VAR Modelling in the Presence of China's Rise: An Application to the Taiwanese Economy

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Abstract

This paper uses the impulse responses of a structural VECM to compare the effect of output shocks originating from the US and China on the Taiwanese economy. From 1980 to 2011 the impact of a US output shock on Taiwan is seven times greater than one originating in China, yet from 2000 to 2011 the impact from either country is the same. Exposure to China has grown more rapidly than exposure to the US, reflecting the rapid growth in cross-strait trade intensity between China and Taiwan this century. Other East Asian economies that have booming trade with China are likely to exhibit similar results, questioning the common practice of using the US as a proxy for foreign effects in the region. We provide two examples motivating the need to include both US and Chinese foreign effects in modelling Taiwan; one based on the evolving economic openness of Taiwan and the second from the East Asia monetary union literature.

Keywords: China, VECM, Taiwan

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1   Introduction

The opening of China's economy is a distinctive feature of our times. It marks the most rapid and sustained growth of any large economy in recorded history, outstripping both Europe during the Industrial Revolution and the United States in the 19th century. Since 1980 China's growth has averaged 12.2 percent annually, with real GDP doubling every 7-8 years (IMF, 2014a). With China making up around a fifth of the world population, its emergence as a formidable economic player has caused large changes in the global economic order, with the world's economic centre of gravity swinging 7,200km East since 1980 from the mid-Atlantic to Central Iran (Quah, 2011).

China's new economic weight has been driven by growing economic linkages with the rest of the world (ROW). The trade linkage has been particularly important, with China's export boom causing its share of world trade to surge to 11.7 percent in 2013 (WTO, 2014). This large share of world trade has even lead to China having a non-negligible impact on commodity price fluctuations (see for example, Osborn & Vehbi, 2013). China's rapid integration with the world economy carries with it an implication that fluctuations in the Chinese economy will now have significant spillovers to the rest of the world.

These spillovers can be understood through examining the nature of its trade surge. China's rise has been driven by its role as the world's factory, operating within a regional production chain. Over half of the exports to China from regional neighbours are production inputs, such as semiconductors and hard drives, bound for final assembly (WTO, 2014). The destination for the majority of these cheap manufactures is the United States and Euro Area. Thus China hasn't been so much an engine of demand, as a transmission belt for demand generated in developed markets. This is reflected in regional neighbours running trade surpluses with China, whilst most other trade partners tend to run trade deficits. Given that imports depress the growth spillover from exports, when trade is considered in isolation, China has likely had a small negative impact on growth in most developed economies, whilst its neighbours have likely felt strong trade borne growth spillovers. Arora & Vamvakidis (2011) confirm this hypothesis empirically, finding the effect of a Chinese growth spillover is quicker and larger for countries closer to China.

A recent series of Structural VAR (SVAR) and global VAR (GVAR) studies have estimated the magnitude of the spillovers to others originating from a Chinese output shock. Despite the Asia region having greater exposure to China than to the ROW, the evidence unanimously estimates the effect on Asian domestic outputs from a Chinese output shock to be some three times smaller than that of a US output shock (Dungey & Vehbi, 2011; Sato et al., 2011; Utlaut & Van

Roye, 2010; Genberg, 2005; Abeysinghe and Forbes, 2005). Likewise, despite China's extraordinary demand for minerals and primary products, Osborn & Vehbi (2013) find that the accumulated increase in Australia and New Zealand's GDP from a one percent increase in output growth in China is only 0.2 to 0.4 percent. Feldkircher & Korhonen (2014) employing a GVAR to 52 countries, note a similar trend globally, while Dungey, Fry-Mckibbin & Linehan (2014) note positive spillovers from demand for iron ore on Australian output, but also evidence for longer term Dutch disease due to reallocation of resources between domestic sectors.

The small estimates of economic impact from China seems incongruous with regional trade statistics that show huge trade surpluses, large bilateral investment, and the fact these regional neighbours are almost all small trade-reliant economies. Moreover, the IMF (2014b) find that during the global financial crisis, China's expansion provided a buffer for emerging market growth, whilst China's recent slowdown has reduced growth in these economies.

There have been divergent economic explanations for this result, including the role of the US as a final source of demand (Pula & Peltonen, 2011; Dungey & Vehbi, 2011); the majority of international trade contracts being priced in US dollars (Dungey & Vehbi, 2011); regional trade competition (Feldkircher & Korhonen, 2014) and the dominance of financial effects in shock transmission (Arora & Vamvakidis, 2011; Bayoumi & Swiston, 2009). Other authors do not provide an explanation, but rather just report their estimates (e.g. Utlaut & Van Roye, 2010; Osborn & Vehbi, 2013; Sato et al., 2011). Gosse and Guillaumin (2013) implement SVARs with exogenous influences from the world economy represented by US financial data, but no output effect. Lastly, some papers point out the possible limitation of using static parameter models such as SVARs when modeling data that contains parameter drift (aka China's growing share of world trade since 1978) (e.g. Cesa et al., 2011; Osborn & Vehbi, 2013; Arora & Vamvakidis, 2011). Accordingly, Dungey & Vehbi (2011) confine conclusions from their SVAR estimates to how best to model foreign effects in Asia, whilst Osborn & Vehbi (2013) and Arora & Vamvakidis (2011) focus on the general increase and nature of China's rise, rather than its exact level.

One aim of this paper is to show that conclusions of China's small effect are a by-product of its sudden rise; and previous fixed parameter SVAR studies have underestimated China's effect on Asia and the world. This is not a new point (see for example, Arora & Vamvakidis, 2011 p.39, Abeysinghe and Forbes, 2005), however, many papers continue to emerge that merely report that employing static parameter SVARs are a *possible* limitation, or report results as though they capture China's current effect on the world (e.g. Utlaut & Van Roye, 2010; Feldkircher & Korhonen, 2014;

this confusion is made explicit when The Economist (2010) cite Arora & Vamvakidis (2011)'s VAR estimate as a measure of the current size of a China growth spillover on ROW[2].

Figure 1 graphs the value of exports from selected Asian economies to China equalized around unity. Asian economies have all experienced a boom in exports to China since 2000, with export value on average increasing ten-fold. If trade links translate fairly monotonically to economic exposure, this figure implies China's impact on Asia has been increasing rapidly, suggesting that the exposure to China at the end of the sample will be much larger than the average; Abeysinghe and Forbes (2005) dispute the direct relationship of trade to interlinkages although their sample is now somewhat dated (1978-1998), but Kim and Lee (2012) contribute evidence of growing economic integration in the region. To examine the degree to which sample choice effects SVAR estimates, we make an application to Taiwan, the economy where trade integration has been most deep and rapid.
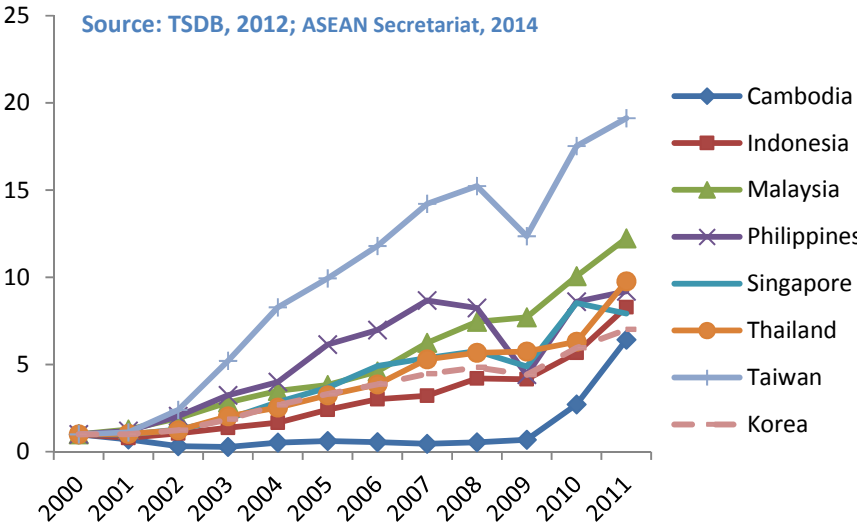

Figure 1: Total Exports with China: Selected Asian Economies (2000=1)

