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Abstract

Singapore was traditionally a “re-export economy” by virtue of her historical role as an entrepôt for Southeast Asia. This paper highlights the continued dependence of her modern economy on external demand and imported inputs. Unit root, cointegration and exogeneity tests reveal the existence of common stochastic trends driving global output on the one hand, and Singapore’s trade cycles on the other. An impulse response analysis confirms that exports co-move with re-exports and imports in the short run. Furthermore, innovation accounting shows that growth in the world economy is the most important contributor to Singapore’s trade expansion in the long run.

1. Introduction

Trade has always been the *raison d'être* for Singapore's existence as a political entity—initially as a colony of the British Empire, and then as an independent nation-state. The economic historian Wong Lin Ken (2003) has meticulously documented how Singapore's commercial growth in the early nineteenth century depended on the expansion of trade with countries in the Malay Archipelago. By the time the Suez Canal opened in 1869, Singapore's lifeblood was the entrepôt trade between Europe and Asia that was conducted through her free port.

After independence in 1965, the size of Singapore's merchandise trade sector grew rapidly to three times the value of overall output by 2007 as domestic exports, or manufactures that have been subject to a greater degree of local processing than just repackaging and transshipment, took centre stage in the process of economic development. Over the years, this secular growth in trade was accompanied by a steady migration of its composition into progressively higher value-added goods, partly due to conscious efforts by the Singapore government to restructure the economy. During the 1990s, for example, the share in exports of electronic products such as disk drives, computer peripherals, and integrated circuits rose to nearly 70% as the global semiconductor market boomed. When the electronics

industry went bust in 2001, newer products such as pharmaceuticals and drugs began to come on stream as the authorities actively promoted the biomedical industries. Such goods currently account for 12% of non-oil exports but they tend to be as volatile as electronic exports. Fluctuations in petrochemical and specialty chemical shipments—the other mainstays of trade—are milder by contrast, but these also declined during the Asian financial crisis before recovering to stabilize at another 12% of visible exports.

Re-exports of goods have not stagnated too, for they currently amount to no less than half of total export volumes. As Singapore's neighbours moved away from being primary commodity producers to become her economic partners in the regional supply chain resulting from production fragmentation, however, the erstwhile entrepôt trade in primary products, food, and crude materials inexorably gave way to re-exports of machinery and equipment, particularly electronic components, and chemicals. There is of course a long-standing trade in oil of both an entrepôt and export nature, which has become even more prominent in recent years as a result of increased storage and refining facilities.

On account of her sustained role as an entrepôt for Southeast Asia, Singapore has continued to be labelled as a 're-export economy' by Lloyd and Sandilands (1986). But the real reason for the label is the widespread engagement of multi-

nationals, or their subsidiaries, in activities that involve the importation of raw materials and their transformation into exports destined for regional or world markets. Specifically, the high import content of Singapore's domestic exports effectively meant that the economic status quo of the olden days was preserved. This made Singapore as reliant on external demand and imported intermediate inputs for its economic survival as before.

To calibrate the extent of this dependence, Lloyd and Sandilands netted out the direct and indirect imported inputs used in domestic exports, thereby deriving a time series on 'net' domestic exports that indicates the amount of value-added by local export industries. During the period 1965–1982, annual net exports constituted on average a mere 25% of official domestic exports, implying that imports made up three-quarters of the latter's value, while 86% of Singapore's overall commodity exports were actually re-exports in the broad sense.

This paper revisits Lloyd and Sandilands' claim that Singapore is a re-export economy in modern guise with the techniques of time series econometrics. Our aims are twofold: initially, we draw out the implications of the re-export economy hypothesis for the joint behaviour of trade aggregates and seek to verify or refute it empirically through formal unit root, cointegration and exogeneity testing (Section 3). Following this, a vector error correction model is estimated, the structural

shocks in this multivariate system are identified, and their impact on Singapore's trade cycles is analyzed (Section 4). Before all this can be carried out, however, we need to specify the econometric model for trade flows—the subject of the next section.

