On the Importance of Export-led Growth: Panel Time Series Evidence

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Introduction

Economies in East Asia, and the Four Tigers in particular which include Hong Kong, South Korea, Singapore, and Taiwan, have provided the most robust experiences of economic catch up with the West compared to any other region in the World. There are various features of commonality in the experience of these economies including the role of savings and investment, importing of technology in many cases, and active government policies. Perhaps the greatest commonality across experiences, however, is a reliance on an export oriented growth strategy. While their experience brought focus and attention to the proposition of

export led growth as a development strategy there is great debate in the literature on the role of export led growth. The paper investigates the importance of the role of exports by examining the joint postwar economic experience across a variety of panel time series datasets, including a panel for the Four Tigers.

Specifically, the paper investigates the role of export shocks using annual panel data from the Penn World Tables Version 9 database, quarterly data from the World Bank Global Economic Monitor (GEM) database and national government statistics from the governments of the Four Tigers. Blanchard-Quah long-run restrictions on the long-run neutrality of demand shocks on real GDP are utilized as identifying restrictions to help identify demand, supply and export shocks in a panel VAR. These restrictions combined with an additional long-run restriction based on the time series properties of the data are sufficient to just identify the three variable structural panel VAR including nominal GDP, real GDP, and the real export to GDP ratio. Results from impulse response functions and variance decompositions show exports play a significant role in explaining and accounting for fluctuations in real GDP across countries over time. In addition, as export shocks are just one form of demand shock, the results suggest that nominal demand shocks are also important sources of real GDP movements at all horizons. However, results show that supply shocks account for the majority of fluctuations in the various panels. The panel for the Four Tigers is an exception in that it is the only case where combined demand shocks account for the majority of explanatory power for real GDP movements at all horizons.

Background

Many have pointed to the role that an export-oriented growth strategy played in the historical development of the Four Tigers; however, there remains a wide debate over its relative importance in general. The role of export-led growth has several strands of theoretical support. The first is the growth theory literature which focuses on externalities [Lucas(1988) and Romer(1986)] and models of increasing returns to scale [Romer(1986a)]: also externalities in the growth literature based on imperfect competition models [Helpman(1988)] or monopolistic competition [Romer(1988b)], which focus on how knowledge is created. Finally there is the externalities that result from demand spillovers between industries that support the potential role of export driven growth [Murphy, Shleifer, and Vishny (1989a,b)].

The empirical literature is quite extensive and wide ranging [see Giles and Williams (2000) for a good review of the literature]. Findlay (1984) and Krueger (1985) were two of the strongest and earliest proponents that the experience of the Four Tigers represented the great potential for development based on export led growth. More recently Blecker and Razmi (2009) examined export led growth and its lessons. The authors point out the importance of export markets in many countries' growth strategy and how the East Asian experience was a case where circumstances were just right: these include the Asian countries following a "flying geese" pattern of moving up the value chain while not over saturating markets in any one level of the chain; the synergistic support of south-south trade as nations grew; and, finally, the role of industrialized nations as a market for the countries pursuing export led growth. Blecker and Razmi (2011) suggest, however, there is a mounting evidence that while the Asian growth experience pointed to the importance of export-led growth, there may be a "fallacy of

composition" as other developing countries following the same strategy are subject to a significant demand constraint in that all are competing over the same export markets in similar products and thus have not been as successful.

Others have also cast serious doubt on the notion that exports were the driver of growth in many of the so-called export led growth cases. Yang (2008) suggests that real exchange rate appreciations accompanying cases of export led growth is more consistent with the scenario that growth drove increases in exports instead of the other way around. Even earlier, Rodrik (1994) argued that it was actually investment stimulated by government industrial policy that led to growth in exports and it was not exports that drove growth and Krugman (1994) suggested the success of the Asian economies was nothing miraculous, but simply strong governments mobilizing resources and generating growth based on traditional factors that lead to growth such as savings, investment, and labor migration, to a name a few. The World Bank (1993) study on the East Asian Miracle also discounted the role of exports and industrial policy relative to traditional growth factors.

This paper investigates the issue by applying recent panel time series techniques to identify export, demand and supply shocks in a panel VAR. The next section introduces the methodology that is utilized to examine the hotly debated and widely studied issue.

Data and Motivation

The panel data sets utilized in the paper are described in Table 1 along with the sources. There are three annual panels and three quarterly panels covering different periods and different sets of countries. All panels are balanced. As we move from longer to shorter time periods for both the annual data from the Penn World Table and the World Bank GEM databases, more countries are included in each panel. An attempt to distinguish between the tradeoff of including a greater number of countries versus a longer time span on the empirical results is done by examining and comparing results across panels.

The theoretical motivation for the empirical work conducted in the paper is based on the model presented in the seminal work of Blanchard and Quah (1989) in which the authors examined the effects of aggregate demand and supply shocks in the US economy during the postwar era. The model is modified to allow for export shocks. The model can be specified as follows:

$$(1)\quad Y(t) = M(t) - P(t) + \alpha\theta(t) + X(t)$$

$$(2)\quad Y(t) = N(t) + \theta(t)$$

$$(3)\quad P(t) = W(t) - \theta(t)$$

$$(4)\quad W(t) = W|\{E_{t-1}N(t) = \bar{N}\}$$

Y, P, θ and X represent the log levels of real GDP, the GDP deflator, productivity and exports, respectively. $\bar{N}$ is full employment and W and M are the log levels of the nominal wage and money supply.