The second component of this paper focuses explicitly on the extensive economic integration occurring between China and Taiwan, which has recently grown to a level unrivalled by other Asian economies, as shown in Figure 1. Taiwan is highly exposed to the world economy in general, experiencing the largest and sharpest drop in exports within Asia during the global

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[2]The Economist. 'The Indispensable Economy'. 2010. http://www.economist.com/node/17363625.

financial crisis (ADB, 2009). Such characteristics stem from Taiwan's export-led growth within the volatile IT and electronics sectors, within which China plays a key role. In 1985, facing fierce price competition from regional competitors, such as South Korea, Taiwan began offshoring manufacturing to China, where wages were substantially lower. Since then, cross-strait trade growth has been a function of the pace of liberalization of trade, facilitated by cost-cutting Taiwanese SME's. Thus Taiwan and China's trade reflects a production network, with 70 percent of exports to China being unfinished goods bound for final assembly (Yuan-Tung, 2004). Of these exports 75 percent are by firms with manufacturing in China, and almost exclusively in electronics and IT goods bound for developed markets (Su, 2011). This regional supply chain, augmented by geographical proximity, a common language, and diplomatic isolation internationally has led to economic integration unmatched by other economies.
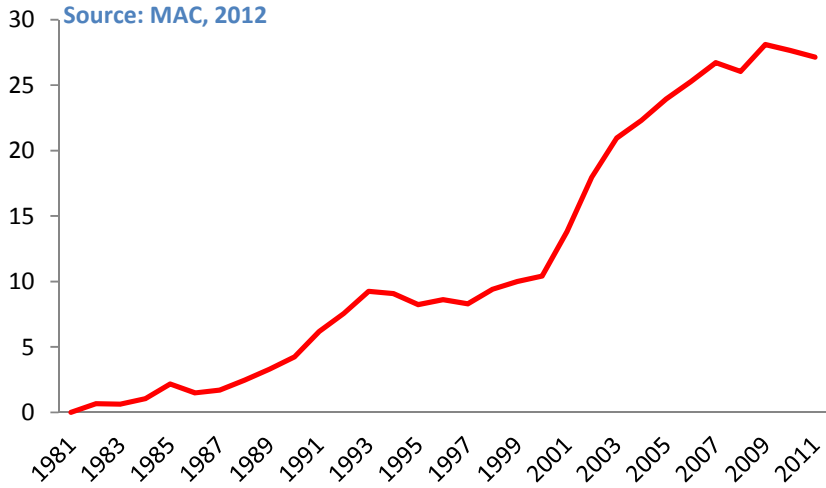

Figure 2: China's Share of Total Trade with Taiwan (%)

Figure 2 shows the acceleration of cross-strait trade since 2000 associated with liberalization measures which include; joining the WTO in 2001, signing the Open Door policy in 2008 and the Economic Cooperation Framework Agreement (ECFA) in 2010. By 2011 Chinese exports were 34.5 percent of Taiwanese GDP, compared with 10.2 percent and 1.9 percent for Asia and ROW. Taiwan's total exports to China in 2011 amounted to US$160 billion, the third largest

after Japan and Korea, and net exports with China are the world's largest at $US89 billion, making up 19 percent of Taiwan's GDP, compared to 11.5 percent for the rest of Asia[3].

Given the increasing structural similarities of East Asia economies since the financial crisis of 1997-98, a number of studies model this region as though it were a country, or as though conclusions about a subsample apply to the general region (For example, Nguyen et al., 2014; Utlaut & Van Roye, 2010). Taiwan's unique trade integration with China relative to other Asian economies suggests that if trade is an important transmission mechanism, this assumption is not valid in relation to China-borne shocks, where Taiwan's reaction is likely much stronger. To date, only Sato et al. (2011) and Abeysinghe and Forbes (2005) assess China's direct impact on Taiwan. Their samples are respectively from 1999 to 2006 and 1978 to 1998 and thus omit the most recent effects of trade intensification[4].The additional time span available provide an opportunity to revisit the issue.

The analysis deals with two main issues, relating to the validity of using the US as a proxy for foreign effects. This a common assumption in open economy SVAR literature introduced by Cushman & Zha (1997). To assess its validity Dungey & Vehbi (2011) compare the impact of similar sized output shocks from China and the US for five East Asian economies over the period 1986 to 2009, concluding that more explanatory power is gained by using the US as a proxy for global conditions, but that in future China is likely to be an important external influence. This paper will assess whether a new definition of foreign effects is already needed for Taiwan, using a similar analytical framework applied to the Taiwanese economy. To illustrate the importance of these choices we examine two cases where the correct representation of foreign effects is likely to be important. The first examines Taiwan's rapid opening to global trade and financial markets, focusing on the role of the Asian financial crisis in this process[5], and assesses if using the US as foreign proxy will yield adequate results in such a context.

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[3]Aggregate trade data and GDP cited in the paper are from the National Bureau of Statistics of China and The World Bank's World Development Indicators, 2011. 'Asia' is defined as Malaysia, Korea, Singapore, Thailand, Vietnam, Philippines, Indonesia and Japan. The 'ROW' measure is the sample used in the GVAR of Feldkircher & Korhonen (2014) less Asia.

[4] Cross-strait trade in 2006 was only .65 of its 2011 level (MAC, 2012).

[5]Zhang et al. (2004) find that the Asian financial crisis initiated a rise in the openness of East Asian economies. However, this seems unlikely for Taiwan for a number of reasons, chiefly that its currency was floating (see Yan & Yang, 2012).

The second case examines the existing SVAR literature regarding monetary union in East Asia[6]. The literature emerged following the AFC and reported increasing similarities in responses to common external shocks by Asian economies, and the declining importance of country specific shocks, and led directly to more recent analysis supporting monetary union amongst certain regional sub-groups (Huang & Guo, 2006; Liu, 2012; Nguyen et al., 2014). However, the symmetry of response to Chinese shocks has not been thoroughly assessed in these studies, but instead uses the US to model foreign effects. Given that China's economic impact is potentially quite large and growing we argue that a more thorough analysis regarding response to China sourced shocks is crucial to assessing the potential for monetary union in East Asia. For example, Nguyen et al. (2014) and Liu (2012) that recommend Taiwan join a North East Asian monetary union on the basis of empirical work concerning a US output shock. If the effect of a Chinese output shock on Taiwan is disproportionately large, there has been a loss of generality from using the US to model foreign effects, and Taiwan is likely not in a position to join such a monetary union.

Taiwan has a number of attractive features for this analysis. Firstly, Taiwan is a harbinger of a broader trend of East Asian trade integration with China (see Figure 1). Secondly, Taiwan has many of the features of a modern developed economy; inflation targeting, floating exchange rates and minimal disturbance from the 1997-98 financial crisis. Finally, China's impact on Taiwan can be given a distinct trade interpretation, given that protectionism blocked cross-strait financial linkages until 2009[7]; thus allowing an analysis of the importance of the trade channel for Taiwan, and by extension its similarly export-reliant neighbours (see Appendix D).

This paper proceeds as follows. Section 2 outlines the theoretical model, Section 3 and 4 describe the economic specification of the SVECM and estimation procedures, Section 5 presents the empirical results and Section 6 makes some concluding remarks.

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[6] An abundance of SVAR literature exists on this topic; all assessing whether the commonality of response to external shocks has become more symmetric over time, which would tick off one of the preconditions for an optimal currency area. See Chow & Kim, 2003; Zhang et al., 2004; Huang & Guo, 2006; Hsu, 2010; Nguyen et al., 2014, Liu, 2013; Quah, 2012 etc.

[7] The absence of financial linkages is backed up empirically, with no stock market correlations or covariability in interest rates found between Taiwan and China (Cheng & Glascock, 2005; Cheung et al, 2005; Bahng & Shin, 2004).

