr2	nxr3	nxr4	nxr5	nxr6	nxr7
totq	-0.68***							0.06
r_ip	-0.78***							-0.14
totq								
L1.		-0.74***						-0.23
L2.			-0.78***					-0.03
L3.				-0.81***				-0.04
L4.					-0.84***			-0.19
L5.						-0.85***		0.09
L6.							-0.85***	-0.61***
r_ip								
L1.		-0.79***						-0.23
L2.			-0.80***					-0.16
L3.				-0.80***				-0.05
L4.					-0.79***			-0.45
L5.						-0.78***		0.13
L6.							-0.77***	0.10
_cons	-0.38***	-0.38***	-0.38***	-0.39***	-0.39***	-0.38***	-0.38***	-0.39***
N	132	132	132	132	132	132	132	132
r2_a	0.61	0.69	0.74	0.78	0.81	0.82	0.81	0.86

legend: * p<0.05; ** p<0.01; *** p<0.001

Table 7: TOT and RER

Variable	dtot1	dtot2	tot	tot2
drer				
--.	0.23***	0.24***		
L1.	0.09			
tot				
L1.		-0.14**		
rer				
L1.		0.04**		0.12
L2.				0.02
L3.				-0.02
L4.				0.01
--.			0.24***	0.11
N	132	132	132	132
r2_a	0.21	0.24	0.48	0.48

legend: * p<0.05; ** p<0.01; *** p<0.001

Table 8: Long-run and short-run estimates

		exr real	exr goods	exr goods
Short run	Price	-0.195***	-0.326**	-0.340***
	Income	-0.364*	-0.261	-0.584**
	Adjustment	-0.093***	-0.072**	-0.078***
Long-run	Price	-1.42	-2.11	-2.26
	Income	-1.24	-1.24	-2.12

Appendix

Datasources are from the BEA unless stated otherwise

- X Exports of Goods and Services (SAAR, Bil.$)
- M Imports of Goods and Services (SAAR, Bil.$)
- XH Real Exports of Goods & Services (SAAR, Bil.Chn.2005$)
- MH Real Imports of Goods & Services (SAAR, Bil.Chn.2005$)
- XM Exports of Goods (SAAR, Bil.$)
- MM Imports of Goods (SAAR, Bil.$)
- XMH Real Exports of Goods (SAAR, Bil.Chn.2009$)
- MMH Real Imports of Goods (SAAR, Bil.Chn.2009$)
- JX Exports of Goods & Services: Chain Price Index (SA, 2005=100)
- JM Imports of Goods & Services: Chain Price Index (SA, 2005=100)
- JXM Exports of Goods: Chain Price Index (SA, 2009=100)
- JMM Imports of Goods: Chain Price Index (SA, 2009=100)
- JMMXPImports: Nonpetroleum Goods: Chain Price Index (SA, 2009=100)
- MMXPHReal Imports of Nonpetroleum Goods (SAAR, Bil.Chn.2009$)
- sa(C110ZI) /*Advanced Economies: Industrial Production (2005=100) International Monetary Fund
- FXTWBC /*Federal Reserve Board Real Broad Trade-Weighted Exchange Value of the US$ (Mar-73=100)
- IPIndustrial Production Index (SA, 2007=100) Federal Reserve Board