The Nexus of Persistent Trade Surplus and High GDP Growth: Theory and Evidence*

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Abstract

Net export has an effect on money supply in the domestic credit market and, as a result, could indirectly affect output in the private sectors. In this paper we provide a model to capture this indirect effect of net export on output and show that persistent trade surplus has a positive effect on domestic output. However, a crucial condition for such a mechanism to work is that the nominal interest rate has to be positive; when the nominal interest is near zero, trade surplus will no longer have any effect on output. We test this theory with Japanese data for the period 1977 to 2010 and find supporting evidence for our theory for the two distinctive pre- and post-1995 periods.

JEL: F40, O11, O53
Key Words: Net Export, Trade Surplus, Domestic Output

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1 Introduction

The 30-year run of high economic growth in Japan and other newly industrialized Asian nations, which lasted until the early 1990s, and then that which occurred more recently in China, has generated much research interest in export-led growth theories. For example, **?** suggest that exports could lead to more efficient resource allocation and higher capital utilization. **?** show that developing countries can benefit from exports by expanding small domestic markets and taking advantage of the economies of scale. As well, **?** suggest that engaging in export activities can also promote the diffusion of advanced foreign technologies. Furthermore, it is also suggested that foreign exchange from exports can be used to import intermediate goods that will then improve the productivity of domestic production (e.g. **?**, **?**).

However, empirical evidence regarding export-led growth has been inconclusive (or mixed)[1] and, when positive, the contribution of exports to economic growth is small (see **?**). What has been missing in the search for the effects of export? This question prompted **?** to estimate both the direct and indirect effect of *net export* on Chinese economic growth–the latter was to capture the effect of net export on consumption, investment and government expenditure. While evidence of the relationship between net export and high economic growth is evident for China (see Figure 3), it is mixed for Japan (see Figure 4). We notice that net export was associated with high economic growth in Japan for the period 1977 to 1994, but not for the period 1995 to 2000.

Countries that have high export growth often also have a trade surplus (or positive net export). Searching for the indirect effect of net export, in this paper we ask the following question: What is the effect of persistent (positive) net export on gross domestic product (GDP) output? In our view, in addition to the direct effect on output (since net export is part of GDP), positive net export generates a trade surplus, which has an effect on money supply in the domestic credit market and, as as a result, has an indirect effect on output in the private sectors. The effect of money supply on the credit channels has been found in many countries (e.g. **?**, **?**, **?**),[2], in addition, the impact of money on output is found in many of these studies. For instance, **?** find that broad money had an impact on economic growth in Japan between 1960 and 2003. Therefore, net exports could indirectly affect output via the monetary channel, and persistent trade surplus could play a role in keeping GDP growth high. However, when the nominal interest in an economy is close to zero (as in a liquidity trap), a persistent trade surplus should not have any effect on domestic output even though it can still affect money supply.

[1] See **?**, and **?** for a comprehensive survey of more than 150 studies on this topic. Another branch of study focuses on the relationship between openness–usually defined as the ratio of the sum of exports and imports to GDP–and economic growth (e.g. **?**).

[2] Empirical works testing the supply-leading growth hypothesis are of special relevance here.

To test this theory, we extend the limited-participation model to an open-economy setting. The limited-participation assumption is commonly used to analyze the effects of money on real economy. This assumption imposes restrictions on the ability of agents to participate in certain types of financial transactions (e.g. **?**, **?**). We focus on the linkage between trade balance, money supply, and domestic output. Our model predicts that trade balance has a real impact on output as long as the nominal interest rate is positive, and that such an impact disappears when the nominal interest rate is zero. We first use the Granger causlity test to identify the causality between trade balance and money supply, and between money supply and output. Then, we use a trivariate vector autoregressive (VAR) framework to investigate the dynamic relationship between trade balance, money and output. We find empirical evidence for the prediction of our model for Japan. Between 1977 and 1994, when Japanese nominal interests was well above zero, we find that Japan's trade surplus had a persistent positive effect on real output. However, between 1995 and 2010, Japan's trade surplus was comparable to the period 1977 to 1994, but it no longer had any impact on real output (because after 1995 the nominal interests in Japan fell to the neighbourhood of zero). The average growth rate in the post-1995 period was 0.9%, compared to 3.6% in the pre-1995 period.

The basic limited-participation model has been extended in many ways. For example, **?** add quadratic costs of portfolio adjustment to produce more persistent effects of monetary shocks. **?** use the limited-participation model to discuss the effects of different monetary policy rules. **?** propose a mechanism where only a fraction of agents participate in the bond market. **?** extend the basic model to include endogenous market segmentation where agents trade infrequently. Other papers along this line include **?**, **?** and **?**. However, all of these studies are restricted to closed-economy settings. **?** is the only study that we are aware of, which analyzes a monetary policy rule of the central bank in a small open-economy. However, unlike our paper, that study focuses on the stabilization effect of this monetary policy rule.