Equation 1 represents aggregate demand and states that demand is related to real money balances and exports. This suggests that exports affect the economy as a demand shifter. Equation 2 represents the production function, where N is employment, and θ represets a supply side productivity shock. Equation 1 follows Blanchard and Quah (1989) in allowing for productivity to potentially have a demand component such as through investment demand and not just a pure supply shock. Equation 3 represents price setting behavior which depends on nominal wages and productivity. Nominal wages, as described by equation 4, are set one period in advance to achieve full employment.

To close the model we specify how M, θ and X evolve:

$$(5)\ M(t) = M(t-1) + e_d(t)$$

$$(6)\ \theta(t) = \theta(t-1) + e_s(t)$$

$$(7)\ X(t) = X(t-1) + e_X(t)$$

where e_d, e_s and e_X are the serially uncorrelated and pairwise orthogonal demand, supply and exports disturbances in the economy. If we let log nominal GDP be $Q(t) = Y(t) + P(t)$, solving for growth in nominal and real GDP we obtain the following:

$$(8)\ \Delta Q(t) = e_d(t) + \alpha e_s(t) + e_X(t)$$

$$(9)\ \Delta Y(t) = e_d(t) - e_d(t-1) + \alpha\big(e_s(t) - e_s(t-1)\big) + e_x(t) - e_x(t-1) + e_s(t)$$

The specification in equations 8 and 9 represent the traditional Keynesian interpretation of disturbances in the economy where demand shocks have purely transitory effects on real GDP and supply disturbances have real long-run effects.

While the model presented above is mainly for illustrative purposes, it does provide the intuition for the estimation strategy in the paper. The estimation procedure will allow for three types of shocks, two representing demand shocks; a nominal demand shock and an export shock, both having transitory effect on real GDP. A third shock represents the permanent component of real GDP fluctuations arising from productivity shocks. While some theoretical growth models such as those presented in the literature review allow for long-run real effects from export shocks, the long-run neutrality of all demand shocks based on traditional macro models is employed here.[1]

More practically, the following three variable VAR is specified:

$$(10)\ Y(i,t) = g(L)\big(Q(i,t-1), Y(i,t-1), X(i,t-1)\big) + u_1(i,t)$$

$$(11)\ Q(i,t) = f(L)\big(Q(i,t-1), Y(i,t-1), X(i,t-1)\big) + u_2(i,t)$$

$$(12)\ X(i,t) = h(L)\big(Q(i,t-1), Y(i,t-1), X(i,t-1)\big) + u_3(i,t)$$

Here, all variables potentially influence the others and the u's represent shocks to the system. The equations for real GDP (Y) , nominal GDP (Q), and the real exports to real GDP ratio (X) represent a three variable system that captures the dynamic relationship between the variables

[1] In some sense one can think of the results here on the effects of demand and exports shocks as being a lower bound estimate since long-run neutrality is imposed on the system.

where it is assumed there is feedback over time and shocks to demand, supply, and exports have varying degree of persistence and importance. Here the export ratio (real exports/real GDP) is used to capture the relative importance of exports in each of the countries in the panels and its variation over time.

Identifying Restrictions and Methodology

The aim is to identify and estimate the three variable system using panel data for our various panels so that a measure of the impact of demand, supply and exports on real GDP over time can be determined. To accomplish this, appropriate restrictions are imposed on the error structure of the panel VAR to allow for structural decomposition of the residuals. Impulse responses and variance decompositions from the structural panel VAR are then investigated.

In order to interpret the shocks from the panel VAR as representing independent structural shocks to exports, supply, and demand, three restrictions must be placed on the system to identify the underlying shocks. The same theoretical assumption employed in Blanchard and Quah (1989) to identify demand and supply shocks is utilized in the current paper to help identify the system: namely, demand shocks, both nominal demand shocks and export shocks, only have transitory effects on real GDP, giving two restrictions to identify structural shocks in the panel VAR. In this case, the identifying restriction used to identify the nominal demand shocks is that the demand shock does not have any long-run effects on real GDP, which is the same restriction Blanchard and Quah (1989) used where the VAR contained real GDP and the unemployment rate.

The long-run neutrality of both demand shocks on real GDP is consistent with standard theoretical Macro models from the various schools of thought where demand shocks only have transitory real effects and gives two identifying restrictions. We turn to the time series properties of the data to support the final identifying restriction used to just identify the structural panel VAR.

Table 2 reports the results of panel unit-root tests developed by Levin, Lin, Chu (2002), Im, Pesaran, and Shin (2003), Choi (2001), and Pesaran (2007): these unit root tests are known as the LLC, IPS, and Fisher ADF, and Pesaran tests, respectively. The null hypothesis of all the tests is that all the panels have unit roots. The results in Table 1 are generally consistent across different tests suggesting log real GDP and log nominal GDP are non-stationary in log levels and are only stationary after first-differencing. Results for the LLC test suggest that the two variables may be stationary in log levels for the annual data and that real GDP may be stationary for the quarterly data. However, for panels A and D, which have the longest time span of data at their respective frequencies the other three unit root tests do not support the LLC results. Based on this observation and all of the panel unit root tests, we reject the null hypothesis of a unit root for log real GDP and log nominal GDP.