2. The trade model

The empirical study of trade flows has a long and well established tradition in applied international economics. A survey of the large literature based on the 'standard trade model' reveals that the predominant approach used in the econometric analysis revolved around the estimation of structural demand and/or supply equations relating exports (or imports) to relevant income and relative price variables.¹ In terms of functional specification, early studies tended to focus exclusively on the demand side via single equation models typically incorporating a partial adjustment mechanism. After the influential critique by Goldstein and Klein (1978), however, researchers began to take supply considerations into account and to do so in a way that allows for simultaneity in the determination of equilibrium prices and quantities.

Recent work, moreover, has emphasized non-stationarities in the time series

¹Strauß (2004) contains a detailed review of the standard model and the empirical literature.

data on foreign trade and accordingly estimated cointegrating relationships for trade movements in the long run and error-correction models in the short run. Abeyasinghe and Choy (2007) provides a good example of this methodological approach in the case of Singapore. They first derived a hybrid model of exports that allows for both demand and supply factors to play a role in driving trade. The model is then used as a guide to the estimation of disaggregated export equations for goods and services, which constitute part of a larger macroeconometric model of the Singapore economy.

In the spirit of this theoretical model, we consider as determinants of Singapore's trade cycles two key variables representing world demand. One is a composite index of foreign output (f) while the other is the volume of worldwide semiconductor sales (s)—an excellent proxy for global electronics demand. On the supply side, a measure of the real effective exchange rate (e) is used to capture the putative influences of relative price and exchange rate movements on trade flows, notwithstanding the fact that Singapore is for all practical purposes a price-taker in world markets. Since the working hypothesis is that the country is still very much a re-export economy, it is postulated that the external demand and price variables will explain not only domestic exports (x), but also re-exports (r) and total imports (m) (i.e. inclusive of re-exports).

The empirical trade model employed in this paper differs from that in Abeysinghe and Choy (2007) in several respects, however. First, it makes no attempt to distinguish structurally between demand and supply equations on the one hand, and export and import equations on the other, thereby eschewing ‘incredible’ identifying restrictions. The critical restrictions used rely only on the time series properties of economic variables. Second, we assume that exogenous shocks hit the economy from time to time in a framework that is rather more amenable to the analysis of trade cycles. Third, by considering the Singapore variables as jointly endogenous in the first instance, the model ensures that valuable information on the dynamic linkages between exports, re-exports and imports is not discarded.

The approach we have in mind is represented by the following vector error-correction model (VECM):

$$\Delta X_t = \mu + \pi X_{t-1} + \pi_1 \Delta X_{t-1} + \cdots + \pi_{k-1} \Delta X_{t-k+1} + \epsilon_t \quad (2.1)$$

where $\Delta X_t = [\Delta f_t, \Delta s_t, \Delta x_t, \Delta r_t, \Delta m_t, \Delta e_t]'$ is the vector of first-differenced time series, μ is a vector of constant terms, π_i are (6×6) matrices of unobserved parameters and the innovations ϵ_t are assumed to be i.i.d. Gaussian processes with zero mean and a possibly non-diagonal covariance matrix Ω . If the individual

series are integrated of first order and also cointegrated, then $\text{rank}(\pi) = r < 6$ and π can be reconstituted as the outer product $\alpha\beta'$, where α and β are $(6 \times r)$ matrices. The columns of β are the coefficients in the r cointegration vectors and the rows of α are the loadings on the error-correction terms $\beta'X_{t-1}$ in each equation, respectively.

On inverting the VECM in (2.1), we obtain the moving average representation (VMA):

$$\Delta X_t = \rho + C(L)\epsilon_t \quad (2.2)$$

L is the lag operator, $C(L) = \sum_{i=0}^{\infty} C_i L^i$ with $C_0 = I_n$, $\rho = C(1)\mu$, and $C(1) = \beta_{\perp} \left(\alpha'_{\perp} \left(I_n - \sum_{i=1}^{k-1} \pi_i \right) \beta_{\perp} \right)^{-1} \alpha'_{\perp}$, where the subscript \perp denotes the orthogonal complement of a matrix. Subject to identification, a structural VMA corresponding to (2.2) is

$$\Delta X_t = \rho + A(L)v_t \quad (2.3)$$

in which the shocks v_t can be given economically meaningful interpretations. In contrast, the innovations in (2.2) are merely linear combinations of the structural shocks i.e. $\epsilon_t = A_0 v_t$.