2 Theoretical Framework

The New Keynesian DSGE framework developed in Gali & Monacelli (2005) is adopted to inform the identifying restrictions made in the empirical specification. The model consists of an open economy IS curve, a Phillips curve, exchange rate equation and Taylor rule. The model structure takes the form:

$$y_t = \mu E_t y_{t+1} + (1 - \mu) y_{t-1} - \emptyset(r_{t-1} - E_{t-1}\pi_t) + \theta_1 \Delta q_t + \theta_2 y_t^* + \epsilon_{AD_t}$$

(1)

$$\pi_t = \delta E_t \pi_{t+1} + (1 - \delta)\pi_{t-1} + \lambda y_t + \theta_3 \Delta q_t + \epsilon_{AS_t}$$

(2)

$$r_t = \rho r_{t-1} + (1 - \rho)(\beta E_t \pi_{t+1} + \gamma y_t) + \epsilon_{MP_t}$$

(3)

$$E_t \Delta q_{t+1} = (r_t - E_t \pi_{t+1}) - (r_t^* - E_t \pi_{t+1}^*) - \epsilon_{RER_t}$$

(4)

Where y_t and y_t^* are the log of domestic and foreign output gaps, r_t and π_t are the nominal interest rate and domestic inflation rate respectively, and q_t is the real exchange rate. ϵ_{AD_t}, ϵ_{AS_t}, ϵ_{MP_t} and ϵ_{RER_t} represent aggregate demand, aggregate supply, monetary policy and real exchange rate shocks. The predictions from the NK DSGE model are used as theoretical justification for the sign restrictions imposed on the specification outlined in the next section.

3 Empirical Specification

Suppose that the economy is described by the following VAR(p):

$$y_t = A_1 y_{t-1} + \cdots + A_p y_{t-p} + u_t \tag{5}$$

where y_t is a ($n x 1$) vector of all endogenous variables, A_i is a ($n x n$) matrix of parameters for $i = 1, 2, \ldots, p$, and u_t is a ($n x 1$) vector of residuals with $u_t \sim N(0, \Sigma_u)$. If all variables are difference stationary the VAR(p) can be written in VECM form as:

$$B_0 \Delta y_t = \Pi^* y_{t-1} + \Gamma_1^* \Delta y_{t-1} + \cdots + \Gamma_{p-1}^* \Delta y_{t-p+1} + \varepsilon_t \tag{6}$$

where Π^* is the structural matrix and the $\Gamma_i^*, i = 1 \ldots p - 1$ are ($n x n$) matrices of the short-run dynamics parameters. ε_t is an ($n x 1$) structural disturbance with zero mean and covariance matrix

Σ_ε and B_0 is an (nxn) matrix of the contemporaneous relations in y_t. Assuming that the B_0 matrix is invertible, Equation 6 is given by

$$\Delta y_t = \Pi y_{t-1} + \Gamma_1 \Delta y_{t-1} + \cdots + \Gamma_{p-1} \Delta y_{t-p+1} + u_t \tag{7}$$

where $B_0^{-1}\Pi^* = \Pi$, $B_0^{-1}\Gamma_j^* = \Gamma_j$ for $j = 1,2,\dots p-1$ and $B_0^{-1}\varepsilon_t = u_t$. When Π has a reduced rank of $r \leq n-1$ then Π can be written as $\Pi = \alpha\beta'$, where β is a (nxr) matrix of long-run relationships and α is a (nxr) matrix of the 'speed of adjustment' coefficients. The model is identified by combining exclusion restrictions on B_0 and Γ_j as well as utilizing cointegration amongst the I(1) variables to provide extra identifying restrictions[8].

Equation 7 can be written with a Beveridge-Nelson Moving Average (MA) representation

$$y_t = F \sum_{i=1}^{t} u_{it} + \sum_{j=0}^{\infty} F_j^* u_{t-j} + y_0^* \tag{8}$$

where y_0^* is the initial value of the series and the matrix $F = \beta_\perp (a_\perp'(I_n - \sum_{i=1}^{p-1} \Gamma_i)\beta_\perp)^{-1} a_\perp'$. With r cointegrating vectors, F is of rank $n-r$ and there are $n-r$ independent common trends. The first term in Equation 8 represents the long run effects of shocks which captures the common stochastic trends. The second term represents the transitory shocks to the system, such that $F_j^* \to 0$ as $j \to \infty$. The common driving stochastic trends are the variables $a_\perp' \sum_{i=1}^{t} u_{it}$ where $\beta_\perp(a_\perp'(I_n - \sum_{i=1}^{p-1} \Gamma_i)^{-1}$ are their factor loadings. Replacing the u_t by their structural counterparts we obtain

$$y_t = y_0^* + F \sum_{i=1}^{t} B_0^{-1}\varepsilon_t + \sum_{j=0}^{\infty} F_j^* B_0^{-1}\varepsilon_{t-j} \tag{9}$$

This allows recovery of transitory and permanent shocks. The permanent effects are captured through FB_0^{-1}, which has a rank $n-r$ with B_0 nonsingular. Thus, while r of the structural shocks have transitory effects, $n-r$ will have a permanent effect and can be restricted to zero, freeing $r(n-r)$ independent identifying restrictions.

Using a Wold decomposition and assuming the first $n-r$ shocks are permanent (ε_{1t}) we can write Δy_t as

$$\Delta y_t = C(L)B_0^{-1}\begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix} \tag{10}$$

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[8] For details see Pagan & Pesaran (2008).

Where $C(L)$ is a polynomial of order q in the lag operator.

For the remaining ε_{2t} shocks to be transitory requires

$$FB_0^{-1}\begin{pmatrix} 0_{(n-r)*r} \\ I_{r+k} \end{pmatrix} = F\alpha = 0 \tag{11}$$

Which implies that $\alpha_1 = 0$, where α_1 is the $(n-r)*r$ matrix of adjustment coefficients of the I (1) variables that give rise to the permanent shocks driving the cointegrating relationships. This suggests that structural equations for which there are known permanent shocks should have no error correction terms in them (see Pagan & Pesaran, 2008).

Lastly, the conventional use of output gap (i.e Gali, 1992) is replaced by the differenced output together with the corresponding error correction term for this variable, in order to avoid misspecification (see Dungey & Pagan, 2009 for details).

4 Estimation Procedure

There are 5 variables included in the vector y_t; foreign and domestic outputs, inflation, interest rates and the real exchange rate, aligning with standard open economy NK DSGE models. Exogenous oil price inflation is added to the Phillips Curve to help solve any potential price puzzle (see Kim & Roubini, 2000). Quarterly data is used from the inception of cross-strait trade in 1980Q3 up until 2011Q4, allowing analysis of more recent cross-strait trade intensification. Appendices A and B contain the data description and variable plots.

Table 1 presents the Augmented Dickey Fuller (ADF) results for all system variables. The ADF test shows that π_t is stationary whilst y_t^*, y_t and q_t are I(1) variables. As is common, the interest rate fails to reject the null of non-stationarity, but is assumed to be I(0); see Clarida et al., 2000.

A trade interpretation of business cycles gives support to cointegration amongst foreign and domestic output and the exchange rate (see Mills & Pentecost, 2003). The Johannsen test confirms the existence of this long run relationship (see Table 2), which is estimated with the Engle-Granger two step procedure using alternatively Chinese or US output for foreign output:

$$Chinese\ GDP\ as\ y_t^*: y_t = -3.71 + .66y_t^* + .83q_t + e_{yt} \tag{12}$$

$$US\ GDP\ as\ y_t^*: y_t = -1.98 + 2.07y_t^* + .40q_t + e_{yt} \tag{13}$$

The ADF statistics for tests of nonstationarity on the residuals, e_{yt}, from the China and US equations are -3.46 and -2.25 respectively, with an associated MacKinnon (1996) 5 percent critical

value of -1.94, thus confirming cointegration in both equations. The Akaike Information Criteria (AIC) and Hannan-Quinn (HQ) point toward two lags, which is chosen in favour of 1 lag suggested by the Schwartz Criterion (SC); as supported by the results of a Likelihood Ratio Test, see Table 3[9].