The unit root results are quite different for the export ratio. In this case there is overwhelming evidence that the export ratio is stationary in levels. In all panels using annual data and for the quarterly data in panels D and E, at least three of the four tests reject the null hypothesis that

the export ratio across countries exhibit a unit root. The results for the Four Tigers in panel F show two of the unit roots tests similarly reject the null, while two do not. Given the consistent and clear evidence of stationarity across the panels we conclude that the export ratio is stationary in levels. While the unit root results are different for the three variables in the VAR, the fact that the export ratio is I(0) and real GDP and nominal GDP are I(1) gives evidence for the final long-run restriction used to identify export shocks based on time series properties of the data. As shocks to a stationary variable cannot have long-run effects on a nonstationary variable, the fact that the export ratio is stationary in levels is used to identify export shocks as the shock in the three-variable system including real GDP, nominal GDP, and the export ratio that does not have a long-run effect on both real GDP and nominal GDP.[2]

We turn next to Granger causality tests which may give information on potential additional identifying restrictions based on the short-run direction of causation. Dumitrescu and Hurlin (2012) discuss the benefits of panel Granger tests including finding meaningful results even with shorter time horizons and improved efficiency of results. Their paper provides a procedure which addresses the problem arising from heterogeneity of individual cross-sections. The test is based on the simple Granger (1969) causality test in a heterogeneous panel model. The spirit of the test is similar to the IPS panel unit root test, in that the individual Wald statistics defined to test Granger non causality hypothesis for each country are averaged. If the null of homogeneous non

[2] The fact that the export ratio is stationary in levels and that real GDP is nonstationary in levels also supports the long-run neutrality restriction/assumption of the export shock as a type of demand shock.

causality is rejected, then there is evidence that a causality relationship can be found in one or more of the bivariate relations in the panel.

Table 3 gives results from panel granger causality tests for the three variables examining all possible bivariate combinations.[3] Results are largely consistent showing bidirectional causation in all cases: causation in each direction between the two variables but no evidence of one direction causation. If there were clear one direction causation between any combinations of the three variables it would allow for the use of short-run restrictions to identify the structural VAR. However, in this case evidence across all panels shows there is no evidence of one directional causation.

Finally, Table 4 presents results for cointegration tests based on Pedroni (1999) between the two nonstationary variables, real GDP and nominal GDP. If cointegration exists a vector error correction model would be appropriate for estimating the three variable system. As there is little evidence in the table for cointegration in any of the panels and there is no additional restriction implied by the time series properties of the data based on the Granger causality test results, we employ the following three restrictions to identify the structural shocks of interest: nominal demand shocks have no long-run real effects on real GDP and export shocks have no long-run effects on real GDP and nominal GDP.

[3] The number of lags were chosen based on the Akaike Criterion.

The estimation strategy here follows Pedroni (2013). While Pedroni (2013) developed an innovative approach not only for the estimation of a panel structural VAR through a group mean/median process, the author also showed how the estimates could be separated into common and idiosyncratic components. Here, we simply apply the group mean/median estimation strategy for the composite shocks without decomposition. We denote the reduced form moving average representation of the three variable VAR by $\Delta z_{it} = F_i(L)\mu_{it}$ and the structural form by $\Delta z_{it} = A_i(L)\varepsilon_{it}$. Δz_{it} is a 3X1 vector consisting of the three stationary variables Δ(log real GDP), Δ(log nominal GDP), and the export ratio. It is assumed there is a vector of white noise shocks for each country, ε_{it} m=1,…,N. The relationship between the reduced form shocks and the structural shocks is given by:

$$(13)\ \ \mu_{it} = A_i(0)\varepsilon_{it}\ \forall i$$

First, the reduced form VARs $R_i(L)\Delta z_t = \mu_{it}$ for each panel member i is estimated.[4] The three long-run restrictions which imposes a zero in the lower left triangle of $A_i(1)$ allows us to identify this matrix, where the appropriate covariance matrices are represented by

$$(14)\ \mathrm{Q}_{\mu i}(1) = \ A_i(1)A_i(1)'$$

Furthermore, using the fact that $\mathrm{F}_i(1)A_i(0) = \ A_i(1)$ and equation (13) the structural shocks ε_{it} are obtained. We then use the sample distribution of these responses to calculate the median response and also perform a panel bootsraping procedure with 1000 draws to compute 95 percent confidence intervals for these median response estimates. Median variance

[4] Lag length is chosen in separate VARs using the GTOS option in procedure varlagselect, RATS 9.0.

decompositions are similarly estimated. We now turn to the impulse responses and variance decompositions resulting from the structural VAR estimation.

Results

Figure 1 shows the impulse responses of real GDP to structural demand, export and supply shocks from the panel VARs using annual data. Results for all three panels show that demand, export and supply shocks all have statistically significant effects on real GDP at all horizons. The impact on real GDP from a supply shocks increases from the initial shock to 5-7 years out, with the effect then leveling off at a sustained higher level. Generally demand shocks have smaller impact, although statistically significant, with export shocks having the second largest, followed by demand shocks. Nonetheless, the evidence shows export shocks have strong significant effects and highlight their importance for understanding real output fluctuations over time. Consistent with the identifying restriction imposed on the system to estimate the structural shocks, the impacts from both demand shocks on real GDP diminishes over time.

