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Working Paper Series

Business Cycles in a Small Open Economy: Stylized Facts from Singapore

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Website: <http://www.ntu.edu.sg/hss/egc/>

Working Paper No: 2006/11

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August 2006

Key words: Business cycles, stylized facts, Singapore, band-pass filter, small open economies

JEL Classification Numbers: C22, E32, F43

Abstract

This paper is an empirical exercise that seeks to reveal the nature of economic fluctuations in the archetypal small open economy of Singapore. We assess the extent to which local business cycles are influenced by their foreign counterparts with regards to cyclical, co-movement and volatility characteristics and then document how shock waves from abroad are spread to the broader macroeconomy once they reach Singapore's shores. To do this, we make use of linear filters and stochastic trend models to extract the cyclical component of economic activity. The results indicate that, while idiosyncrasies are present in Singapore's macroeconomic fluctuations, there are also stylized facts to be distilled for small open economies.

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Is the business cycle dead? This question has been asked time and again with the same answer always given in retrospect: ‘No’. Since the business cycle is still very much alive and with us, the study of its stylized facts cannot be *passé*. These facts were already the subject of the early and classic monograph by Burns and Mitchell (1946). A spate of papers revisited the issue in the nineties, mostly inspired by the ideology and methodology of the Real Business Cycle (RBC) school of thought (see Kydland and Prescott, 1990). Now that the Nobel Prize in Economic Sciences has been awarded to its founders in 2004, the novelty of the RBC paradigm has finally died down. Even before that, some papers attempted to isolate the stylized facts of business cycles in a more ideology-free manner and by using more sophisticated time series techniques (Baxter and King, 1999; Stock and Watson, 1999; McMillan and Speight, 1998; Bjørnland, 2000; Cashin and Ouliaris, 2001).

It is in this spirit that the present manuscript was drafted. What follows is a purely empirical exercise that seeks to reveal the nature of economic fluctuations in the archetypal small open economy of Singapore. Amongst other objectives, the paper consciously endeavors to complement the excellent study of Hong Kong by Leung and Suen (2001) because astonishingly, there does not seem to be any full-length studies on the stylized facts of business cycles in small open economies, either individually or *sui generis*. That said, a resurgence of academic interest in explaining fluctuations in small emerging economies is evident of late e.g. Neumeyer and Perri (2004). This working paper focuses on the transnational dimensions of national business cycles, especially the role of the world real interest rate in precipitating financial crises and economic recessions. In an analogous way, our paper does the same thing for the small but developed

economy of Singapore by assessing the extent to which local business cycles are influenced by their foreign counterparts with regards to cyclical, co-movement and volatility characteristics. This we undertake to do initially by computing descriptive statistics such as autocorrelations, cross-correlation functions and standard deviations for the quantities and prices related to international trade and finance. We then document how the shock waves from abroad are spread to the broader macroeconomy once they reach Singapore’s shores. Business cycle scholars will no doubt recognise that we have invoked Ragnar Frisch’s ‘rocking horse’ analogy in which a wooden horse is hit sporadically by a club (exterior impulses to the economy), causing it to swing with a regular movement (interior propagation through the economic system).

Unfortunately, studies of business cycles are bedevilled in one way or another by an old and intractable problem in statistics: the classical decomposition of a time series into trend and cycle components. Luckily for us, this detrending conundrum has received much needed clarification and enlightenment—at least where economic data are concerned—from the progress made in time series econometrics (although we abstain from causal econometric models, preferring instead to let the stylized facts speak for themselves). In particular, the erstwhile reliance on deterministic (log-)linear trends has been supplanted by the discovery and widespread use of stochastic trend models. Simultaneously, the use of simple moving averages to unravel the trend and cyclical components of economic time series has been replaced by linear filters in contemporary studies of business cycle regularities. We draw on all these advances in the paper.

Section 1 is entitled ‘Trends versus Cycles’ because it discusses potential solutions to the stubborn decomposition problem alluded to above. By using a combination of filtering and signal extraction methods, Section 2 constructs a ‘reference cycle’ for Singapore, which is compared with the official chronology. Section 3 finds out exactly how vulnerable growth cycles are to foreign linkages whilst Section 4 turns to the idiosyncrasies of domestic economic fluctuations. By way of a conclusion, Section 5 summarises the stylized facts of business cycles in small open economies that can be distilled from Singapore’s experience.