4.1 Exclusion Restrictions

The contemporaneous exclusion restrictions are shown explicitly in Equation 14 and reflect a small open economy. Foreign output is most exogenous, and the real exchange rate least exogenous. Between those, domestic output is followed by domestic inflation and the monetary reaction function. The lag matrices in Equation 15 have a similar structure, but with additional dynamics that can be traced back to the lag structures in Equations 1-4.

$$B_0 u_t = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ b_{21}^0 & 1 & 0 & 0 & 0 \\ 0 & b_{32}^0 & 1 & 0 & 0 \\ 0 & b_{42}^0 & b_{43}^0 & 1 & 0 \\ b_{51}^0 & b_{52}^0 & b_{53}^0 & b_{54}^0 & 1 \end{bmatrix} \begin{bmatrix} u_{y_t^*} \\ u_{y_t} \\ u_{\pi_t} \\ u_{r_t} \\ u_{q_t} \end{bmatrix} = \begin{bmatrix} \varepsilon_{y_t^*} \\ \varepsilon_{y_t} \\ \varepsilon_{\pi_t} \\ \varepsilon_{r_t} \\ \varepsilon_{q_t} \end{bmatrix} (14) \quad B_L(L) = \begin{bmatrix} b_{11}^l & 0 & 0 & 0 & 0 \\ b_{21}^l & b_{22}^l & b_{23}^l & b_{24}^l & b_{25}^l \\ 0 & b_{32}^l & b_{33}^l & 0 & b_{35}^l \\ 0 & b_{42}^l & b_{43}^l & b_{44}^l & 0 \\ b_{51}^l & b_{52}^l & b_{53}^l & b_{54}^l & b_{55}^l \end{bmatrix} (15)$$

The identification of the temporary and permanent shocks involves estimating the long-run impact matrix, J; which estimates shock values as $j \to \infty$. A pre-cursor to this estimation is to specify the speed of adjustment matrix, α and cointegrating vector, β:

$$\alpha = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 0 & 0 \\ 0 & a_{32} & 0 \\ 0 & a_{42} & a_{43} \\ a_{51} & a_{52} & a_{53} \end{bmatrix} (16) \quad \beta = \begin{bmatrix} \beta_{11} & 0 & 0 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ \beta_{51} & 0 & 0 \end{bmatrix} (17)$$

The two I(0) variables contain pseudo-ECM terms, which are the coefficients of unity in columns 2 and 3 of β (see Dungey and Pagan, 2009). These terms correct for the levels effect that is lost when using a VECM.

Given the specification of the α and β matrices the structural form α^* is found via $B_0^{-1}\alpha$. These matrices are converted into their orthogonal complements, and the long run impact matrix is found through Equation 16:

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[9]The LR statistics for China and the US are 71.6 and 56.44 respectively, against a critical value of 37.65, thus rejecting the null of the VAR(1) in first differences which was suggested by SC.

$$J = FB_0^{-1} = \beta_\perp (a'_\perp (I_n - \sum_{i=1}^{p-1} \Gamma_i)\beta_\perp)^{-1} a'_\perp B_0^{-1} = \begin{bmatrix} \Pi_{11} & 0 & 0 & 0 & 0 \\ \Pi_{21} & \Pi_{22} & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ \Pi_{51} & \Pi_{52} & 0 & 0 & 0 \end{bmatrix} \qquad (18)$$

The J matrix is of reduced rank given there are $n - r$ long run trends. Thus ε_{π_t}, ε_{r_t} and ε_{q_t} are transitory shocks. The first two columns show that foreign and domestic output shocks have a permanent effect on y_t^*, y_t and q_t, with the block exogeneity condition precluding y_t's effect on y_t^*.

5 Results

We report the impulse responses from the SVECM model applied to Taiwan for samples between 1980 and 2011. Although a full set of impulses were produced, we report only the foreign variable sourced shocks here (however, the domestic economy shocks all produce reasonable results without evidence of price puzzle or exchange rate puzzle). Our analysis concentrates on foreign shocks emanating from China and the US. We first examine how the SVECM model results are affected by sequentially shorter and more recent sample lengths with either China or US as the source of foreign shocks. Our preferred specifications are used to assess the implications of China's growth on SVAR modeling in the East Asia region. Finally we consider our two applications around the Taiwanese economy to demonstrate the importance of accounting for China in the modeling of foreign effects.

The impulses are in response to one standard deviation shocks to the errors over a time span of 50 quarters (12.5yrs) with all calculations performed in MatLab. Shorter samples are estimated using the full sample error correction specification representing the long-run relationship. Appendix C shows that short-run deviations can take a long time to return to the long-run relationship; a short-sample error correction specification is likely to lose precision.

5.1   Effect of Sample Choice on SVAR estimates

Without reliable point estimates of China's current impact it is difficult to determine whether trade is a weak transmission mechanism or if SVARs tend to underestimate China's impact on East Asia and ROW. Unfortunately, little light is shed on this question by using very short-sample SVAR's, as they are imprecise, and time varying parameter models are difficult to implement in such a setting. We address this matter by utilizing SVECM estimates over

sequentially shorter more recent samples, to give an illustration of the evolving nature of exposure to China and the US.

Figure 3 shows Taiwan's output response to Chinese and US shocks. Each line on the figure represents the response in Taiwanese output to the same sized output shock originating from the US (in the left side panel) and from China (in the right side panel). The five lines on each panel represent the impulses resulting from estimates over different sample periods, starting from 1980 when cross-strait links were initiated and then sequentially omitting the earliest five years from subsequent samples.

Figure 3 illustrates the speed at which Taiwan's exposure to both economies has risen over time. This is particularly the case for shocks originating from China (right hand panel). Omitting the years 1980 to 1985 more than doubles the output rise caused by a positive Chinese output shock; the earliest five years have almost non-existent cross-strait trade. After 1985, the trade growth has consistently increased with the lifting of cross-strait trade restrictions, as seen in Figure 3; the gap at each five year interval grows consistently larger through time. The largest increase in the gap occurs when omitting the years 1995 to 2000, representing the particularly intensive trade that has taken place since 2000 (see Figure 2).
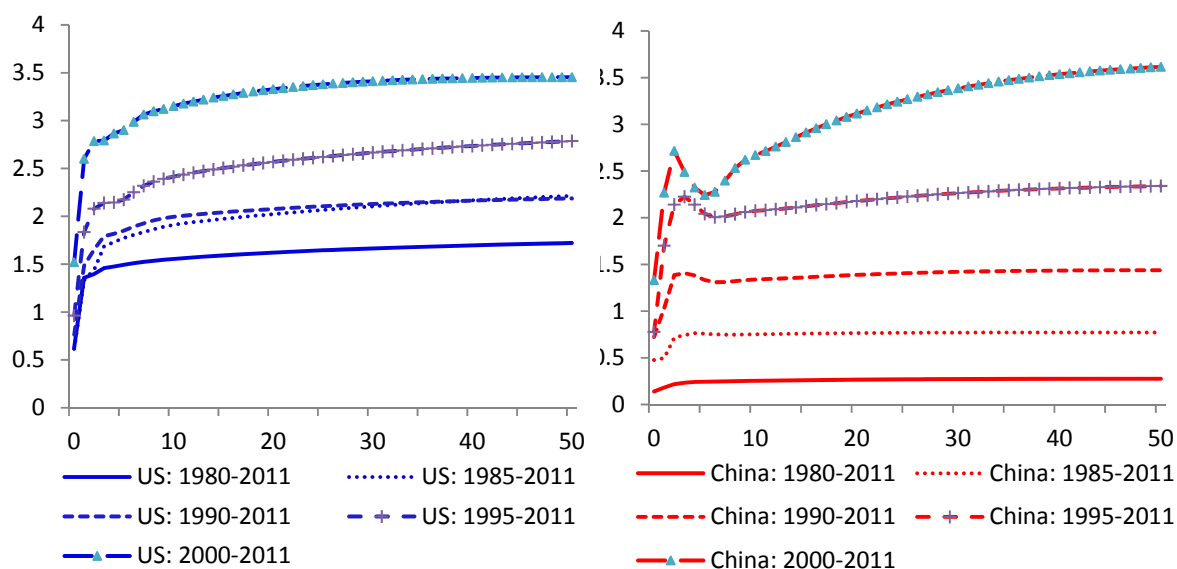

Figure 3: Output Responses to US and China Output Shocks

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A similar, albeit more muted pattern of exposure exists for US shocks. Omitting the first five years increases exposure slightly; possibly due to the investment restrictions in place at the time. Removing the next five years has little effect due to the prominence of domestic factors (see Chang et al., 2002). Exposure then increases more rapidly, in alignment with renewed financial integration with the US and deepened bilateral cooperation and trade with US technology markets.