Results for more recent data in panel C which covers 208 countries for the period 1990-2014, shows a somewhat dampened impact relative to the other two panels. It is possible this difference is due either to the additional countries in the more recent sample, all being developing and transition countries, or due to the shorter time span, not allowing for as accurate an estimation of the impact. In the more recent panel the relative size of the impacts between demand, exports and supply differ from those in panels A and B. While supply shocks

still have the largest relative impact, the relative size of the impact of export shocks lessens compared to those from the demand shocks. Moving down rows in figure 1 we see this change progresses as the size of the impact on real GDP from the export shock is smaller as we shorten the time span in each panel and increase the number of countries.

Table 5 gives the median variance decompositions at various horizons for real GDP across the three panels using annual data. In all panels, supply shocks account for a majority of the variation of real GDP fluctuations at all horizons, increasing in percentage over time. While the relative importance of the two demand shocks varies across the panels, consistent with the smaller impact for export shocks found in the impulse responses in more recent panels, export shocks account for a smaller fraction of the variation in real GDP as well. As the table presents median estimates for each panel the variance decompositions across the three shocks do not necessarily sum to 100. Nonetheless, while both demand shocks have statistically significant effects on real GDP, they account for a greater percentage of real GDP variation in panels that cover longer time spans, with the export shock having relatively greater explanatory power, even accounting for 25 percent of variation in the immediate period of a shock in panel A. This could indicate that adding the additional countries in later panels, which is primarily developing and transition economies, dampens the estimated impact and importance of export shocks.

Figure 2 shows impulse responses from the structural VAR estimation using quarterly data. Results for panels D and E using World Bank data are similar to those from panel A. Responses

from real GDP to all demand and supply shocks are statistically significant at all horizons, supply shocks have the largest impact and increases over time, and the relative size of the impact from exports shocks is greater than from nominal demand shocks. The variance decompositions in Table 6 for the quarterly data shows supply shocks account for the majority of variation at all horizons and increases to over 80 percent in the long-run. Table 6 also shows that export shocks account for a greater share of variation relative to nominal demand shocks. Given most of the countries in the quarterly sample would not be classified as "low income" countries, results here combined with those from the annual panels suggest that incorporating more developing countries does dampen the estimate of the impact of export shocks.

The impulse response results for the Four Tigers' panel F in figure 2 shows much larger estimates for both type of demand shocks compared to the other panels. In fact, the size of the impact from the nominal demand shock is larger than the supply shock at all horizons. Impacts from both demand shocks also show greater persistence despite the identifying restriction imposed on the system of long-run neutrality of demand shocks. Variance decomposition estimates in table 6 show that nominal demand shocks account for a larger percentage of variation in real GDP than supply or exports shocks, and combined, both demand shocks account for over 50 percent of real GDP variation, at all horizons. Export shocks account for roughly the same fraction of variation as supply shocks in panel F. The distinct difference in the results for the Four Tigers panel supports what as others have concluded in the literature, the experience of these nations is simply different than most. Results here suggest that the

difference is in the importance of demand shocks in particular, but not necessarily export shocks. Of course, it may be that the identifying restrictions used in this paper do not accurately separate demand shocks into nominal domestic demand shocks and export shocks and part of the nominal demand shock impact could actually contain export shocks.

Conclusion

Overall, the results suggest that exports play an important role in understanding real GDP fluctuations across countries. There is a sustained significant effect to real GDP from an export shock and at various horizons export shocks can account for as much as 15-20 percent of output variation. The similarity of results across panels both with annual and quarterly data and from different sources suggest that while there may be some differences across panels, the significant role of exports in driving real GDP changes over time is a robust finding for a wide cross section of countries. There is evidence that as one includes more developing countries in the sample the estimated impact of exports diminishes and the impact and importance of domestic nominal demand shocks increases. Except for the case of the Four Tigers, supply shocks account for the majority of real output variation over time. For the Four Tigers, it seems demand has played a much more significant role. Many have pointed to the different circumstances that allowed the Four Tigers to develop so rapidly. Results here suggest that while exports played a significant role, other demand shocks played a more significant role.

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Table 1. Panel data sets: coverage and sources

Panel	Period	Number of Countries	Number of Observations	Data Source
A	1960-2014	113	6215	Penn World Table Version 9. Annual data 1960-2014 GDP, GDP at constant national 2011 prices, and exports at constant national 2011 prices. The data set covers 1950-2014 and includes 200+ countries and territories. Exchange rates from database used to convert data into dollars.
B	1970-2014	182	8190	
C	1990-2014	208	5200	
D	1995:1-2016:4	20	1760	World Bank Global Economic Monoitor Database. Quarterly data 1990-2016. GDP, GDP at constant 2010 prices, and exports at constant national 2010 prices in dollars.
E	1999:1-2016:4	28	2016	
F	1975:1-2016:4	4	672	Taiwan: The Directorate General of Budget, Accounting and Statistics (DGBAS), Republic of China (Taiwan); South Korea: Korea Statistical Information Service, Statistics Korea. Singapore: Department of Statistics, Government of Singaproe. Hong Kong: Census and Statistics Department, The Government of the Hong Kong Special Administrative Region. Exchange rate for Korea, Singapore, Hong Kong: IMF International Financial Statistics data base. Taiwan exchange rate: Central Bank of the Republic of China (Taiwan). GDP, GDP in chained 2010 national prices, exports in chained 2010 national prices. Exchange rates used to convert data into dollars.