1. Trends versus Cycles

In this paper, no special preference will be accorded to any macroeconomic school of thought in the reporting of the results. To show how serious we are about scientific objectivity, this section presents statistically-based methods of investigating business cycles rather than relegate them to an appendix (the reader is invited to at least skim through the material). But try as we might to stick to ‘measurement without theory’, subject to the constraint of data availability, theoretical considerations cannot be avoided altogether in a study of this kind, even if they only creep in subtly through our choice of macroeconomic variables and relationships to analyse.

Bearing this caveat in mind, let us start with the basic equation

$$y_t = \tau_t + c_t \tag{1}$$

separating a time series y into a trend (τ) and a cycle (c) (the seasonal component has been suppressed because we shall work with seasonally-adjusted data throughout). Three general approaches for attacking the decomposition problem are employed in the literature: smoothing filters, band-pass filters and signal extraction techniques. The first set of methods, which includes the familiar moving averages, defines the trend by *ad hoc* smoothness characteristics. Perhaps the best known example of a smoothing filter in business cycle research is the Hodrick-Prescott filter invented by the Real Business Cyclists and which is still seen in studies notwithstanding the critiques mounted on it by Harvey and Jaeger (1993), Cogley and Nason (1995) and Canova (1999), *inter alios*. We eschew the filter not so much because of its ideological baggage, but in view of its tendencies to generate spurious business cycles—a classic example of the Yule-Slutsky effect—and to retain high-frequency movements in time series.

Band-pass filters are better behaved and are, in fact, the preferred tool for extracting cycles from economic time series in recent work. The theory underlying their design, though pretty refined, can be comprehended by

considering the two-sided infinite moving average $a(L) = \sum_{j=-\infty}^{\infty} a_j L^j$. In mathematical terms, this is just a convolution operation with frequency response function given by the Fourier transform of the filter weights: $a(\omega) = \sum_{j=-\infty}^{\infty} a_j e^{-i\omega j}$. For a symmetric filter, the phase shift is zero and $a(\omega) = |a(\omega)|$, where the second quantity is called the gain. If we specify the indicator gain function

$$|a(\omega)| = \begin{cases} 1 & \text{for } \underline{\omega} \leq |\omega| \leq \bar{\omega} \\ 0 & \text{elsewhere} \end{cases},$$

applying the inverse Fourier transform yields

$$a_j = \frac{1}{2\pi} \int_{-\pi}^{\pi} a(\omega) e^{i\omega j} d\omega = \begin{cases} \frac{1}{j\pi} (\sin \bar{\omega} j - \sin \underline{\omega} j) & \text{for } j \neq 0 \\ \frac{1}{\pi} (\bar{\omega} - \underline{\omega}) & \text{for } j = 0 \end{cases}. \quad (2)$$

Notice that the weights a_j die out at the rate $1/j$ and the ideal filter passes everything inside the frequency band $\underline{\omega} \leq |\omega| \leq \bar{\omega}$ and nothing outside it (actually, the modulus in the inequality is superfluous since we can restrict attention to the positive frequencies, all the input series in our study being real-valued).

The ideal band-pass filter is infeasible because an infinite number of observations will be needed to construct one. But all is not lost. Baxter and King (1999) showed that the finite moving average $a_k(L) = \sum_{j=-k}^k a_j L^j$ with weights as in Equation (2) is an optimal approximation to the ideal filter in the sense that the gain of $a_k(L)$ is as close as possible to the gain of $a(L)$ for a truncated k th-order filter (technically, this means minimizing a quadratic loss function for the difference between the exact and feasible filters).¹ They also defined, in deference to Burns and Mitchell, the business cycle cut-off frequencies as those corresponding to periodicities of 6 to 32 quarters (periodicity $= 2\pi/\omega$). Due to the Gibbs phenomenon, however, the power transfer function of the feasible filter (i.e. the squared gain function) is only roughly flat within the pass-band and is non-zero for some wavelengths in the stop-band.