The rest of the paper is organized as follows. Section 2 develops an open-economy limited-participation model to analyze the linkage between net export and domestic output. Section 3 uses quarterly data from Japan to test the model and section 4 provides some concluding remarks.

2 Model

In this paper we develop an open-economy model with a limited-participation assumption to investigate the relationship between net export and domestic output. This model, following **?** and **?**, assumes that the representative household consists of several members and that each member plays different roles within each period and that they reunite at the end of the period. The

benefit of this setting is that heterogeneity is introduced into the model while all households remain identical in equilibrium.

In this model, a household is assumed to consist of a shopper, a worker, a domestic firm manager, an importer and a representative (commercial) bank. There are two goods in this economy. Good 1 is produced by the domestic firm and exported to a foreign market. Good 2 is not produced domestically and can only be imported from the foreign market.

The timing of the model is crucial, as is the case in other limited-participation models. The household enters period t with money holdings M_t. The amount D_t is deposited into the bank, and the rest of the money $M_t - D_t$ is used by the shopper to purchase consumption goods 1 and 2. The worker supplies labour N_t^s to the domestic firm, which obtains loans from the representative bank to pay for labour costs.

The deposit decision D_t is made before the realization of the central bank's transfer H_t to the bank or any shocks in the loanable fund market. Thus the household cannot adjust its portfolio in response to the change of the money supply in the market. The bank and the domestic production firm, on the other hand, are able to respond to H_t.

2.1 The Household

Let the household's contemporaneous utility function takes the form of:

$$u(C_{1t}) + u(C_{2t}) - \nu(N_t^s) \tag{1}$$

where C_{1t} and C_{2t} are the real consumption of goods 1 and 2 in period t, respectively, and where $u_C, \nu_N \geq 0$, $u_{CC} \leq 0$ and $\nu_{NN} \geq 0$.

The assumption of limited participation frequently appears in models with cash-in-advance (CIA) constraints. The household needs cash to finance consumption in each period. The CIA constraint takes the form of:

$$P_{1t}C_{1t} + P_{2t}C_{2t} \leq M_t - D_t \tag{2}$$

where P_{1t} and P_{2t} are the domestic price of goods 1 and 2, respectively.

The CIA constraint is binding as long as the nominal interest rate on deposits is positive because deposits D_t brings back the positive nominal return $1 + R_t^D$ while holding cash leads to zero return. R_t^D is the deposit interest rate offered by the bank. When the interest is zero, as in a liquidity trap, the household is indifferent between depositing and holding cash as neither generates a positive return. The CIA constraint does not bind in this circumstance.

2.2 The Domestic Firm

The domestic firm takes the nominal loan L_{1t} from the bank at the beginning of period t to pay a fraction of the total labour costs. L_{1t} is a fraction of total labour costs. The value of this fraction in period t is denoted as J_{1t}.

$$J_{1t} = \frac{L_{1t}}{W_t N_t^d}, \quad \text{or} \quad L_{1t} = J_{1t} W_t N_t^d \tag{3}$$

where N_t^d is the demand for labour and W_t is the nominal wage in period t. Notice that when this constraint is binding, an increase in labour demand, which results from the expansion of production, is transferred into a higher demand for loans. The firm maximizes the following profit function by choosing labour input level N_t^d:

$$\Pi_t^1 = P_{1t} Y(N_t^d) - R_t^L L_{1t} - (1 - J_{1t}) W_t N_t^d \tag{4}$$

where R_t^L is the interest rate the representative bank charges on loans. $Y(N_t^d)$ is the twice continuous production function of the domestic firm and $Y'(N_t^d) > 0$ and $Y(N_t^d) < 0$.

This firm also exports C_{1t}^* units of good 1 to foreign markets, but it needs to convert $P_{1t}^* C_{1t}^*$ to domestic currency (since it does not import). Let e_t be the nominal exchange rate. The value of exports in terms of the domestic currency is $e_t P_{1t}^* C_{1t}^*$.

2.3 The Importer

The importer gets loans from the bank before it goes to the foreign market to purchase good 2. P_{2t}^* is the price of good 2 in the foreign market. Here L_{2t} is the fraction of the total value of imported goods. The value of this fraction in period t is denoted as J_{2t}.

$$L_{2t} = J_{2t} P_{2t}^* C_{2t} \tag{5}$$

Then the importer sells C_{2t} units of good 2 in the domestic market at price P_{2t}. The profit function for the importer is

$$\Pi_t^2 = P_{2t} C_{2t} - R_t^L L_{2t} - (1 - J_{2t}) P_{2t}^* C_{2t} \tag{6}$$

Total demand for loans in period t is equal to the sum of loans required by the domestic firm and the importer.