Table 2: Panel unit root tests results

Variable	LLC		IPS		Fisher-ADF		Pesaran	
A: Annual 1960-2014 N=113								
ln(Real GDP)	**	-2.90		2.83		1.75		5.41
△ln(Real GDP)	**	-39.48	**	-41.13	**	-18.70	**	-14.59
ln(Nominal GDP)		-1.01		2.51		3.66		1.32
Δln(Nominal GDP)	**	-43.38	**	-41.17	**	-18.12	**	-17.07
Real Export/Real GDP	**	-3.06	^	-1.37	**	-21.86	**	-3.57
B: Annual 1970-2014 N=182								
ln(Real GDP)		0.31		1.45		3.42		4.73
△ln(Real GDP)	**	-34.05	**	-42.24	**	-20.49	**	-11.45
ln(Nominal GDP)	**	-4.30	**	-5.45	**	3.42		3.90
Δln(Nominal GDP)	**	-42.70	**	-44.99	**	-21.35	**	-17.29
Real Export/Real GDP	**	-3.73	**	-1.84	**	-25.17	**	-3.64
C: Annual 1990-2014 N=208								
ln(Real GDP)	**	-7.15	**	-4.57		2.60		4.73
△ln(Real GDP)	**	-25.43	**	-28.47	**	-11.88	**	-3.43
ln(Nominal GDP)	**	-9.86	**	-9.04		2.93	**	-2.57
Δln(Nominal GDP)	**	-29.98	**	-31.16	**	-7.93	**	-6.89
Real Export/Real GDP	**	-104.00	**	-70.57	**	-11.81	**	-3.31
D: Quarterly 1995:1-2016:4 N=20								
ln(Real GDP)	**	-3.35		-0.21		-0.34		3.65
△ln(Real GDP)	**	-20.06	**	-21.23	**	-12.08	**	-9.26
ln(Nominal GDP)		-0.23		1.39		1.96		-1.33
Δln(Nominal GDP)	**	-24.33	**	-22.90	**	-12.76	**	-11.09
Real Export/Real GDP	**	-3.17	**	-2.84	**	-16.84		-3.63
E: Quarterly 1999:1-2016:4 N=28								
ln(Real GDP)	*	-2.21		-0.13		0.42		4.22
△ln(Real GDP)	**	-22.57	**	-22.18	**	-11.90	**	-9.28
ln(Nominal GDP)		3.11		5.21		6.44		-1.26
Δln(Nominal GDP)	**	-20.05	**	-19.70	**	-14.15	**	-10.62
Real Export/Real GDP	**	-3.59	**	-2.56	**	-16.74	^	-1.56
F: Quarterly 1975:1-2016:4 N=4								
ln(Real GDP)		0.02		-0.76		0.05		0.21
△ln(Real GDP)	**	-4.00	**	-7.58	**	-7.28	**	-6.70
ln(Nominal GDP)		-1.38		0.98		1.30		0.24
Δln(Nominal GDP)	**	-5.09	**	-7.88	**	-6.88	**	-6.68
Real Export/Real GDP		-0.35		-0.43	**	-10.15	**	-2.05
Reported Test Statistic	LLC adjusted t		IPS W_{t-bar}		Choi Inverse Normal Z		Pesaran Standardized $\bar{t}$	

Note: * significant at 5 percent; ** significant at 1 percent,^ significant at 10 percent.

Lag lengths for the LLC and IPS tests were determined using the AIC;

For the Fisher-ADF and Pesaran tests, Schwert's (1989) criterion was used: $lags_{max} = [4 \cdot (T/100)^{0.25}]$