Moreover, there is a trade-off between the quality of the approximation and the number of observations lost at the end-points of a filtered series. In a compromise, Baxter and King recommended that the value of k be set equal to 12 for quarterly macroeconomic series, implying that 3 years of data are sacrificed at both the beginning and end of the sample. We follow their prescriptions when it comes to implementing the approximate band-pass filter. As a remedy to the end-point problem, however, we resort to a signal extraction method that exploits all the observations in the complete sample. This is also done for the sake of robustness since Murray (2003) has demonstrated that the band-pass filter does not isolate the cycle properly if a stochastic trend model is in fact the true data-generating process.

The basic premise underlying this alternative ‘unobserved components’ model employed in the paper should be declared right at the outset: the trend and cycle are uncorrelated. We think this dichotomy is more intuitive, according to the usual understanding of what is meant by long-term trends and short-run cycles, than the assumption implicit in the ever popular (but in our view flawed) Beveridge-Nelson decomposition viz., that secular movements and cyclical fluctuations are perfectly negatively correlated.² If the reader agrees, we can go back to the trend-cycle decomposition in (1) to put some flesh on the skeleton:

$$\begin{aligned}\tau_t &= \tau_{t-1} + \delta_{t-1} + \eta_t \\ \delta_t &= \delta_{t-1} + \zeta_t\end{aligned}\tag{3}$$

$$\begin{bmatrix} c_t \\ c_t^* \end{bmatrix} = \rho \begin{bmatrix} \cos \omega & \sin \omega \\ -\sin \omega & \cos \omega \end{bmatrix} \begin{bmatrix} c_{t-1} \\ c_{t-1}^* \end{bmatrix} + \begin{bmatrix} \varepsilon_t \\ \varepsilon_t^* \end{bmatrix}\tag{4}$$

The setup consists of a stochastic trend and a cycle made up of damped sinusoids, both unobserved components being hidden in mutually independent noise i.e. $E(\eta_t^2) = \sigma_\eta^2$, $E(\varepsilon_t^2) = \sigma_\varepsilon^2$ and $E(\eta_t \varepsilon_{t-i}) = 0$ for all i . The slope parameter δ can, and will, be fixed if the restriction $E(\zeta_t^2) = \sigma_\zeta^2 = 0$ is legitimate, resulting in a random walk with drift specification for the trend component (when it is not, ζ is assumed also to be uncorrelated with η and ε).

Despite our calling it noise, ε_t plays a constructive role in allowing the cyclical pattern to evolve over time. By contrast, the pseudo-cycle c_t^* appears merely to form the stochastic cycle c_t , which has frequency ω ($0 < \omega < \pi$) and amplitude damping factor ρ ($0 < \rho < 1$). Unlike in band-pass filtering, ω will be estimated from the raw data rather than imposed *a priori*. Rewriting the cyclic component as $c_t = [(1 - \rho \cos \omega \cdot L)\varepsilon_t + (\rho \sin \omega \cdot L)\varepsilon_t^*] / (1 - 2\rho \cos \omega \cdot L + \rho^2 \cdot L^2)$ immediately makes it apparent that the reduced form of the cycle is an ARMA(2,1) process with severe restrictions on the parameter space. Add the proviso that the disturbances are normally distributed, and maximum likelihood estimation can proceed by casting the model into state-space form and applying the Kalman filter. For the uninitiated, refer to Koopman et al. (2000) for details.

2. The Reference Cycle

A more meaningful inquiry into stylized facts can be carried out if a benchmark business cycle is first arrived at via the trend removal methods described above. Ever since the time of Burns and Mitchell, this yardstick giving the dates of the peaks and troughs in the recurrent expansions and recessions of market economies has been called the ‘reference cycle’. Their worthy successors at the National Bureau of Economic Research (NBER) in the United States have pushed the idea and its praxis further, culminating in the current method of business cycle dating based on the ‘specific cycles’ in the so-called coincident indicators of economic activity (Zarnowitz, 1992).³ We will encounter such an official chronology of Singapore in a moment; for ease of comparison with existing studies, however, we shall derive our reference cycle by either filtering or extracting the cyclical signals in the most comprehensive summary measure of output viz., real GDP.⁴

As they say, the proof of the pudding is in the eating: Figures 1 and 2 plot the reference cycles thus obtained. Juxtaposed with them in Figure 3 is the official growth cycle chronology reproduced from the very informative paper put out by the Singapore Department of Statistics in 2004 (shaded columns demarcate recessions). Admittedly, the span of the government chronology from 1983 to

2003 is shorter than our sample periods, which commence from 1975 or 1978 and terminate in 2002 or 2005, depending on the decomposition procedure employed (several exceptions to this rule will be noted as we go along). Putting that aside, we are indeed comparing like and like because both the band-pass filtered and signal extracted cycles represent deviations from trends that are normalized to unity—the precise definition of a growth cycle (Mintz, 1972).