$$L_t^D = L_{1t} + L_{2t} \tag{7}$$

2.4 The Monetary Authority

Within each period the monetary authority provides money injection H_t to the bank. This money injection is influenced by both internal and external factors. Internally, it serves as the monetary policy instrument (Q_t) with which the monetary authority *exogenously* stabilizes the economy. Externally, it serves currency exchange transactions (buying and selling foreign currencies), which is determined by the magnitude of the trade balance at every exchange rate level, $e_t TB_t$, where

$$TB_t = P^*_{1t} C^*_{1t} - P^*_{2t} C_{2t} \tag{8}$$

P^*_{1t} and P^*_{2t} are the prices of goods 1 and 2 in the foreign market in period t, respectively. The monetary authority accumulates foreign reserves if there is a trade surplus. The total monetary injection H_t is:

$$H_t = e_t TB_t + Q_t = e_t(P^*_{1t} C^*_{1t} - P^*_{2t} C_{2t}) + Q_t \tag{9}$$

We have:

$$\frac{\partial H_t}{\partial C^*_{1t}} = e_t P^*_{1t} > 0 \tag{10}$$

and

$$\frac{\partial H_t}{\partial C_{2t}} = -e_t P^*_{2t} < 0 \tag{11}$$

2.5 The Representative Bank

The representative bank takes the deposit from the household and provides loans to the firm and importer. Assuming banks behave competitively, in equilibrium the interest rates on deposits and loans must be equal: $R^D_t = R^L_t \equiv R_t$. The bank also receives money injection H_t from the central bank. The total supply of loans in the loanable fund market, or the balance sheet of the representative bank, is:

$$L^S_t = D_t + H_t \tag{12}$$

which implies that:

$$\frac{\partial L^S_t}{\partial H_t} = 1 \tag{13}$$

The equilibrium interest rate R_t is determined in the credit market when $L^S_t = L^D_t$. Since the household cannot adjust the portfolio in response to a monetary injection, changes in H_t, either by net exports or Q_t, will affect the equilibrium interest rate in the loanable fund market. The profit for the bank is

$$\Pi^b_t = R_t L_t - R_t D_t + H_t = (1 + R_t) H_t = (1 + R^L_t)(e_t(P^*_{1t} C^*_{1t} - P^*_{2t} C_{2t}) + Q_t) \tag{14}$$

2.6 Solving the Model

Given the functional form of the contemporary utility function in equation (1), the value function of the household can be written as:

$$V(M_t) = \max_{d} E\left(\max_{D_t, C_{1t}, C_{2t}, N_t^s, N_t^d, L_{1t}, L_{2t}, M_{t+1}} [u(C_{1t}) + u(C_{2t}) - \nu(N_t^s) + \beta V(M_{t+1})]\right) \tag{15}$$

subject to the CIA constraint and the following budget constraint:

$$W_t N_t^s + R_t D_t + \Pi_t^1 + \Pi_t^2 + \Pi_t^b + (M_t - D_t - P_{1t}C_{1t} - P_{2t}C_{2t}) = M_{t+1} \tag{16}$$

Let λ_{1t}, λ_{2t}, λ_{3t} and λ_{4t} be the Lagrangian multipliers of the the budget constraint, the CIA constraint and the two constraints on demand for loans equation (3) and equation (5). The first-order conditions when the CIA constraint is binding are:

$$D_t : \ E_h[-\lambda_{1t} + R_t^D \lambda_{2t}] = 0 \tag{17}$$

$$C_{1t} : \ U'(C_{1t}) = \lambda_{1t}(P_{1t}) + \lambda_{2t}P_{1t}) \tag{18}$$

$$C_{2t} : U'(C_{2t}) = \lambda_{1t}P_{2t} + \lambda_{2t}(P_{2t} + (1+R_t^L)e_t P_{2t}^* - P_{2t} + R_t^L J_t e_t P_{2t}^* + (1-J_t)e_t P_{2t}^* \tag{19}$$

$$N_t^s : \ -\mu'(N_t^s) + W_t\lambda_{2t} = 0 \tag{20}$$

$$N_t^d : \ \lambda_{2t}(P_{1t}Y'(N_t^d) - J_{1t}R_tW_t - (1-J_{1t})W_t) = \lambda_{3t}J_{2t}W_t \tag{21}$$

$$L_{1t} : \ \lambda_{3t} - R_t\lambda_{2t} = 0 \tag{22}$$

$$L_{2t} : \ \lambda_{4t} - R_t\lambda_{2t} = 0 \tag{23}$$

$$M_{t+1} : \ -\lambda_{2t} + \beta V_M(M_{t+1}) = 0 \tag{24}$$

and

$$V_M(M_t) = E_h(\lambda_{1t} + \lambda_{2t}) \tag{25}$$

E_h indicates that D_t is chosen before the household knows the current period money transfers from the monetary authority.