Table 3. Panel Granger causality test results

A: Annual 1960-2014 N=113						
	Δln(Real GDP) ≠> Δln(Nominal GDP)			Export Ratio ≠> Δln(Nominal GDP)		Δln(Real GDP) ≠> Export Ratio
$W_{N,T}^{Hnc}$		1.82		1.67		3.34
$Z_{N,T}^{Hnc}$	**	6.13	**	5.07	**	17.59
$\tilde{Z}_{N}^{Hnc}$	**	5.43	**	4.43	**	16.10
	Δln(Nominal GDP) ≠> Δln(Real GDP)			Δln(Nominal GDP) ≠> Export Ratio		Export Ratio ≠> Δln(Real GDP)
$W_{N,T}^{Hnc}$		1.21		2.39		1.56
$Z_{N,T}^{Hnc}$		1.59	**	10.43	**	4.21
$\tilde{Z}_{N}^{Hnc}$		1.19	**	9.43	**	3.64
B: Annual 1970-2014 N=182						
	Δln(Real GDP) ≠> Δln(Nominal GDP)			Export Ratio ≠> Δln(Nominal GDP)		Δln(Real GDP) ≠> Export Ratio
$W_{N,T}^{Hnc}$		2.03		2.05		2.45
$Z_{N,T}^{Hnc}$	**	9.84	**	9.98	**	13.78
$\tilde{Z}_{N}^{Hnc}$	**	8.56	**	8.68	**	12.16
	Δln(Nominal GDP) ≠> Δln(Real GDP)			Δln(Nominal GDP) ≠> Export Ratio		Export Ratio ≠> Δln(Real GDP)
$W_{N,T}^{Hnc}$		1.31		2.14		1.54
$Z_{N,T}^{Hnc}$	**	3.00	**	10.91	**	5.19
$\tilde{Z}_{N}^{Hnc}$	**	2.30	**	8.53	**	4.30
C: Annual 1990-2014 N=208						
	Δln(Real GDP) ≠> Δln(Nominal GDP)			Export Ratio ≠> Δln(Nominal GDP)		Δln(Real GDP) ≠> Export Ratio
$W_{N,T}^{Hnc}$		3.46		4.07		2.50
$Z_{N,T}^{Hnc}$	**	10.54	**	15.00	**	15.32
$\tilde{Z}_{N}^{Hnc}$	**	7.03	**	10.57	**	11.88
	Δln(Nominal GDP) ≠> Δln(Real GDP)			Δln(Nominal GDP) ≠> Export Ratio		Export Ratio ≠> Δln(Real GDP)
$W_{N,T}^{Hnc}$		1.61		2.33		1.73
$Z_{N,T}^{Hnc}$	**	6.17	**	13.61	**	7.44
$\tilde{Z}_{N}^{Hnc}$	**	4.25	**	10.46	**	5.30
D: Quarterly 1995:1-2016:4 N=20						
	Δln(Real GDP) ≠> Δln(Nominal GDP)			Export Ratio ≠> Δln(Nominal GDP)		Δln(Real GDP) ≠> Export Ratio
$W_{N,T}^{Hnc}$		1.04		2.04		2.30
$Z_{N,T}^{Hnc}$		0.11	**	3.29	**	4.12
$\tilde{Z}_{N}^{Hnc}$		0.04	**	3.08	**	3.87
	Δln(Nominal GDP) ≠> Δln(Real GDP)			Δln(Nominal GDP) ≠> Export Ratio		Export Ratio ≠> Δln(Real GDP)
$W_{N,T}^{Hnc}$		4.48		4.88		4.44
$Z_{N,T}^{Hnc}$	**	11.02	**	12.27	**	10.87
$\tilde{Z}_{N}^{Hnc}$	**	10.48	**	11.69	**	10.34
E: Quarterly 1999:1-2016:4 N=28						
	Δln(Real GDP) ≠> Δln(Nominal GDP)			Export Ratio ≠> Δln(Nominal GDP)		Δln(Real GDP) ≠> Export Ratio
$W_{N,T}^{Hnc}$		0.92		1.94		5.24
$Z_{N,T}^{Hnc}$		-0.29	**	3.51	**	15.86
$\tilde{Z}_{N}^{Hnc}$		-0.38	**	3.23	**	14.94
	Δln(Nominal GDP) ≠> Δln(Real GDP)			Δln(Nominal GDP) ≠> Export Ratio		Export Ratio ≠> Δln(Real GDP)
$W_{N,T}^{Hnc}$		3.24		4.53		2.61
$Z_{N,T}^{Hnc}$	**	8.38	**	13.19	**	6.01
$\tilde{Z}_{N}^{Hnc}$	**	7.84	**	12.41	**	5.60
F: Quarterly 1975:1-2016:4 N=4						
	Δln(Real GDP) ≠> Δln(Nominal GDP)			Export Ratio ≠> Δln(Nominal GDP)		Δln(Real GDP) ≠> Export Ratio
$W_{N,T}^{Hnc}$		5.89		7.01		3.96
$Z_{N,T}^{Hnc}$	**	6.92	*	5.01	^	1.96
$\tilde{Z}_{N}^{Hnc}$	**	6.75	*	4.86	^	1.88
	Δln(Nominal GDP) ≠> Δln(Real GDP)			Δln(Nominal GDP) ≠> Export Ratio		Export Ratio ≠> Δln(Real GDP)
$W_{N,T}^{Hnc}$		4.84		3.44		5.58
$Z_{N,T}^{Hnc}$	**	5.43	**	3.46	**	6.49
$\tilde{Z}_{N}^{Hnc}$	**	5.29	**	3.76	**	6.33