Lest anyone doubts the existence of business cycles in Singapore, the first feature to highlight in the graphs is that well articulated oscillations are visually evident and what’s more, they look alike. The congruence is most striking between the growth cycles estimated over the traditional business cycle frequencies and those recovered from the stochastic trend model, with the latter appearing rather like a smoothed version of the former. Without giving a blow-by-blow account of events, the common cycles found correspond to the mid-eighties recession of 1985, the early nineties downturn from 1990 to 1992, the Asian financial crisis of 1997/1998 and the recent IT débâcle in 2000/01. Interestingly, the cycle identified by the official chronologists during 1988/89 and 1994/95 using the NBER methodology are hardly detectable by our techniques, while the SARS-induced collapse of economic activity in 2003 has been conflated with the preceding trough in Figure 2. All in all, the official chronological record isolated 7 major and minor growth cycles since 1983, whereas we discerned only 4 in the GDP reference series.

How does our constructed reference cycle compare with the government’s chronology where duration and amplitude properties are concerned? Although we do not pretend to be able to fix the location of putative turning points, inspection of the most prominent peaks and troughs in Figures 1 and 2 suggests that the average duration of recessions lies somewhere between 6 and 11 quarters. The official estimates have it at only 5 quarters. The mean lengths of upturns are necessarily more disparate due to the omission of the minor cycles, but the expansionary state outlives the recessionary phase. This last finding is indicative of weak asymmetry in Singaporean business cycles, weak because the skewness coefficients calculated for cyclical real GDP are insignificantly different from zero.

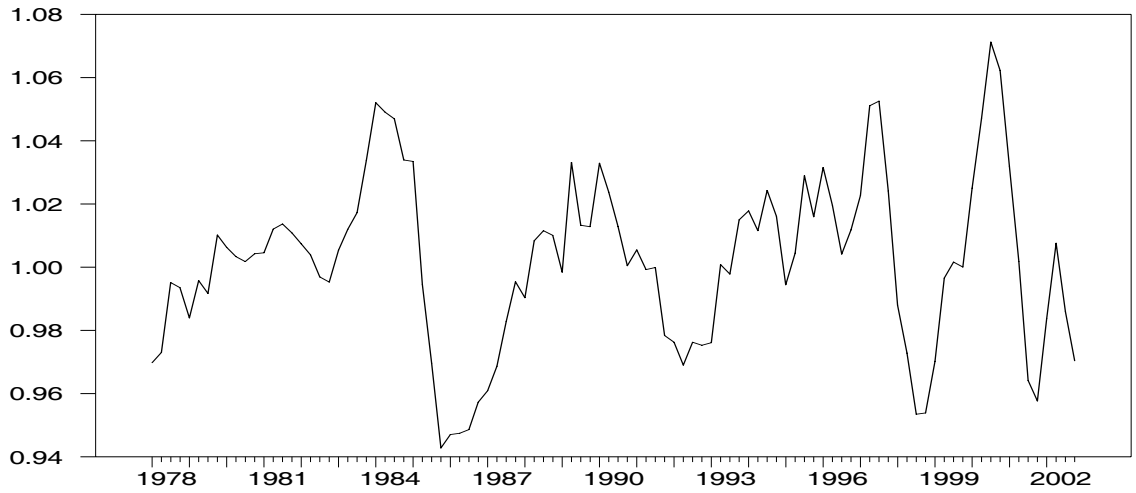


Figure 1. Band-pass filtered reference cycle.