From equations (21) and (22) we obtain:

$$P_{1t}Y'(N_t^d) = W_t(R_t(J_{1t} + J_{2t}) + 1 - J_{1t}) \tag{26}$$

The left-hand-side is the marginal return from production and the right-hand-side is the marginal cost, which is determined by the real wage and the interest rate charges on loans. At each real wage, the expansion of production–equivalent to higher demand for labour and loans–is associated with a lower of interest rate due to the diminishing marginal return from production. Let $\bar{N}$ be the level of labour when the nominal interest rate is zero. The firm has no incentive to hire more labour beyond this level. The reason is that, at each real wage, the marginal return from production of any further expansion is insufficient to pay the real wage, although borrowing from the bank is without cost.

For example, if we use the following functional form for the production function:

$$Y(N_t^d) = (N_t^d)^\alpha \tag{27}$$

where $0 < \alpha < 1$, we have

$$Y'(N_t^d) = \alpha(N_t^d)^{\alpha-1} \tag{28}$$

From equations (26) and (28), we obtain:

$$N_t^d = \left(\frac{\omega_t(R_t^L(J_{1t} + J_{2t}) + 1 - J_{1t})}{\alpha}\right)^{\frac{1}{\alpha-1}} \tag{29}$$

where $\omega_t = \frac{W_t}{P_{1t}}$. Then we have

$$\frac{\partial N_t^d}{\partial R_t} = \left(\frac{1}{\alpha-1}\right)\left(\frac{\omega_t(R_t(J_{1t} + J_{2t}) + 1 - J_{1t})}{\alpha}\right)^{\frac{-\alpha}{\alpha-1}}\left(\frac{\omega_t}{\alpha}\right) < 0 \tag{30}$$

because the first term on the right-hand-side of equation (30) is negative and the other two terms are positive. The higher the borrowing costs R_t, the less the demand for labour. Setting R_t equals to zero, we find the maximum amount of labour $\bar{N}$.

Equations (30) and (3) also imply a downward-sloping loan demand curve.

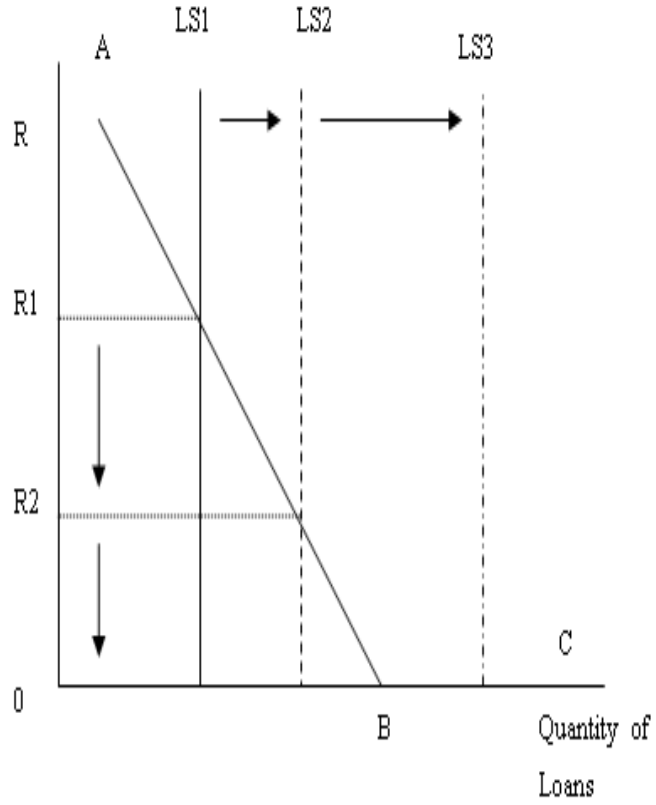
$$\frac{\partial L_t^d}{\partial R_t} = \frac{\partial L_{1t}^d}{\partial R_t} = \left(\frac{\partial L_{1t}^d}{\partial N_t^d}\right)\left(\frac{\partial N_t^d}{\partial R_t}\right) \tag{31}$$

because $\frac{\partial L_{1t}^d}{\partial N_t^d}$ is positive and $\frac{\partial N_t^d}{\partial R_t}$ is negative. Thus, the higher the borrowing cost, the lower the demand for loans.

The equilibrium interest rate of the loanable funds market is determined by the demand and supply of loans (e.g. intersection of lines AB and LS1 in figure 1). From (8), we have

$$\frac{\partial Y_t}{\partial TB_t} = e_t\frac{\partial Y_t}{\partial H_t} \tag{32}$$

Figure 1: Loanable Fund Market



and

$$\frac{\partial Y_t}{\partial H_t} = \left(\frac{\partial Y_t}{\partial N_t}\right)\left(\frac{\partial N_t}{\partial R_t}\right)\left(\frac{\partial R_t}{\partial L_t^S}\right)\left(\frac{\partial L_t^S}{\partial H_t}\right) > 0 \tag{33}$$

which is positive as long as R_t is above zero. Therefore, in each period, the trade surplus has a positive effect on output.