The cointegration property allows the levels of the series to be written as:

$$\begin{aligned} X_t &= \rho t + (1 - L)^{-1} A(L) v_t \\ &= \rho t + A(1) \sum_{i=1}^t v_i + A^*(L) v_t \end{aligned} \tag{2.4}$$

where $A^*(L) = (1 - L)^{-1} (A(L) - A(1))$. Equation (2.4) is the multivariate Beveridge-Nelson decomposition of the endogenous variables into a deterministic time trend, $n - r$ permanent shocks, and r transitory disturbances.

The Beveridge-Nelson decomposition suggests that for identification purposes, restrictions can be placed on either the long-run impact matrix $A(1)$ or the transitory matrix $A^*(L)$. The former strategy is to assume that some shocks have no long-run effects on variables, thus effectively separating the transitory disturbances from the permanent ones, which are the common stochastic trends in the cointegrated model (see King et al., 1991). In this paper, the permanent shocks are taken to be those associated with worldwide disturbances. This assumption is a consequence of the re-export economy hypothesis, with the corollary being that shocks originating from domestic disturbances are not expected to have any effects on the rest of the world.

If the permanent shocks are also weakly exogenous with respect to the coin-

tegration vectors, then Fisher and Huh (1999) show that our presumptions are consistent with a recursive ordering of the endogenous variables *à la* Sims (1980). In particular, these authors prove that when the number of exogenous variables equals the number of common trends in the VECM, the assumption that transitory disturbances do not have permanent effects on the levels of series is equivalent to them not having a contemporaneous impact on the variables that are weakly exogenous. This result simplifies the numerical computations substantially as the structural shocks could then be identified by pre-multiplying ϵ_t by the inverse of the lower triangular Cholesky decomposition of the covariance matrix Ω (with ones running down its main diagonal).

The Sims procedure further ensures that the influence of each permanent and transitory shock is isolated through zero contemporaneous restrictions in the $A^*(L)$ matrix, depending on how the endogenous variables are ordered. The ordering used later in the empirical exercises follows that given after Equation (2.1), thus constraining global chip sales not to instantaneously affect foreign output and the real exchange rate to have only a delayed impact on trade flows in view of the time lag taken for exchange rate pass-through. In any event, the results are not very sensitive to the choice of ordering as long as the Singapore variables are put after those representing world demand.

3. Common trends in a re-export economy

Monthly data covering the period 1990 to 2007 is studied in this paper. As such, preliminary seasonal adjustments were performed where needed and variables are measured on a logarithmic scale to avoid heteroscedastic effects in trade. The index of foreign output is computed as the export-weighted average of the indices of industrial production in Singapore's major trade counterparts.² To arrive at a proxy for electronics demand, nominal global chip sales were downloaded from the Semiconductor Industry Association website and deflated by the US producer price index for electronic components and accessories, obtained from the Bureau of Labour Statistics database (the series identification code is WPU1178). The real effective exchange rate used is from the *International Financial Statistics* online database.³

The Singapore customs trade data in nominal terms is courtesy of International Enterprise Singapore, the government agency tasked with trade promotion. Unlike the series published by the statistical authorities, our figures include trade with Indonesia.⁴ Since the oil trade is affected by its own unique set of factors, we

²These are the US, EU, Japan, Korea, Taiwan, Malaysia, Thailand and India.

³A few missing values in 2003 and 2004 were interpolated using a cubic spline.