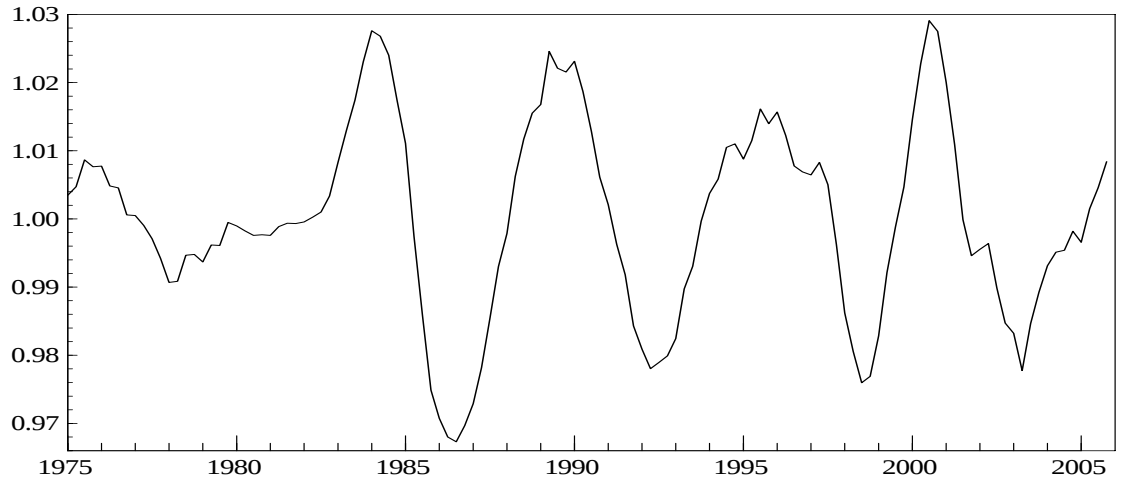


Figure 2. Signal extraction reference cycle.

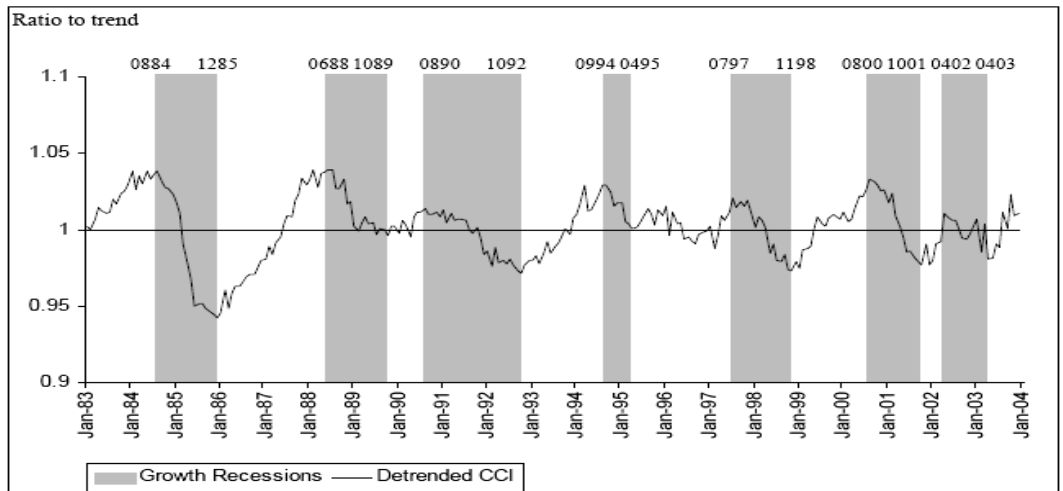


Figure 3. Official growth cycle chronology.

From the unobserved components model⁵, we also know that the estimated period of a full cycle is 23 quarters, or 5.7 years; in stark contrast, an official cycle lasts for a brief 3 years because there are more of them. Whichever estimate one believes, growth cycles in Singapore appear to owe more to Kitchin than to Juglar. In terms of amplitude, the severity of the fluctuations in the filtrated GDP series shown in Figure 1 are commensurate with those in Figure 3, except for the boom-and-bust episode in 2000/01 when output fell by a whopping 11.3% from zenith to nadir. The magnitudes of the smoothed cycles in Figure 2 pale in comparison. Still, all three reference cycles are unanimous in pointing the finger at the 1985 recession as the worst contraction experienced by Singapore so far.