However, when the L_t^S curve is to the right of Point B (e.g. line LS3), which could happen if the marginal product of the firm decreases (e.g. in a recession) or there is already too large a money supply in the economy, the interest rate becomes zero and $\bar{N}$ is reached. In this case, trade surplus can no longer affect output. Therefore, we obtain the following proposition.

Proposition*: Trade surplus has a positive effect on domestic output as long as the nominal interest rate is well above zero; the effect of trade surplus on*

output disappears when the nominal interest rate is near zero.

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This proposition suggests that whether or not the trade surplus affects real output depends on the conditions of the economy. When the nominal interest rate is positive , trade surplus has a positive effect on output and, therefore, can play a role in keeping GDP growth high[3]. However, if the economy is in a liquidity trap, trade surplus can no longer affect output.

3 Empirical Evidence

A number of econometric methods have been applied to explore the linkage between output, money and trade balance in Japan. The quarterly Japanese data of GDP, consumer price index (CPI), M2, exports and imports, spanning from 1977Q1 to 2010Q4 are obtained from International Financial Statistics. We choose this period to avoid the impacts of the oil crisis. This period also covers years with both positive and very low nominal interest rates. The details of the data are described in the Data Appendix.

3.1 Structural Break

Many studies suggest that structural breaks existed in the Japanese economy in the 1990s. **?** describes Japan's monetary policy as consisting of three periods: very low interest rate (since 1995), zero interest rate (since 1999) and quantitative easing (since 2001). He shows that optimal monetary policy is different in these three periods. **?** detects a structural break in the Japanese employment rate around 1993. **?** finds structural breaks in the Nikkei Stock price and M2+CD around 1990. **?** studies the impacts of Japan's foreign exchange intervention on the volatility of the yen/dollar exchange rate. The main findings suggest that the impacts differ before and after the late 1990s.

? adopts a VAR framework and finds a structural break in 1995, particularly in terms of the role played by monetary policy. His findings are consistent with the observation that the nominal interest rate has been very low since 1995, and that the Japanese economy has arguably been in a liquidity trap since that time. In his later research, **?** uses the structural break tests to study the stability of long-run money demand in Japan. The results confirm the existence of the structural break in 1995.

[3] Please note that the effect is short-run rather than long-run in this simple model because households are able to reallocate resources between deposits and cash holdings at the end of each period. Changes that occurred in the past do not constrain the household's portfolio decision when the household enters a new period. Our model can be easily extended to generate persistent liquidity effects. The introduction of quadratic adjustment costs is a convenient and straightforward way to do this, as in **?** and **?**. Price stickiness can be another natural alternative.

In line with these studies, we divide the whole sample into two sub-sample periods. The first sub-sample period covers 1977Q1 to 1994Q4, when the nominal interest rate was substantially above zero. The second sub-sample period covers the low interest rate period after 1995. We explore the dynamic relationship between output, money and trade balance in each of these two sub-sample periods.

3.2 Correlation Coefficients

Table 1 shows the correlations between Japanese GDP, M2 and trade balance in different time period. [4]. In the whole sample period, GDP and M2 are highly correlated. The correlation coefficient is 0.933. This correlation is greater in the pre-1995 period, with a coefficient of 0.996. However, in the period after 1995, GDP and M2 seem to be negatively correlated with a coefficient of -0.404. Both the sign and the magnitude of the correlation between M2 and trade balance differ significantly within different time periods. In the first sub-sample period, the correlation between M2 and trade balance is quite strong at 0.753; while in the second sub-sample period, this number becomes -0.382. Trade balance is strongly linked to output before 1995, with the correlation of 0.766; the linkage becomes quite moderate after 1995, as reflected by the correlation of 0.380.

Table 1: Correlation

	GDP	M2	Trade Balance
1977Q1–2010Q4			
GDP	1		
M2	0.932851	1	
Trade Balance	0.569248	0.392977	1
1977Q1–1994Q4			
GDP	1		
M2	0.996461	1	
Trade Balance	0.765825	0.752656	1
1995Q1–2010Q4			
GDP	1		
M2	-0.404382	1	
Trade Balance	0.379539	-0.337023	1

These correlations confirm that in Japan the linkage between output, money and trade balance is quite strong in the pre-1995 period. After the mid of 1990s–a time of very low nominal interest rates–this linkage is rather moderate. In other words, the macroeconomic conditions, including the level

[4] We also checked the correlations between GDP, M1 and trade balance. The results are very similar.

of nominal interest rates in Japan, seem to have significantly affected the linkage.