⁴Singapore's bilateral trade statistics with this close neighbour has been suppressed since pre-independence days up till 2003. The official series therefore contains a break, with the data prior to this date excluding this trade and the post-2003 observations including it.

exclude it from the empirical analysis. That being so, domestic exports, re-exports and overall imports of non-oil products are converted into constant 2006 prices by deflating them with their respective price indices. We would have used data on intermediate good imports instead of total imports had it been available on a consistent basis; unfortunately, this was not the case. Nevertheless, the proportion of imports retained for final consumption pales in comparison with that employed as production inputs.

The time series of the above variables are plotted in Figs. 1 and 2. The first figure shows that the proxies for world demand exhibit strong upward trends with evident cyclical fluctuations. In contrast, the real exchange rate behaves like a random walk characterized by weak mean reversion. Trade cycles are also apparent in the second figure, but whether these cycles are captured by stationary deviations from deterministic trends or are synonymous with the stochastic trends in the time series is hard to tell simply by graphic inspection, thus making it necessary to formally test for unit roots.⁵ In doing so, one should not fail to notice that most of the series seem to have experienced a downward shift some time in late 2000 due to the collapse in global electronics demand following the

⁵Incidentally, trade cycles is the old name given to Juglar business cycles with periods of roughly seven years. Here, we use the term more generally to refer to fluctuations in trade aggregates.

bursting of the information technology bubble.

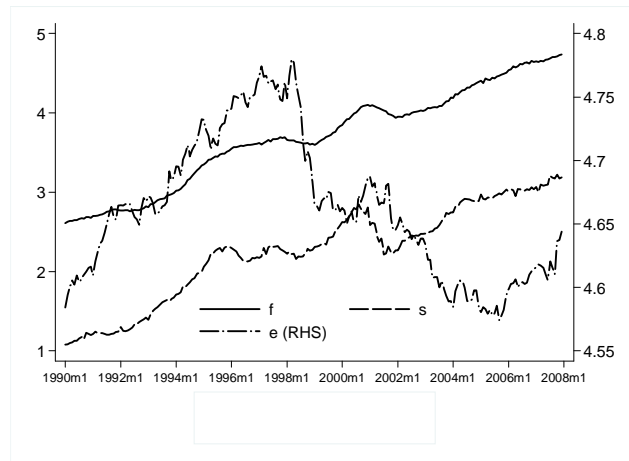


Fig. 1 Foreign output and real exchange rate

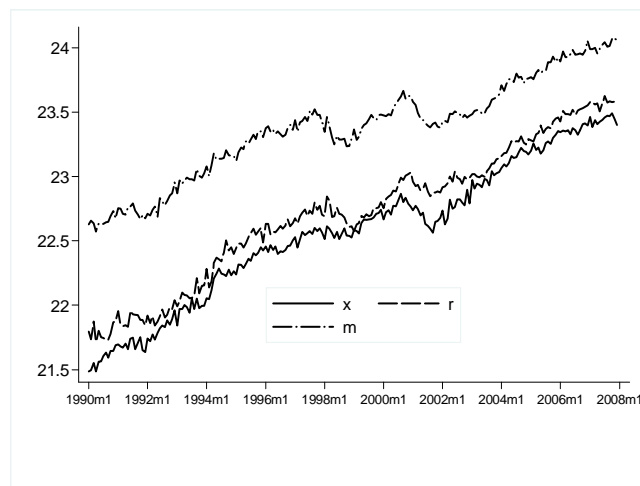


Fig. 2 Singapore trade aggregates

Table 1. Unit root tests

	Levels		Differences		Levels		Differences	
	Lags	τ_τ	Lags	τ_μ	Lags	τ_{int}^+	Lags	τ_{int}^{+0}
<i>f</i>	4	-3.455*	2	-3.480*	4	-3.543*	2	-3.510*
<i>s</i>	12	-2.002	11	-5.092*	12	-1.821	11	-5.164*
<i>x</i>	2	-2.133	1	-14.706*	2	-1.969	1	-14.878*
<i>r</i>	2	-2.109	2	-11.263*	2	-2.174	2	-11.324*
<i>m</i>	12	-1.832	11	-4.997*	12	-1.722	11	-5.197*
<i>e</i>	3	-2.207	2	-6.861*	3	-1.001	2	-6.798*

Notes: τ_τ is the ADF test statistic with constant and trend terms while τ_μ includes only an intercept. τ_{int}^+ and τ_{int}^{+0} are the analogous adjusted statistics. An asterisk means that the hypothesis of a unit root can be rejected at the 5% level.