This increased exposure to foreign output shocks seems to fit quite closely with the nature and intensity of Taiwan's economic linkages with the US and China. As economic linkages deepen between the economies, the estimated impact of a shock increases. Moreover, since the economic influence of China on Taiwan has been increasing much faster than the US influence, historical samples will tend to overstate the influence of the US relative to China. For example, the 1980-2011 sample indicates a US shock will have an effect seven times larger than one from China, whilst a 2000-2011 sample estimates the exposure as approximately equivalent (Abeysinghe and Forbes (2005), estimate the effect of a US output shock on Taiwan as having over 4 times more impact than a Chinese output shock for the period 1978-1998.) Given cross-strait integration has been almost exclusively through trade, the results provide strong evidence of the importance of the trade channel to Taiwan. As other East Asian countries are similarly susceptible to trade conditions, and have experienced rapid trade integration with China, similar conclusions are likely to apply to these economies. As a result, existing statements concerning the predominance of US shocks in East Asia are likely to be overstated using this type of framework. In fact both economies now have a large influence on macroeconomic outcomes. The evidence supports the practice of limiting SVAR conclusions to the general increase and nature of China's rise, rather than its exact level.

The dynamic approach used in Figure 3, however, does allows broad statements to be made about the current impact of a Chinese output shock. Transmission of Chinese shocks to Taiwan is exclusively through trade, and Figure 3 shows that the magnitude of these shocks reflects the nature of cross-strait trade. Given that from 1980 to 2000 trade flows grew from zero to $US32bn, yet by 2011 had grown to $US160bn, one can posit that the exponential growth of cross-strait trade since 2000 has caused a similarly unprecedented jump in the impact of a Chinese output shock to Taiwan in the present. The analysis implies Taiwan's exposure to China is now significantly larger than its exposure to the US.

5.2   The Empirical Adequacy of Using US as Foreign Proxy

The empirical evidence for Taiwan suggests the Chinese economy is now more influential than the US economy. Thus, the exclusion of China in the modeling of foreign effects, at least in recent

years, will give misleading results. We explore this notion by using SVAR analysis to examine a historic issue and a policy issue that both require a good representation of foreign effects. The historic issue is an examination of the path of Taiwan's rapid transition to becoming one of the most open economies in the region. The policy related issue is to add to the evidence regarding whether Taiwan is well positioned to enter an East Asia currency union.

5.2.1 Application 1: Taiwan's Evolving Openness

The path of Taiwan's evolving openness to global conditions is yet to be thoroughly examined. It is of interest because Taiwan was minimally impacted by the Asian Financial Crisis in 1997-8, yet experienced the largest impact of any East Asian economy from the global financial crisis in 2008. We use a historical decomposition of output to elicit which variables have contributed to growth over time[10]. Such an analysis by its nature involves a longer sample of data. We use the full sample, 1980 to 2011, and follow the traditional practice of using the US as a proxy for foreign effects.
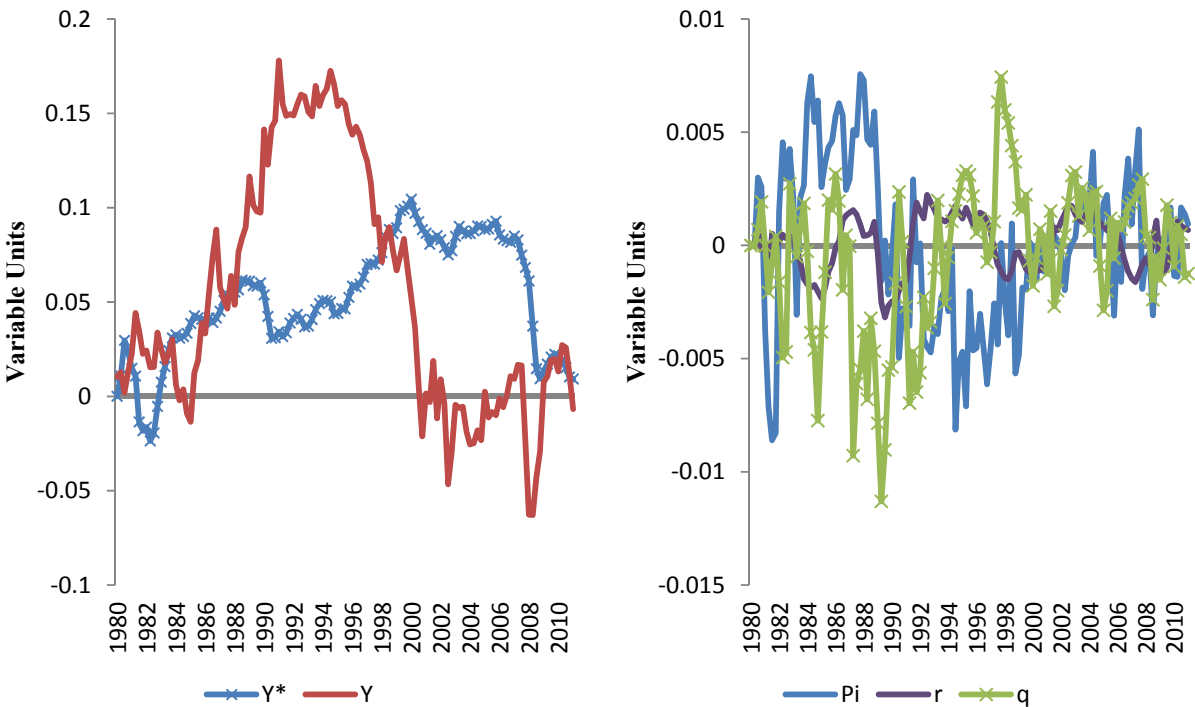

Figure 4: Historical Decomposition of Output

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[10]For more on historical decomposition, see for example Buckle et al., (2007)

To the authors' knowledge the only Taiwan specific research examining the importance of global conditions is by Chang et al. (2002), who found that from 1985 to 1999 domestic shocks had a much larger influence than external shocks on Taiwan. Dungey & Vehbi (2011) note a similar trend of domestically sourced growth in other East Asian economies over this period. They note that the Asian Financial Crisis tended to *initiate* increased openness within East Asia, with foreign factors displacing domestic factors in driving output growth up until the onset of the global financial crisis, when the influence of foreign factors dropped off dramatically. The IMF (2014b) find that China played a large offsetting role during this period; with renewed demand for East Asian exports helping to prop up East Asian economies in the aftermath of the crisis.

The historical decomposition for Taiwanese output is shown in Figure 4. The most striking feature of the figure is the dramatic shift in the relative importance of domestic and foreign output shocks in driving output over the sample. Domestic shocks drove growth from the late 1980s to the late 1990s, consistent with the analysis of Chang et al. (2002), but have rapidly declined in importance since 1995, such that over the last decade domestic shocks have had a slightly negative impact on Taiwanese output. That is, Taiwan has been increasingly reliant on foreign output shocks to drive domestic output growth. Indeed Figure 4 shows that other than a slight dip in 1989, foreign factors have gradually grown in importance since the beginning of the sample until the earliest indications of global financial stress in 2007. This is in contrast to the sudden rise of the role of foreign factors for other East Asian economies reported in Dungey & Vehbi (2011), and indicates that Taiwan's rising openness is associated with a gradual process of liberalization rather than the abrupt Asian Financial Crisis induced structural change posited by Zhang et al (2004) for East Asian economies in general.

Using the US economy as a foreign economy proxy captures the slowing of domestic demand as the economy matured, the minimal effect of the AFC and the growing reliance on world markets. However, the model does not seem to capture the full extent of this opening to global conditions, with the contribution of foreign shocks increasing only marginally from 1997 to 2007. This reflects the rise in the contribution of 'foreign output shocks' actually only reflecting an increase in the contribution of US output shocks. As demonstrated in Section 5.1 the influence of Chinese shocks on the Taiwanese economy has grown rapidly in the later parts of the sample. This point is made starkly evident in the wake of the global financial crisis with the model only capturing the waning recovery of developed economies. In fact, although it experienced a severe blow to growth in the early part of the financial crisis in 2007, Taiwan had a strong trade driven recovery, with 38 percent export growth and 10.7 percent GDP growth in 2010. That this huge growth surge

is not seen in Figure 4 reflects the lack of information about the role of China, where renewed export demand propped up the growth of its regional neighbours (IMF, 2014b). This application shows the loss of generality resulting from excluding China in the definition of foreign effects for East Asian economies.