3. Foreign Impulses: Fact or Fiction?

The conventional wisdom holds that foreign shocks lurk behind all business cycles in Singapore. We explore in the present section whether this view can lay claim to being a stylized empirical fact or is just a convenient piece of fiction. Yet before we could do that, a few statistical preliminaries and niceties must first be gotten out of the way. Specifically, we wish to introduce at this stage the sample moments we report in the rest of the paper: (i) the univariate first and second-order autocorrelation coefficients; (ii) the bivariate cross-correlation function for the contemporaneous period and for leads and lags of up to 4 quarters between the cyclical deviations of each series and the reference cycle; and (iii) the full sample as well as rolling standard deviations over a window of 21 quarters (actually 5 years, albeit with a quarter added to centre the moving average).⁶

The definitions of these statistics are all nested in the formula below:

$$\hat{\rho}_{xy}(k) = \frac{\sum_{t=1}^T (x_t - \bar{x})(y_{t+k} - \bar{y})}{\left\{ \sum_{t=1}^T (x_t - \bar{x})^2 \sum_{t=1}^T (y_t - \bar{y})^2 \right\}^{\frac{1}{2}}} \quad (5)$$

where a bar over a variable denotes a sample mean and T is the terminal observation. The expression as it stands in (5) is the cross-correlation coefficient at a lead of k quarters (negative leads refer to lags) for the observations on x

and y . It automatically follows that $\hat{\rho}_{xx}(k)$ and $\hat{\rho}_{yy}(k)$ are the k th-order autocorrelations. The corresponding autocovariances at lag 0 are of course the unconditional variances of the variables, whilst their rolling standard deviations are generated by moving the time span across the length of the sample from $t = 1, \dots, 21$ to $t = T - 20, \dots, T$ and taking the square root. Bartlett (1946) gave the asymptotic standard error for the autocorrelations and cross-correlations as

$$s.e.[\hat{\rho}_{xy}(k)] = \frac{1}{\sqrt{T}} \left[1 + 2 \sum_{h=1}^q \hat{\rho}_{xx}(h) \hat{\rho}_{yy}(h) \right]^{\frac{1}{2}} \quad (6)$$

for all $|k| > q$ but most authors are satisfied with comparing the sample statistics with confidence bounds of $\pm 2/\sqrt{T}$ (if they bothered to provide any measures of precision at all).⁷ Since the computational costs are trivial, however, we based significance tests on the standard error in (6).

Such tests should be able to tell us the direction of the co-movements in aggregative time series which lie at the heart of Lucas' (1977) conception of business cycles. In particular, a variable shall be adjudged to be pro-cyclical if its contemporaneous correlation coefficient with real GDP is significantly positive (i.e. where the point estimate is about twice as large as the Bartlett standard error), counter-cyclical if it is significantly negative, and acyclical if it is neither. Furthermore, a variable is said to lead (lag) the growth cycle if the maximum and statistically significant correlation is found at a positive (negative) value of k . As noted by Kydland and Prescott (1990), such displacements can be construed as phase shifts in the frequency domain and NBER workers have long exploited them in coming up with leading and lagging economic indicators.

The set of co-movements that interest us initially are those between foreign variables and Singapore's aggregate output. These are shown in Table 1 together with the individual autocorrelations and standard deviations.⁸ Apart from series capturing the diverse facets of the external environment, we have included global semiconductor sales as a proxy for electronics demand despite its much shorter sample length from 1989Q1 onwards because Singapore is a key producer of

electronic components and accessories. And in order to give each of our two cycle extraction methods a fair hearing, we report the result from band-pass filtering as the top number in each cell and its analogue from signal extraction as the bracketed number (asterisks indicate statistical significance at the 5% level). Generally speaking, the outcomes are robust to the choice of detrending method. As an illustration, the autocorrelations of GDP are significant either way, vindicating the presumption of the unobserved components model that the cyclical component of output obeys a second-order stochastic difference equation.