3.1. Unit root tests

Two versions of the augmented Dickey-Fuller (ADF) unit root test are implemented: one without accounting for the structural break and the other after taking it into consideration. Table 1 reports the results of both types of tests on the logarithmic time series with the number of lags selected by the AIC, subject to a maximum of twelve months. The standard ADF test statistics are insignif-

icant at the conventional level of 5% for every variable except foreign industrial production, where the null hypothesis of a unit root can only be maintained at the 1% level. Identical tests on the first differences of the variables confirm that they are all difference-stationary.

The second unit root test explicitly allows for a level shift at a known date and is based on Lanne *et al.* (2002). In this test, the deterministic components of the data generation process, which include a linear time trend and a shift function, are first estimated by a generalized least squares (GLS) procedure. Then the deterministic part is subtracted from the original series and an ADF-type test is applied to the adjusted series, in the process correcting for estimation errors in the nuisance parameters.⁶

We chose the break date to be December 2000 because this was the month when a majority of the time series achieved a peak.⁷ As for the shift function, we use a step dummy variable for the test in levels and an impulse dummy for the one in differences—more complicated functions may actually reduce their power. Save for global output again, the presence of a single unit root in each series is

⁶As in the ADF test, the adjusted statistic converges to a non-standard distribution. Critical values tabulated by Lanne *et al.* (2002) have been incorporated into **JMulTi** 4.23, the software used to execute the unit root as well as cointegration tests described below.

⁷Lütkepohl and Krätzig (2004) state that the choice of the break date will not be critical if it is not totally unreasonable.

not rejected by these tests, as Table 1 shows. The applied literature usually treats industrial production as being a non-stationary variable and for convenience, we will do the same here.

3.2. Cointegration tests

Additional testable implications can be derived from the re-export economy hypothesis. For a pure entrepôt economy, it is obvious that the unit value of exports is just a markup on imports, so the trade aggregates in such an economy will be trivially cointegrated. In a modern re-export economy dependent on imported inputs, the situation is not too different with the role of the markup replaced by indigenous value-added, as noted in the introduction. Therefore, we should expect to find cointegration between x , r , m and perhaps e , since the real exchange rate inserts a wedge between the local and foreign currency prices of domestic exports.

Returning to Figs. 1 and 2, it is seen that the Singapore variables co-move with world production and global chip sales, which provides tentative evidence of imported cycles in her international trade. From an econometric point of view, it follows that x , r , m and e are also likely to be cointegrated with f , and with s separately. These are some plausible cointegration relations that could result from long-run export demand relationships.

The foregoing relations, if they exist, can be detected within the bounds of sampling error in the multiple cointegration framework introduced by Johansen (1988). The idea is to consistently estimate the cointegration matrix π by a reduced rank regression based on the VECM in (2.1). A trend that is orthogonal to the matrix is included in the model specification in view of the trending character of the endogenous variables in the dataset. Once more, the AIC was used to pick an optimal lag length of four, leading to serially uncorrelated innovations across twelve lags in all the equations of the model, according to a multivariate version of the LM test.

Still, not all the normality checks are passed. To some extent, non-normality is mitigated by the use of Johansen's likelihood ratio (LR) trace statistic to test for the cointegration rank, which tends to be more robust to both skewness and excess kurtosis in residuals (Cheung and Lai, 1993). Table 2 presents the outcomes together with the asymptotic critical values. Clearly, the hypothesis of $r \leq 2$ is rejected, but both the 95% and 90% quantiles are larger than the trace statistic for $r \leq 3$. The statistical inference to be drawn is that there are three distinct stationary relations, or cointegrating vectors, amongst the six integrated variables. Even though our interest is not in the relations *per se*, their estimated coefficients are broadly consistent with the theorized equilibrium relationships.