3.3 Causality Tests

The Granger causality tests have been performed to examine the linkage between M2, trade balance and output. This test helps to determine whether one series is useful in forecasting another series (**?**). A time series X is said to Granger-cause Y if it can be shown–usually through a series of t-tests and F-tests on lagged values of X (with lagged values of Y also included)–that those X values provide statistically significant information about future values of Y. In this case we are able to tell whether trade balance or M2 provide useful information in forecasting output in Japan. The results are shown in Table 2.

Table 2: Granger Causality Tests

Null Hypothesis	Prob.
1977Q1–2010Q4	
H_0:M2 does not Granger Cause Output	0.0001
H_0:Trade Balance does not Granger Cause Output	0.0927
1977Q1–1994Q4	
H_0:HM2 does not Granger Cause Output	0.0007
H_0:Trade Balance does not Granger Cause Output	0.0474
1995Q1–2010Q4	
H_0:M2 does not Granger Cause Output	0.9080
H_0:Trade Balance does not Granger Cause Output	0.1747

For the whole study period, M2 Granger-causes output in Japan at a 1% significance level and trade balance Granger-causes output at a 10% significance level. Such causalities hold in the pre-1995 period with a significance level of 5%. However, between 1995 and 2010, neither M2 nor trade balance Granger-cause output in Japan. Before 1995, both M2 and trade balance can provide statistically significant information of the future values of output in Japan. This does not hold after 1995. As suggested in our model, this may be due to the lack of a link between money and output in Japan when the nominal interest rate is very low (since the middle of the 1990s).

3.4 Vector Autoregressive Models

We adopt a VAR framework[5] to analyze the dynamic relationship between output, money supply and trade balance in Japan.

[5] Other relatively new econometric methods, such as Bayesian VAR (BVAR) and Time-Varying Parameter VAR (TVP-VAR) have been applied to check the robustness of the

The following variables are used in our analysis: log GDP (LY), log CPI (LP), log M2 (LM) and the ratio of export to import volume (XM),[6] The selection of the underlying variables follows some previous empirical studies in Japan and other countries.

As a preliminary step, we apply three criteria to perform unit root tests for each of these three variables, namely an augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test. In the ADF test, the optimal length is selected based on Akaike Information Criteria (AIC) up to 12 lags. In the PP test, the Bartlett Kernel and Newey-West Bandwidth are used. Test results are summarized in Table 3.

Results show that for both LY and LM the null hypothesis of a unit root cannot be rejected. As well, strong rejections are detected for the first difference of these two variables. For XM and LP, the null of a unit root can be rejected against the alternative. These results show that LY and LM are integrated of order one (I(1)) while LP and XM are I(0). Based on the unit root test results we use the first differences of LY and LM and the levels of LP and XM in the VAR.

Table 3: Unit Root Tests

	ADF	PP
LY	0.3141	0.0879
LP	0.0052	0.0000
LM	0.4300	0.1350
XM	0.0331	0.0159

The impulses response functions (IRFs) of output to an M2 shock and M2 to a trade balance shock are shown in Figure 2. We generate the IRFs by using a Cholesky decomposition (e.g. the shocks are assumed to be orthogonal to each other). Each variable in VAR is subject to a one standard deviation shock. The confidence intervals are at a 95% significance level and are bootstrapped in 5000 iterations.

How output responds to M2 shocks and how M2 responds to trade balance shocks differ significantly before and after 1995. The top panel of Figure 2 shows how M2 affects output in Japan. The greatest magnitudes of the output

analysis. Due to the limited number of observations, these methods do not provides useful information of each sub-sample period. However, for the whole sample period, these methods generate similar impulse response functions as standard VAR does for the pre-1995 period.

[6] CPI has been seasonally adjusted using the ARIMA-X12 technique.

response to M2 shocks occur in the second period after the shock. Prior to 1995 M2 significantly increases output and effects. Such response is moderate in the whole sample period, but diminishes in the period 1995 to 2010. The bottom row shows the responses of M2 to trade balance shocks. Again, the responses are strong before 1995, moderate in the whole sample period, and close to zero in the low nominal interest rate years after 1995. This result is consistent with the mechanism we modelled.

Here Y is Japanese real GDP, $M2$ represents broad money stock, and XM is the ratio of exports over imports. The numbers on the horizontal axis represent the quarters after the initial shocks. The magnitude of the responses are measured on the vertical axis.