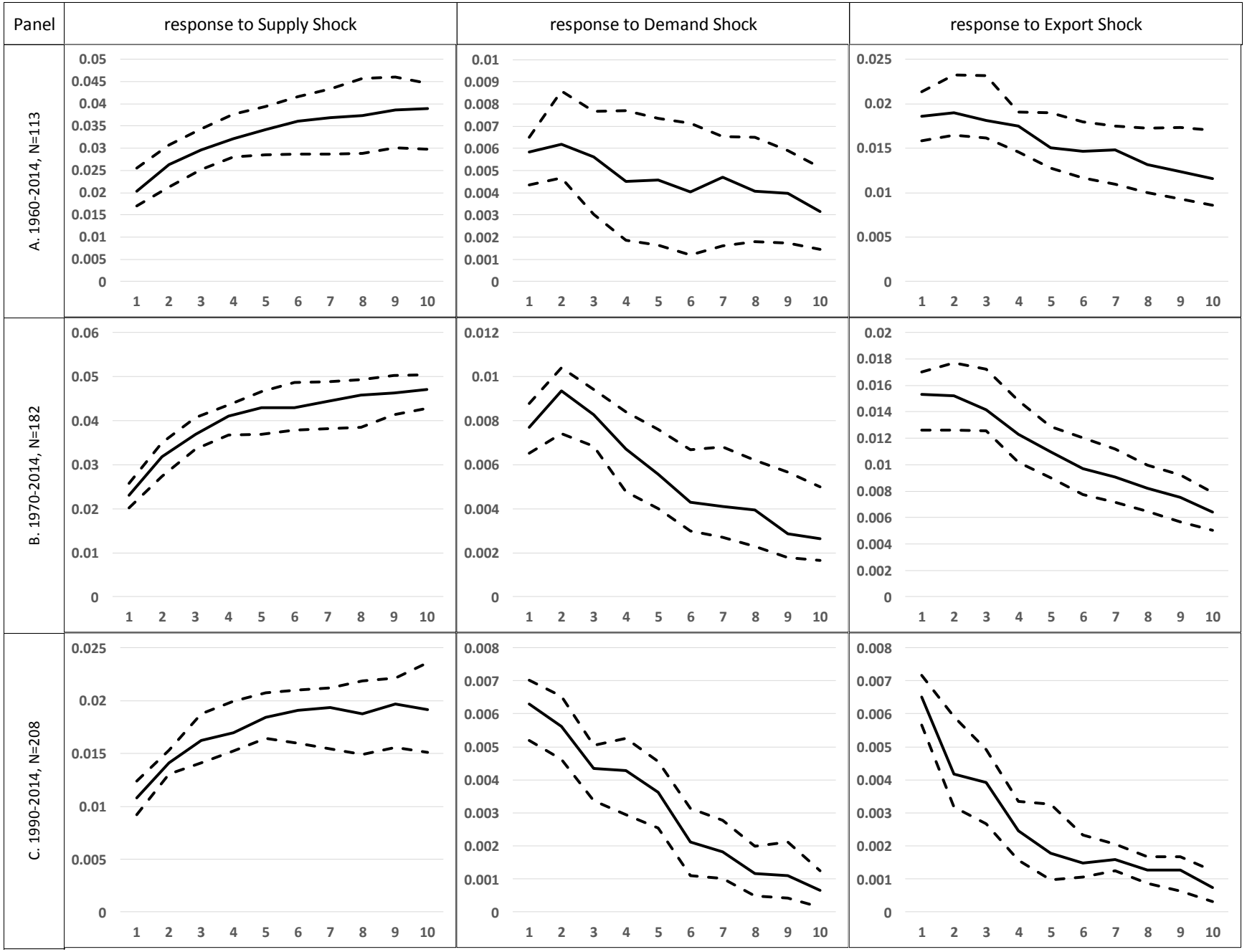
Note: * significant at 5 percent; ** significant at 1 percent; ^ significant at 10 percent. HO (null hypothesis): ≠> = "does not cause"

Table 4. Pedroni's panel cointegration tests results

A: Annual 1960-2014 N=113						
	v-stat		rho-stat		t-stat	adf-stat
Panel-stats:	-4.29		4.02		4.07	2.54
Group-stats:			3.41		4.23	3.33
B: Annual 1970-2014 N=182						
	v-stat		rho-stat		t-stat	adf-stat
Panel-stats:	-5.08		3.73		2.49	1.66
Group-stats:			4.90		3.55	1.83
C: Annual 1990-2014 N=208						
	v-stat		rho-stat		t-stat	adf-stat
Panel-stats:	0.44		0.16	**	-4.16	0.57
Group-stats:			2.76	**	-4.28	-0.20
D: Quarterly 1995:1-2016:4 N=20						
	v-stat		rho-stat		t-stat	adf-stat
Panel-stats:	-2.31		-0.20		-0.68	-1.01
Group-stats:			0.99		0.10	-0.85
E: Quarterly 1999:1-2016:4 N=28						
	v-stat		rho-stat		t-stat	adf-stat
Panel-stats:	-2.34		-0.04		-0.68	* -1.96
Group-stats:			1.70		0.39	-2.01
F: Quarterly 1975:1-2016:4 N=4						
	v-stat		rho-stat		t-stat	adf-stat
Panel-stats:	-1.82		0.15		-1.38	0.35
Group-stats:		*	-2.19	*	-1.94	** -2.97

Note: All reported test statistics are normalized to the N(0,1) distribution with the null of no cointegration.
* significant at 5 percent; ** significant at 1 percent.