Table 2. Cointegration tests

r	Johansen			Saikkonen-Lütkepohl		
	Trace	95% c.v.	90% c.v.	LR	95% c.v.	90% c.v.
0	128.10	95.51	91.01	97.48	77.41	73.31
1	86.43	69.61	65.73	62.13	54.59	51.10
2	48.26	47.71	44.45	39.64	35.76	32.89
3	22.30	29.80	27.16	21.18	20.96	18.67
4	7.45	15.41	13.42	6.31	9.84	8.18

Notes: The test statistics are from models that include an orthogonal trend and a constant in the cointegrating relation, thus making it unnecessary to test for a cointegration rank of five. Critical values for the trace and LR tests are computed from the response surface analyses in Doornik (1998) and Trenkler (2004) respectively.

Corresponding to the structural break unit root tests, we have carried out the cointegration tests with structural shifts under both the null and alternative hypotheses proposed by Saikkonen and Lütkepohl (2000). These tests also perform prior trend and break adjustment through a feasible GLS procedure before computing another LR test statistic from a reduced rank regression. The form and timing of the dummy variable we employ are the same as in the univariate case. Four lags are included in the underlying model, with the results displayed

in Table 2.

It is comforting to observe that the Saikkonen-Lütkepohl cointegration test effectively reaches the same conclusion as the Johansen test that three cointegrating relations are present (the LR statistic for $r \leq 3$ is on the border of the 95% cut-off value). Hence, the empirical data does not refute the conjecture that the Singapore trade aggregates and their determinants are collectively driven by three common stochastic trends. Based on the discussion in Section 2, these trends are also the permanent shocks in the estimated system. In the following sub-section, we identify them through tests of weak exogeneity.

3.3. Exogeneity tests

Weak exogeneity of an economic variable in the context of cointegration means that there is no information in its marginal distribution that is relevant to the estimation of the long-run relationships or alternatively, the variable does not react to a state of disequilibrium. Apart from the fact that weak exogeneity of some variables is required for our identification scheme to be viable, exogeneity testing subjects the re-export economy hypothesis to further verification, particularly its prediction that domestic trade cycles are caused by exogenous changes in foreign demand and the exchange rate.

Table 3. Exogeneity tests

	$\chi^2(3)$ statistic	p -value
f	5.348	0.148
s	9.228	0.026
x	5.172	0.160
r	18.17	0.000
m	9.502	0.023
e	17.08	0.001

We consider here a test of the restriction that all the cointegration relations, which are the parameter vectors of interest, do not enter a particular equation. This is a likelihood ratio test of the null hypothesis that a given row of the loading matrix α in (2.1) contains only zeros. In each case, the joint LR test statistic on the adjustment coefficients is distributed as a $\chi^2(3)$ variate in large samples since we have chosen to work with three cointegrating vectors.

For this choice of r , we are able to accept individual weak exogeneity for foreign output and domestic exports (Table 3). That exports are found to be exogenous probably reflects the importance of supply shocks such as foreign direct investment or production capacity increases. As expected, the exogeneity restric-

tions are invalid for re-exports and imports. They are also rejected for the exchange rate—suggesting that nominal currency movements respond endogenously to disturbances—and surprisingly, for global chip sales as well at the 5% level of significance. If we are willing to assume on *a priori* grounds that Singapore is too small to influence long-run world semiconductor demand, however, we would have found as many weakly exogenous variables as the number of common trends. This allows us to apply the Sims recursive structure to analyze the impact of external demand and relative price shocks on trade variables.

4. Analyzing the impact of trade shocks

Having partially validated the re-export hypothesis, we re-estimated the unrestricted VECM by the method of full information maximum likelihood with the objective of performing impulse response analysis and innovation accounting, both derived from the structural VMA representation in (2.3). The results so obtained describe the behaviour of the first differences of variables, which are then successively cumulated over time to yield inferences on their levels in conjunction with bootstrap standard errors.⁸

⁸A non-parametric bootstrap based on resampling the residuals 1000 times with replacement was employed.