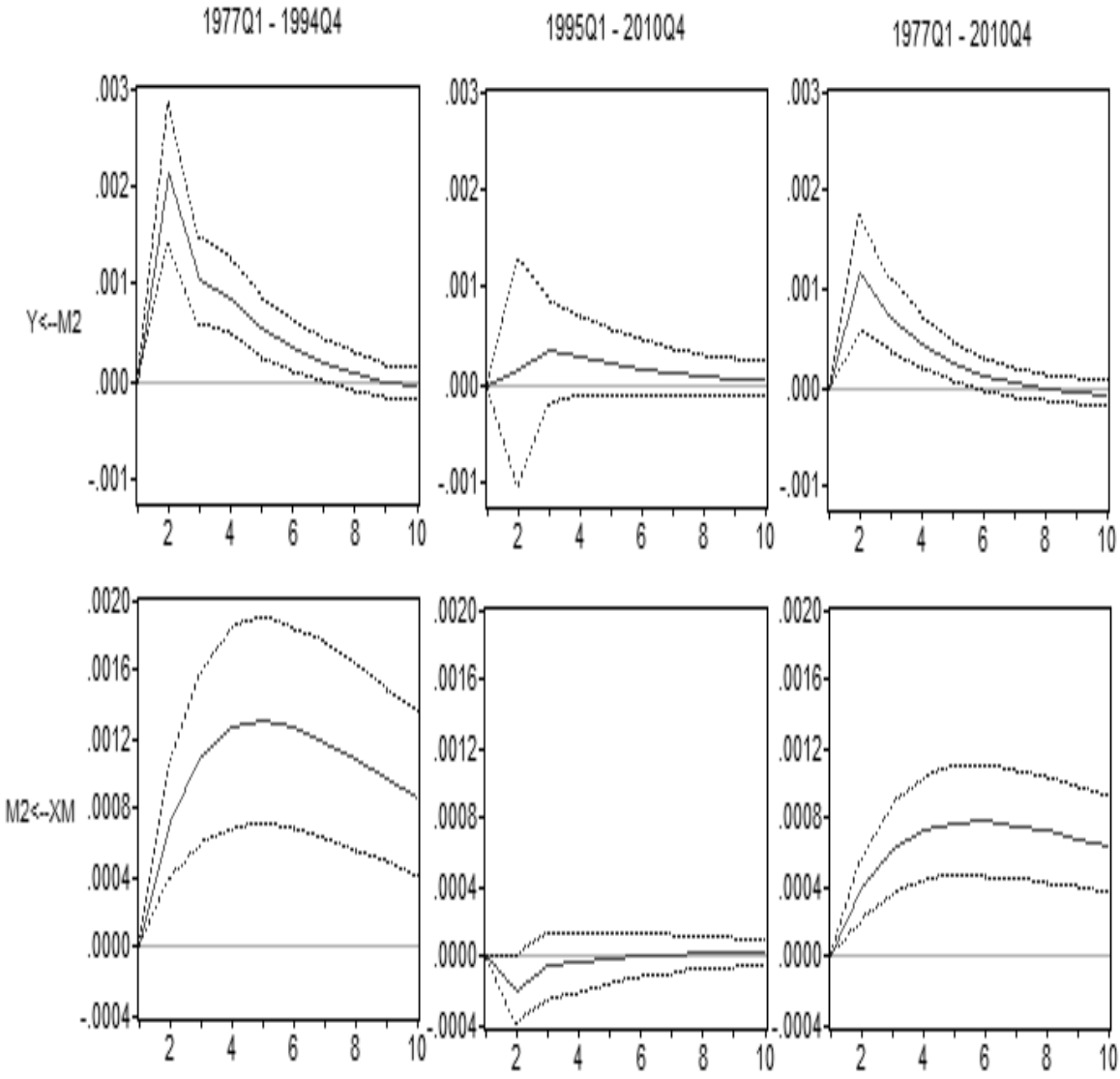
We recognize that we are working with a relatively short sample period (136 observations), especially the post-1995 period (64 observations). Diagnosis tests such as normality and serial-correlation tests suggest that our estimations are not flawed with the small sample problem. However, interpretation of our results should still proceed with caution.

4 Conclusion

What are the effects of persistent trade surplus (i.e. positive net export) on GDP output? Net export could have both direct and indirect effects on output. On the one hand, net export directly affects output since it is part of GDP; on the other hand, it has an effect on money supply in the domestic credit market and, as a result, indirectly affects output in the private sectors. In this paper we provide a model to capture the indirect effect of net export (in the form of trade surplus) on GDP output. We show that persistent trade surplus has a positive effect on domestic output and, therefore, could play a role in keeping GDP growth high. However, for such a mechanism to work, the nominal interest rate has to be positive. When the nominal interest is near zero, trade surplus will no longer have any effect on output.

We also test this theory with Japanese data for the period 1977 to 2010. Using a VAR Model we find supporting evidence for our theory. Based on the IRF, we find that Japanese persistent trade surplus had a positive impact on domestic output and played a role in keeping its GDP growth high (an average of 3.6%) during the period 1977 to 1994 when the Japanese nominal interest was well above zero. However, after 1995 Japan continued to enjoy a similarly persistent trade surplus but we did not find that it had any impact on output, which could be a contributing factor to the lower GDP growth in Japan after 1995 (only an average of 0.9%). We point to the "close-to-zero" nominal interest rate in Japan during the post-1995 period as the reason why this link between net export and GDP output was broken.