5.2.2 Application 2: Monetary Union in East Asia

A popular application for SVAR studies in East Asia has been assessing the feasibility of monetary union. One condition for currency union is that member countries respond similarly to common exogenous shocks. Nguyen et al. (2014) and Liu (2012) find that North East Asia's response to a US output shock (proxy for foreign effects) has recently become relatively homogenous. Possibly due to the abundance of SVAR literature showing the small impact of China on East Asian economies, they use this evidence alone to recommend a North East Asia monetary union. However, as discussed in Section 5.1, within East Asia the impact of China is currently likely to be on par with that of the US. For this reason, it seems important that the Chinese economy is included in the representation of foreign effects.
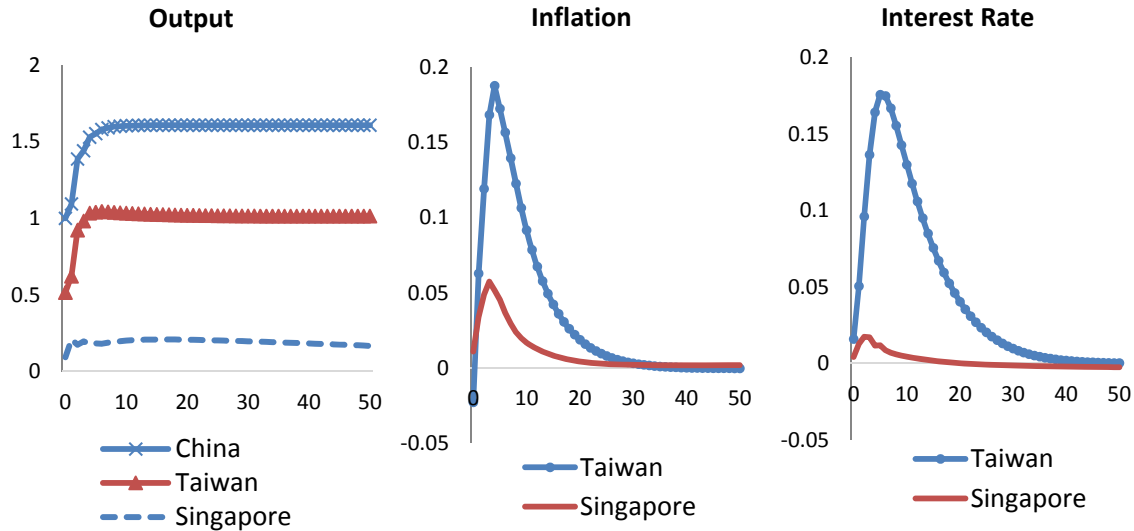

Figure 5: Impulse Responses of Taiwan and Singapore to a Chinese Output Shock

We assess the conclusions made by Nguyen et al. (2014) and Liu (2012) that Taiwan is well positioned to enter a North East Asian monetary union. We do this by comparing the impulse responses of a number of domestic variables in Taiwan and Singapore - a representative East Asian

16

economy - to a Chinese output shock[11]. If the responses in these two East Asian economies to the same Chinese output shock are not similar this will throw doubt on the effectiveness of a monetary union involving their currencies. Figure 5 shows the output, inflation and interest responses in Taiwan and Singapore to a Chinese output shock. The size of the Chinese output shock itself is shown as the top line in the left hand panel of the figure.

The far left panel shows that both the initial impact and longer run response of Taiwanese output to the Chinese output shock is roughly five times larger than in Singapore. As a result the inflation increase is also much larger for Taiwan. Although the monetary response is endogenous to the central banks inflation sensitivity, the results imply that the interest rate response to the same China originated shock is some ten times greater in magnitude for Taiwan than for Singapore. If Taiwan were included in a regional monetary union with Singapore the chosen monetary policy stance would not be strong enough to stem Taiwanese inflation. Consequently and in contrast to the results of Nguyen et al. (2014) and Liu (2012), this evidence suggests that Taiwan is not well positioned to enter an optimal currency area in this region, due to its unique integration with China relative to other East Asian economies.

The example shows that even over a relatively long sample period, the definition of the foreign shock will affect conclusions about the nature of integration in the region. A narrow definition concentrating on the US economy will provide a misleading picture of Taiwan's susceptibility to foreign shocks.

These two cases both show that for Taiwan, including the effect of China's economy is imperative for SVAR analysis focused on the past decade or so. The same boom in China-directed exports for other East Asian economies, which will likely continue as China's consumer market opens further, imply that this finding will become increasingly true for the entire region. The second case illustrated that for policy decisions such as establishing a monetary union, accounting for China's influence is particularly crucial.

6 Conclusion

China's extraordinary 30 plus years of trade-driven economic growth has markedly changed the global economic landscape. The IMF writes of the 'decoupling' of Emerging Asia from the

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[11]As the SVECM used in this paper is that of Dungey & Vehbi, 2011, a direct comparison can be made between Taiwan and Singapore, as its domestic output response was around the mid-range amongst East Asian economies. We follow the Dungey & Vehbi (2011) sample: 1986-2009.

outcomes of developed economies in light of this rapid growth. Yet surprisingly, the findings of many SVAR studies quantifying these spillovers find that China's influence is still small in the region. This is in stark contrast to what is inferred by trade statistics and anecdotal evidence. Consequently, many studies continue to pay minimal heed to the effect of China when modeling East Asian economies. To examine this contradiction an application was made to Taiwan, the economy at the forefront of trade integration with China. It was found that Taiwan's exposure to China is increasing in tandem with the recent exponential rise in cross-strait trade, such that China's influence on Taiwan has been on par with the US from 2000 to 2011.

Previous findings of China's small influence relative to the US were shown to be a byproduct of longer sample size. In fixed parameter SVAR models, the historic weight of the US and swift rise of China results in an overstatement of the influence of the US relative to China, and more generally an understatement of the effects of China on East Asia. Given rapid cross-strait trade and the link between trade intensity and shock exposure the revealed effects of China on Taiwan is now likely to be substantially larger than the US. Similarly configured East Asian economies, such as Malaysia and Korea, are likely to have reached or be facing a similar situation.

Given this new bi polar external environment affecting East Asian economies during the last decade, we examined the validity of a single source definition of foreign effects. It was found that using the US as foreign proxy failed to show the full extent of Taiwan's reliance on external markets, or its export-led growth recovery after the global financial crisis. We also provided evidence that previous studies' advocating that Taiwan enter a North East Asian monetary union are likely to be misleading when they do not account for the country's uniquely large economic integration with the Chinese economy. This finding shows the need for further assessment in the optimal currency area literature of homogeneity of response to China originated shocks rather than just US shocks when assessing the feasibility of monetary union.

The key contribution of this paper is to use the rapid growth in exposure between Taiwan and China in the 20th century to suggest that models of East Asia take account of this increasingly important source of shocks. It is unlikely that the US now provides an appropriate proxy for foreign shocks for countries in the region. As the world's economic centre of gravity continues to rapidly swing east, increasingly new modeling frameworks are needed to account for the altering configuration of the global economy.

References

ABEYSINGHE, T. & FORBES, K. (2005). Trade linkages and output-multiplier effects: A structural VAR approach with a focus on Asia, *Review of International Economics*, 13(5), 356-375.

ARORA, V. & VAMVAKIDIS, A. (2011). China's economic growth: International spillovers. *China & World Economy,* 19(5), 31-46.

ASEAN SECRETARIAT. (2014). ASEAN Stats Database. http://www.asean.org/resources/category/asean-statistics. Accessed 2 April 2014.

ASIAN DEVELOPMENT BANK (ADB). (2009). The impact of the Global Financial Crisis on Asia and Asia's responses. In *Crisis Developments and Long-Term Global Responses: Insights from Asia and Europe AEEF Conference, Kiel, 7.*

BAHNG, S. & SHIN, S. (2004). Interactions of stock markets within the Greater China economic bloc. *Global Economic Review,* 33(3), 43-60.