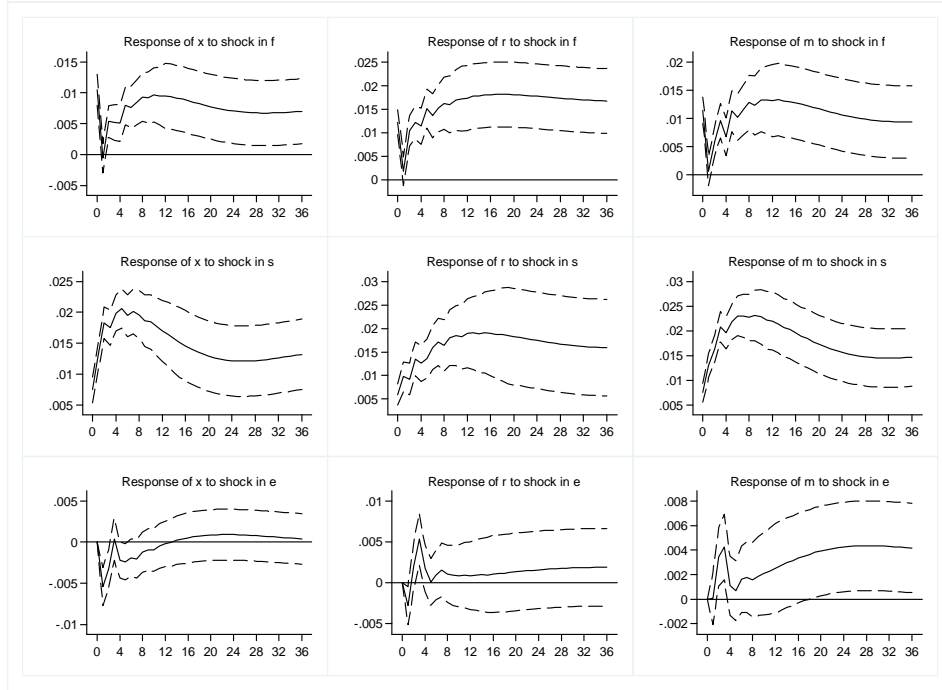


Fig. 3 Impulse response functions

4.1. Impulse response analysis

Fig. 3 depicts the impulse responses of x , r and m to normalized shocks in f , s and e . The dashed lines calibrate the estimation uncertainty surrounding the most probable response in the form of the one standard error band advocated by Sims and Zha (1999), which in the Gaussian case represents a 68 percentile confidence interval. While the abscissa marks the number of months after the unit impulse

has occurred, the ordinate measures the response in logarithmic units.

Taking the top row of charts first, it is seen that an increase in foreign output immediately stimulates Singapore's domestic exports, re-exports and imports in roughly equal measure. This is followed by a temporary dip in trade before the three variables converge erratically to their long-run levels, wherein re-exports rise noticeably more than exports and imports. In the second row, a positive shock to the global demand for electronic goods has roughly the same dynamic effects on the trade aggregates as a foreign demand disturbance, but without the early decline found in the latter situation. In reaction to an unanticipated increase in semiconductor sales, we also find exports and imports rising for about half a year and overshooting their long-run equilibrium levels whilst re-exports build up gradually.

The similarity of the trade adjustment patterns across shocks and variables strongly supports the re-export economy hypothesis by demonstrating that domestic exports, imports and re-exports fluctuate together over the course of trade cycles induced by external disturbances. The long-run effects of both types of external demand shocks are significant and permanent, thus insinuating that they are the proximate sources of the unit roots in the trade series.⁹

⁹In contrast, Abeysinghe and Choy (2007) found from a single equation model that chip sales

By contrast, the estimated impulse response functions for real exchange rate shocks in the last row of Fig. 3 suggest that the impact of such disturbances is mostly absorbed by the variables. A real currency appreciation seems to have small and negative, albeit statistically significant, effects on domestic exports and re-exports in the short run, and a positive impact on imports. Consistent with the results from the exogeneity tests, however, relative price shocks are transitory in nature—their impulse responses and error bands creep very near to the horizontal axis in the long run.