Figure 1: Impulse responses of log real GDP, annual data

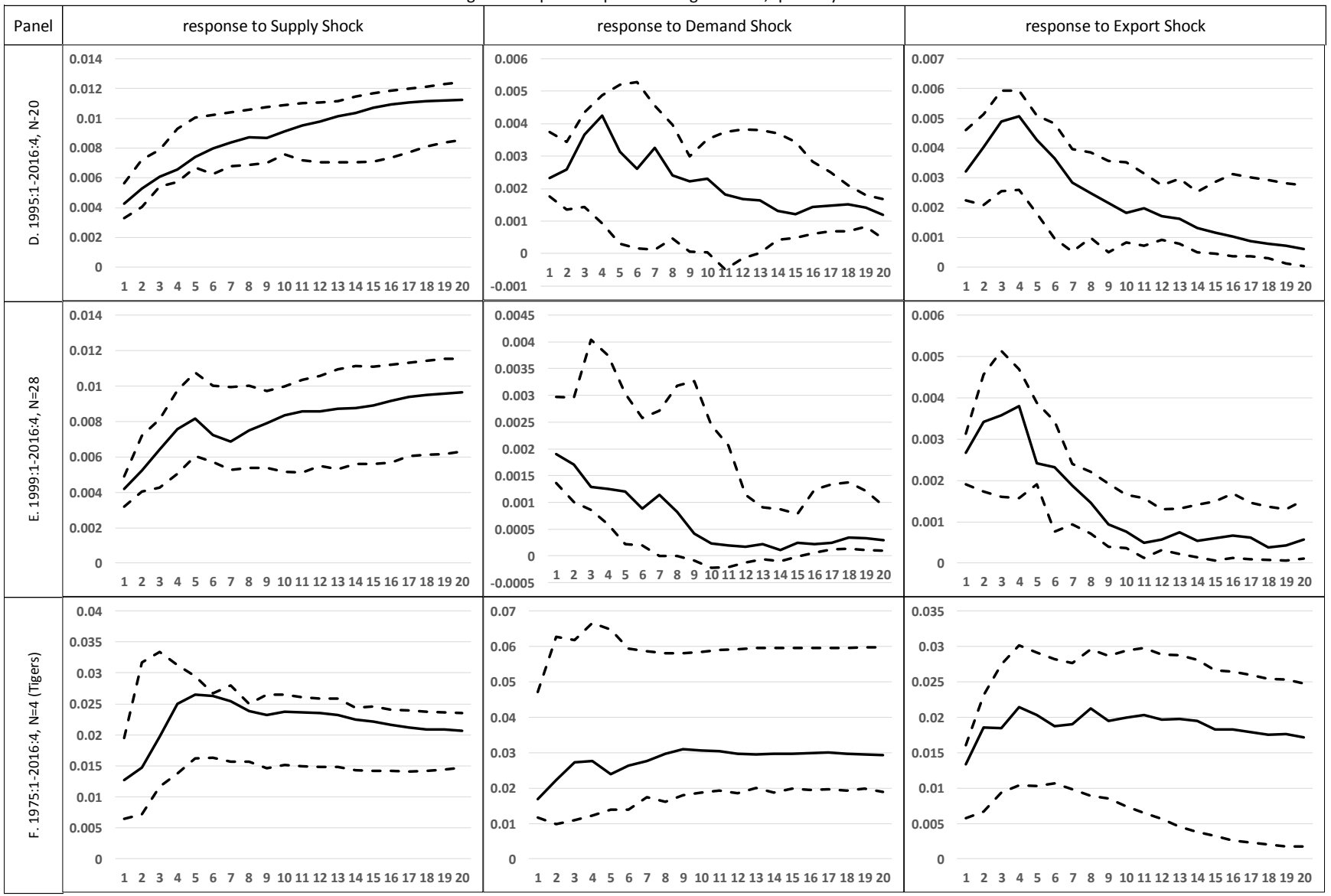


Note : Dashed lines are 95 percent confidence intervals base on 1000 sample bootstrap

Table 5: Variance decompostions for log real GDP, annual data

Panel	Horizon	variation due to:		
		Supply	Demand	Exports
A. 1960-2014, N=113	1	52.8	7.1	25.4
	3	57.7	9.3	20.1
	7	70.9	10.6	13.6
	10	72.0	10.3	10.6
B. 1970-2014, N=182	1	50.6	15.5	14.6
	3	62.1	13.1	11.5
	7	64.8	12.8	9.6
	10	72.5	12.0	8.3
C. 1990-2014, N=208	1	56.9	12.6	14.8
	3	68.6	12.9	9.5
	7	78.1	10.5	5.9
	10	84.4	7.8	4.2

Figure 2: Impulse responses of log real GDP, quarterly data



Note : Dashed lines are 95 percent confidence intervals base on 1000 sample bootstrap

Table 6: Variance decompostions for log real GDP, quarterly data

Panel	Horizon	variation due to:		
		Supply	Demand	Exports
D. 1995:1-2016:4, N=20	1	54.8	8.7	21.0
	4	50.5	6.9	25.0
	8	59.4	8.1	16.4
	16	83.5	7.2	10.1
	20	88.2	5.9	7.2
E. 1999:1-2016:4, N=28	1	53.1	10.9	18.5
	4	61.3	8.4	24.9
	8	67.9	7.8	14.5
	16	81.1	6.7	7.7
	20	85.2	5.4	5.5
F. 1975:1-2016:4, N=4 Tigers	1	14.7	50.6	15.7
	4	20.5	43.0	20.3
	8	22.8	39.9	20.4
	16	21.0	43.2	19.8
	20	20.5	44.5	19.3