Figure 2: Impulse Response Functions



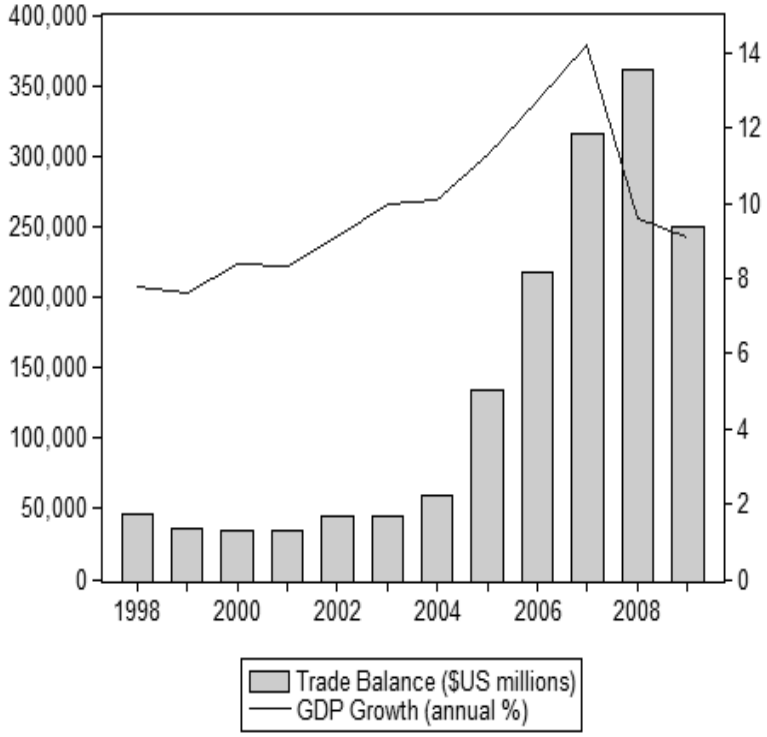
In our simple analysis, there are many abstractions (different regimes of foreign exchange control, etc.) from the real world. However, it is not difficult to see that the main insight of our analysis would be preserved in a model with a richer structure. The findings of this paper have important implications for understanding the impact of international trade on economic development, as well as the linkage between export-led development and macroeconomic policy.

Data Appendix

The data are downloaded from International Financial Statistics. Here are the details of the series that has been used in this paper. The dataspan is 1977Q1 to 2010Q4.

Variable	Unit	Scale	Series Code
GDP (seasonally adjusted)	Yen	Billions	15899B.CZF...
M2 (seasonally adjusted, period average)	Yen	Trillions	15859MBCZF...
CPI:All Japan 485-Items	Index Number	Units	15864...ZF...
Exports	Yen	Billions	15870...ZF...
Imports (CIF)	Yen	Billions	15871...ZF...

Figure 3: GDP Growth Rate and Trade Balance in China



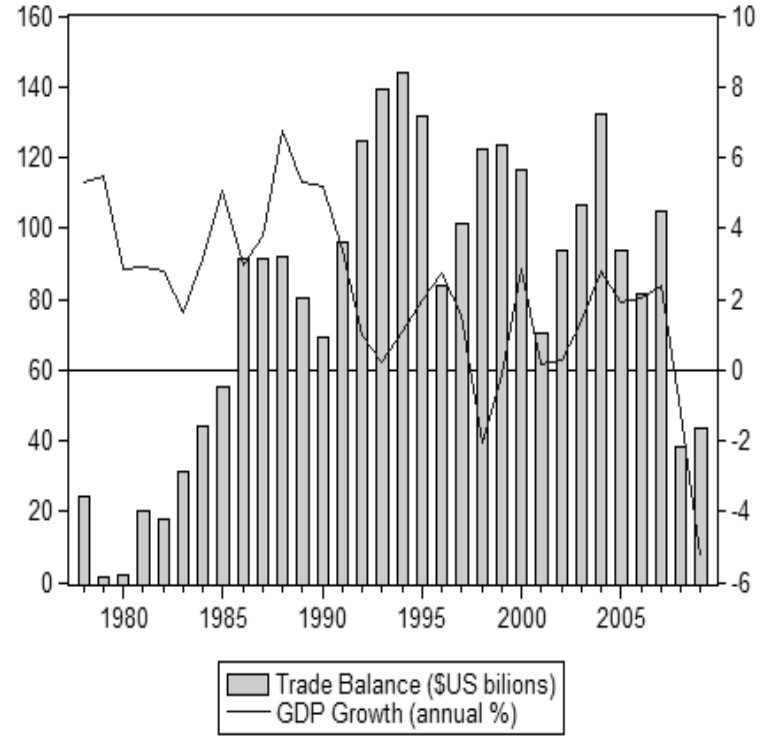


Figure 4: GDP Growth Rate and Trade Balance in Japan