4.2. Innovation accounting

The second set of results to be discussed sheds light on the long-term determinants of trade growth in Singapore through innovation accounting exercises. As the name suggests, this involves a decomposition of each trade variable’s mean squared forecast error (MSFE) into components due to the different structural innovations. Given the orthogonality of these shocks, the forecast errors are uniquely distributed amongst them in a way that allows us to judge what are the main factors influencing the observed movements in the variable.

merely create a transitory effect on Singapore’s exports, even though the resultant fluctuations are large.

Table 4. Innovation accounting

	Percentage contributions to MSFE								
	f			s			x		
Shock:									
Variable:	x	r	m	x	r	m	x	r	m
6 months	5.4	19.8	8.4	35.6	19.2	34.6	53.8	13.6	8.2
1 year	7.8	27.9	12.0	41.6	31.2	44.1	47.2	14.6	9.9
2 years	9.1	33.6	15.3	36.0	36.6	44.5	49.5	16.8	15.6
3 years	8.7	35.4	15.4	33.0	36.4	42.0	49.5	18.8	18.4

Notes: The numbers for a given variable do not add up to 100% across the rows due to the omitted contributions from the transitory shocks.

Instead of reporting the results for the transitory exchange rate shock as in the previous sub-section, we concentrate on the permanent shocks in the system identified from the innovations in foreign production, chip sales and domestic exports. The proportions of the MSFEs of the trade aggregates attributed to each of these shocks are shown in Table 4 for the short-term horizon of six months and thereafter, at yearly intervals up to thirty six months.

Several regularities stand out from the results in the table. First, the contributions of global output shocks to the MSFEs of the endogenous variables are largest for re-exports, reflecting the long-standing observation that a considerable

portion of Singapore's entrepôt trade is oriented towards the Asian region. In contrast, such shocks account for only about 10–15% of the growth in export and import volumes in the long run i.e. after three years.

Second, innovations in world semiconductor demand are responsible for the bulk of trade fluctuations at virtually all time horizons, bearing out the critical role played by the electronics trade during the long boom of the 1990s. These shocks are the major sources of import fluctuations and they are as important as foreign production disturbances in terms of their contribution to the forecast errors in re-exports. Third, supply-side disturbances captured by the domestic export shock explain close to half of its own variability but less than a fifth of the variation in re-exports and imports. In other words, the catalytic effect of investments in new manufacturing plants and industries have mainly been limited to raising export volumes.

5. Conclusion

Despite being highly industrialized, Lloyd and Sandilands (1986) hypothesized that modern Singapore remains essentially as a 're-export economy'. By that, they meant her trade-driven economy's continued dependence on external demand and imported inputs. Their provocative claim has the following econometric im-

plication: if exports, re-exports and imports in Singapore are all integrated time series, then cointegration between them and their determinants is a necessary, but not sufficient, condition for the hypothesis to be true.

We set about in this paper to test the re-export economy hypothesis in a rigorous manner by estimating, identifying and analyzing a multivariate error correction model. In such an empirical framework, cointegration and exogeneity tests are easily performed. The results vindicate Lloyd and Sandilands by revealing the presence of common stochastic trends driving global output and Singapore's trade aggregates. However, it was found that exports are weakly exogenous, with the implication that domestic supply shocks play an independent role in determining trade growth in the long run. This role turned out to be much more influential for domestic exports than for re-exports and imports.

In analogy with the modern definition of business cycles, we went on to show the existence of 'trade cycles', whereby exports, re-exports and imports co-move closely together in response to global demand gyrations, which in itself constitutes further evidence in favour of the re-export economy hypothesis. The impulse response analysis upon which this finding is based also suggests that shocks to foreign production and semiconductor sales leave permanent effects on domestic trade activity. From an innovation accounting perspective, the secular growth

in the world electronics industry is the single most important contributor to the long-term expansion of Singapore's trade.

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