BAYOUMI, T & SWISTON, A. (2009). Foreign entanglements: Estimating the source and size of spillovers across industrial countries. *IMF Staff Papers,* 56(2).

BUCKLE, R., K, KIM., KIRKHAM, H., McLELLAN, N. & J, SHARMA. (2007). A structural VAR business cycle model for a volatile small open economy. *Economic Modelling,* 24(6), 990-1017.

CESA-BIANCHI, A., PESARAN, H., REBUCCI, A., XU, T. & CHANG, R. (2012). China's emergence in the world economy and business cycles in Latin America [with comment]. *Economia,* 1-75.

CHANG, K., FILER, L. & YING, Y. (2002). A structural decomposition of business cycles in Taiwan. *China Economic Review,* 13(1), 53-64.

CHENG, H. & GLASCOCK, J. (2005). Dynamic linkages between the Greater China economic area stock markets – Mainland China, Hong Kong and Taiwan. *Review of Quantitative Finance and Accounting,* 24(4), 343-357.

CHEUNG, W., CHINN, D. & FUJII, E. (2005). Dimensions of financial integration in Greater China: money markets, banks and policy effects. *International Journal of Finance & Economics,* 10(2), 117-132.

CHOW, K. & KIM, Y. (2003). A common currency peg in East Asia? Perspectives from Western Europe. *Journal of Macroeconomics, 25(3),* 331-350.

CLARIDA, R., GALI, J. & GERTLER, M. (2000). Monetary policy rules and macroeconomic stability: Evidence and some theory. *The Quarterly Journal of Economics*, 115(1), 147-180.

CUSHMAN, D. & ZHA, T. (2007). Identifying monetary policy in a small open economy under flexible exchange rates. *Journal of Monetary Economics, 39(3),* 433-448.

DUNGEY, M. & PAGAN, A. (2009). Extending a SVAR Model of the Australian Economy. *Economic Record,* 85(268), 1-20.

DUNGEY, M., FRY-MCKIBBIN, R. & LINEHAN, V. (2014).Chinese Resource demand and the natural resource supplier, *Applied Economics*, 46(2), 167-178.

DUNGEY, M. & VEHBI, T. (2011). Modelling East Asian economies in a small open economy VECM: the influence of international and domestic shocks. Discussion Paper. School of Economics and Finance, University of Tasmania.

FELDKIRCHER, M. & KORHONEN, L. (2014). The rise of China and its implications for emerging markets-Evidence from a GVAR model. *Pacific Economic Review, forthcoming.*

GALI, J. (1992). How well does the ISLM model fit Postwar U.S. Data? *Quarterly Journal of Economics,* 107(2), 709-735.

GALI, J. & MONACELLI, T. (2005). Monetary policy and exchange rate volatility in a small open economy. *The Review of Economic Studies,* 72(3), 707-734.

GENBERG, H. (2005). External shocks, transmission mechanisms and deflation in Asia. *BIS Working Paper No. 187.* HKIMR Working Paper No. 06/2005.

GOSSE, J-B., & GUILLAUMIN, C. (2013). Can external shocks explain the Asian side of global imbalances? Lessons from a structural VAR with block exogeneity. *Review of International Economics,* 21(1), 85-102.

HSU, H. (2010). Is a common currency area feasible for East Asia? A multivariate structural vector autoregression approach. *Asian Economic Journal,* 24(4), 391-411.

HUANG, Y. & GUO, F. (2006). Is currency union a feasible option in East Asia? A multivariate Structural VAR approach. *Research in International Business and Finance,* 20(1), 77-94.

INTERNATIONAL MONETARY FUND (IMF). (2014). *World Economic Outlook,* April 2014. https://www.imf.org/external/datamapper/index.php.

INTERNATIONAL MONETARY FUND (IMF). (2014). *World Economic Outlook,* Chapter 4: On the receiving end? External conditions and emerging market growth before, during, and after the Global Financial Crisis. April 2014.*www.imf.org/external/pubs/ft/weo/2014/01/pdf/c4.pdf*.

KIM, S. & LEE, J-W. (2012). Real and financial integration in East Asia. *Review of International Economics,* 20(2), 332-349.

KIM, S. & ROUBINI, N. (2000). Exchange rate anomalies in the industrial countries: A solution with a structural VAR approach. *Journal of Monetary Economics*, 43(3), 561-586.

LIU, X. (2012). Does East Asia move towards an optimum currency area? Evidence from the multivariate structural VAR analysis. *International Journal of Economics & Finance,* 4(12), 159-177.

MAINLAND AFFAIRS COUNCIL (MAC). (2012). *Cross-Strait Economic Statistics Monthly (*Taipei, Taiwan), 230, p.2.

MILLS, T. & PENTECOST, E. (2003). Is there a relationship between real exchange rate movements and the output cycle? *Economic Modelling,* 20(3),593-603

NGUYEN, H., TRAN, T. & LE, M. (2014). The impact of external shocks on small open economies: evidence from East Asian countries. *International Journal of Economics and Finance*, 6(2), 207-217.

OSBORN, D. & VEHBI, T. (2013). Empirical evidence on growth spillovers from China to New Zealand. New Zealand Treasury, 13(17).

PAGAN, A. & PESARAN, M. (2007). Econometric analysis of structural systems with permanent and transitory shocks. *Journal of Economic Dynamics and Control,* 32(10), 3376-3395.

PULA, G. & PELTONEN, T. (2011). Has emerging Asia decoupled? An analysis of production and trade linkages using the Asian International Input-Output Table. Vol. 9, Emerald Group Publishing Limited.

QUAH, D. (2011). The global economy's shifting centre of gravity. *Global Policy,* 2(1), 3-9.

QUAH, C. (2012). The case for monetary union in East Asia: From theory to empirics. In Quah, C. (ed.) *Business Dynamics in the 21st Century.* 237-260.

SATO, K., ZHANG, Z. &McALEER, M. (2011). Identifying shocks in regionally integrated East Asian economies with structural VAR and block exogeneity. *Mathematics and Computers in Simulation,* 81(7), 1353-1364.

SU, M. (苏美祥). (2011). From the perspective of endogenous dynamics to observe Cross-Strait economic relationship after the signing of ECFA (从内生动力看 ECFA 时代两岸经贸关系的发展). *Asia-Pacific Economic Review(亚太经济), 4(1),* 125-129.(In Chinese).

TAIWAN STATISTICAL DATA BOOK (TSDB). (2012). Council for Economic Planning and Development, Executive Yuan, Taiwan.

UTLAUT, J. & VAN ROYE, B. (2010). *The effects of external shocks to business cycles in emerging Asia: A Bayesian-VAR approach.* Institute for the World Economy.

WORLD TRADE ORGANISATION (WTO). (2014). International Trade and Market Access Data.

YAN, H. & YANG, C. (2012). Does an undervalued currency merit economic growth? Evidence from Taiwan. *Panoeconomicus,* 59(1), 37-57.

YUAN-TUNG, C. (2004). Economic relations between Taiwan and China. *UNISCI Discussion Papers*, (4), 2-7.

ZHANG, Z. SATO, K. &McALEER, M. (2004). Asian monetary integration: a structural VAR approach. *Mathematics and Computers in Simulation*, 64(3), 447-458.

Table 1: Augmented Dickey Fuller Unit Root Tests

Levels	CHN y^*	US y^*	y	π	r	q
Test Statistic	-2.56	-3.03	$-.91$	-7.53	-2.22	-2.97
Integration	$I(1)$	$I(1)$	$I(1)$	$I(0)$	$I(1)$	$I(1)$

*Lag length is selected based on the AIC, with max lag 4. Variables are in log-levels except for r, which is expressed as an annualised % and π, which is expressed as %Δ per annum. Regressions include constant and linear trend; except for r and π, which just include a constant. The 5% critical value for log-level variables is -3.45, and -2.88 for r and π.

Table 2: Johannsen test of the number of cointegrating vectors

	China		US	
	At most 1	At most 2	At most 1	At most 2
$\rho - val$	$.00$	$.47$	$.01$	$.37$

*The test specification assumes a constant and no trend in the cointegrating equation.

Table 3: Lag Selection Criteria

	China			US		
Lag Length	AIC	SC	HQ	AIC	SC	HQ
0	1.62	1.89	1.73	2.30	2.58	2.41
1	-6.21	-5.58^*	-5.96	-6.00	-5.36^*	-5.74
2	-6.43^*	-5.43	-6.02^*	-6.33^*	-5.33	-5.92^*
3	-6.28	-4.92	-5.73	-6.24	-4.87	-5.68
4	-6.16	-4.43	-5.45	-6.11	-4.39	-5.41

* Denotes the minimum value of each criteria, which is the designated optimal lag length for that given criteria.

Appendix A: Data Descriptions and Sources

| variable	Code	source
Domestic output	y	log Taiwan Real GDP, Seasonally Adjusted, constant prices, National Currency, Oxford Economics (Datastream code: TWXGDSA.D)
China output	$CHN\,y^*$	China output as above (Datastream code::CHXGDSA.D)
US output	$US\,y^*$	US output as above (Datastream code::USXGDPR.D
Treasury bill rate	r	Taiwan Treasury Bill Rate, % per annum Oxford Economics (Datastream code: TWXRCB..R)
Inflation	Π	CPI, % Change per annum Taiwan Directorate of Budget, Accounting & Stats
Real exchange rate	q	log Taiwan Effective Real Exchange Rate, Not Adjusted, National Currency Oxford Economics (Datastream code: TWXRXER.F)
Oil price	oil	Oil Price, yoyΔ% World Oil Price, West Texas Intermediate, Oxford Economics (Datastream code: WDXWPOWYR)

Appendix B: Variable Plots

US GDP

China GDP

Taiwan GDP

Inflation

Interest Rate

Real Exchange Rate

Oil Prices
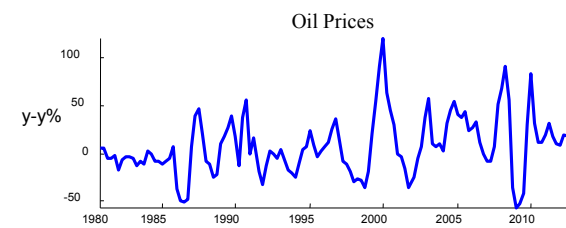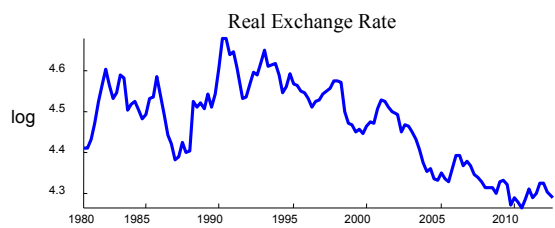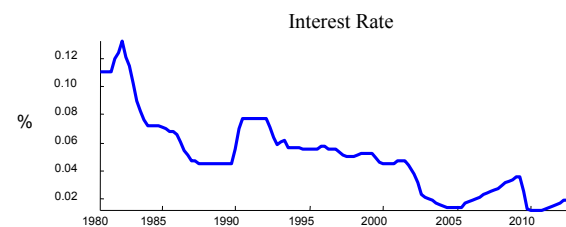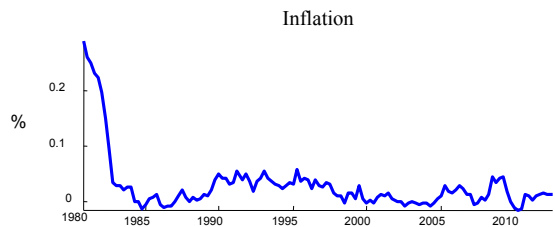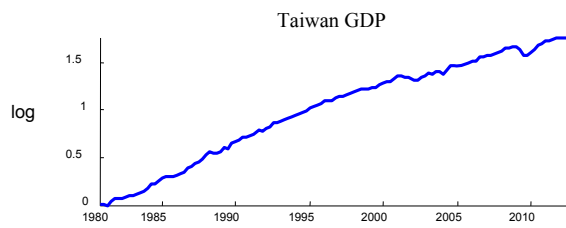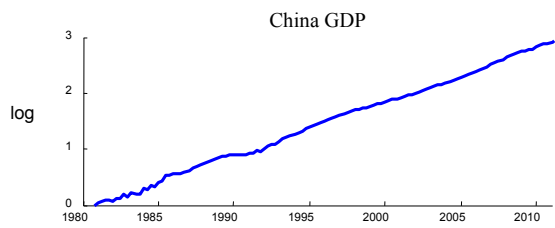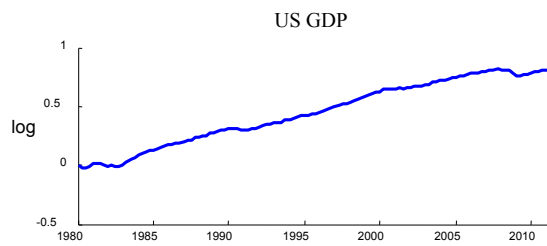
Appendix C: Error Correction Term Plot

China ECT
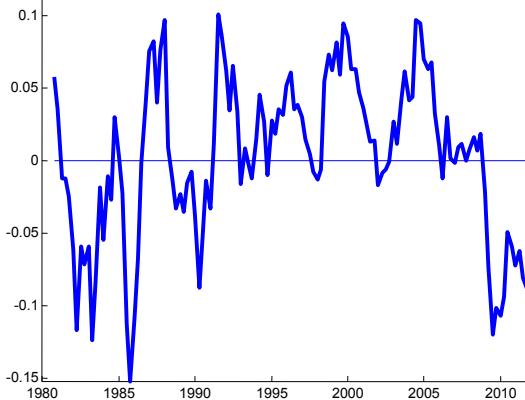
US ECT
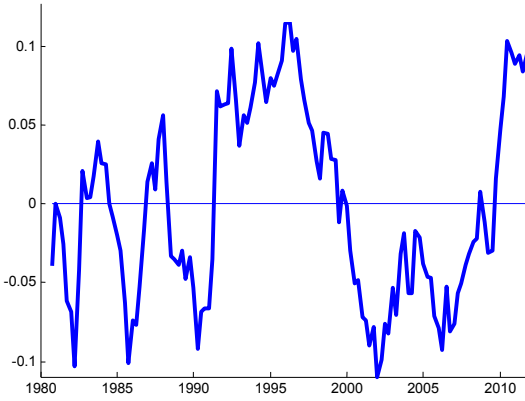
Appendix D: Trade to GDP ratios of East Asia

*Data sourced from WTO Country Profiles
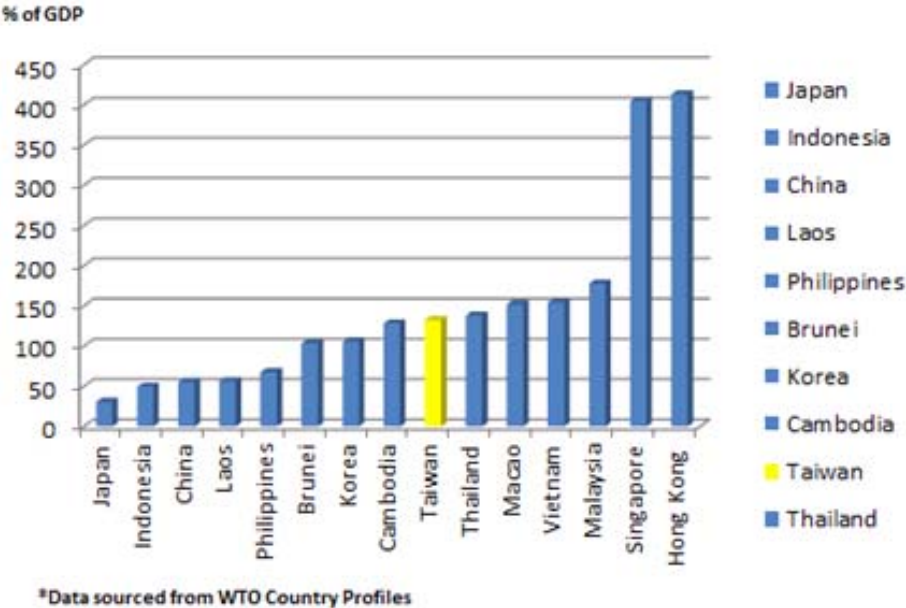
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