Every student of statistics knows that it is one matter to present raw sample correlations as we do here and quite another to infer causal linkages from them. Nevertheless, the statistical evidence in Table 1 shows that it is fluctuations in foreign composite GDP and global chip sales which are the most highly correlated with Singapore's reference cycle. That these are acutely cyclical series themselves is attested to by their large autocorrelation coefficients. Viewed as a general measure of external demand, the positive correlation between foreign output and domestic production is strongest at the contemporaneous period, thus suggesting that the transmission of international business cycles to the Singapore economy is very rapid. In contrast, it would appear that the maximum impact of world electronics cycles is only felt after a one-quarter lag.

The world real interest rate, represented by the untransformed US treasury bill rate minus inflation, is not meaningfully related to Singapore's macroeconomic fluctuations. For a start, the maximal correlation falls at lag 1, which is hard to rationalise since no economist would seriously contemplate causation running from a small economy to the world. Then we have the positively signed coefficients insinuating that a rise in the international interest rate, far from being a harbinger of recession, will stimulate domestic economic activity! (this strange finding probably reflects the procyclical tendency of the US rate). A similar anomaly arises with the Brent oil price, although the results are not so incredible in this case because higher oil prices are a boon to the local petroleum and petrochemical industries.⁹ More in line with what one would expect of a non-primary commodity producing country, the terms of trade are totally acyclical.

Table 1. Foreign Shocks and Aggregate Output.

Variable	SD	AR	AR	Cross-correlation at lead k								
	(%)	(1)	(2)	-4	-3	-2	-1	0	1	2	3	4
Real GDP	2.7 (1.5)	0.83* (0.94*)	0.57* (0.80*)									
Foreign GDP	1.3 (0.7)	0.88* (0.91*)	0.63* (0.68*)	-0.07 (0.12)	0.13 (0.27)	0.36* (0.40*)	0.53* (0.48*)	0.60* (0.49*)	0.51* (0.41*)	0.32 (0.26)	0.09 (0.08)	-0.12 (-0.12)
Global chip sales	13.3 (12.0)	0.88* (0.91*)	0.61* (0.68*)	-0.25 (-0.19)	-0.04 (0.04)	0.24 (0.29)	0.52* (0.51*)	0.70* (0.68*)	0.70* (0.74*)	0.53* (0.70*)	0.32 (0.59*)	0.17 (0.46)
World real interest rate	1.1 (1.9)	0.70* (0.92*)	0.38* (0.81*)	0.31 (0.23)	0.38* (0.29)	0.44* (0.34*)	0.49* (0.37*)	0.43* (0.36*)	0.32* (0.33*)	0.19 (0.28)	0.02 (0.22)	-0.14 (0.15)
Oil price	20.0 (9.1)	0.76* (0.85*)	0.42* (0.55*)	0.05 (-0.18)	0.29 (0.31)	0.44* (0.41*)	0.47* (0.45*)	0.45* (0.43*)	0.36* (0.35*)	0.25 (0.22)	0.14 (0.06)	-0.04 (-0.11)
Terms of trade	1.8 (0.7)	0.80* (0.88*)	0.57* (0.65*)	0.23 (0.18)	0.22 (0.17)	0.20 (0.13)	0.17 (0.08)	0.10 (0.02)	-0.01 (-0.05)	-0.10 (-0.09)	-0.07 (-0.10)	-0.04 (-0.09)

Notes: The sample period is 1975:Q1–2005:Q4 for all variables except foreign GDP (1978Q1–2005Q4) and chip sales (1989Q1–2005Q4). Numbers on top are estimates from the filtered log series (logs are not taken of the world interest rate) whereas those below in parentheses are the corresponding results from signal extraction. An asterisk denotes statistical significance at the 5% level.

Looking at the sample standard deviations next, we mention in passing that foreign GDP, being a weighted average of national products in many countries, is by construction smoother than that in any one country. Singapore’s output has an average volatility of 2.7% according to the band-pass filtered series, twice that of the foreign composite as well as the estimate from the stochastic trend model. This statistic is by no means time invariant: Figure 4 plots the 5-year rolling standard deviations alongside the other foreign variables (the signal extraction results are similar and therefore not depicted). After peaking in the mid-eighties, the variability of domestic output gyrations came down, remained low in the early nineties, but started to climb up again from 1995. Call it coincidence or causation, there has been a comparable increase in the percentage standard deviation of foreign output which predates the Asian financial crisis. Over the same period, the volatility of world electronics demand nearly doubled to 20% by the turbulent end of the decade.

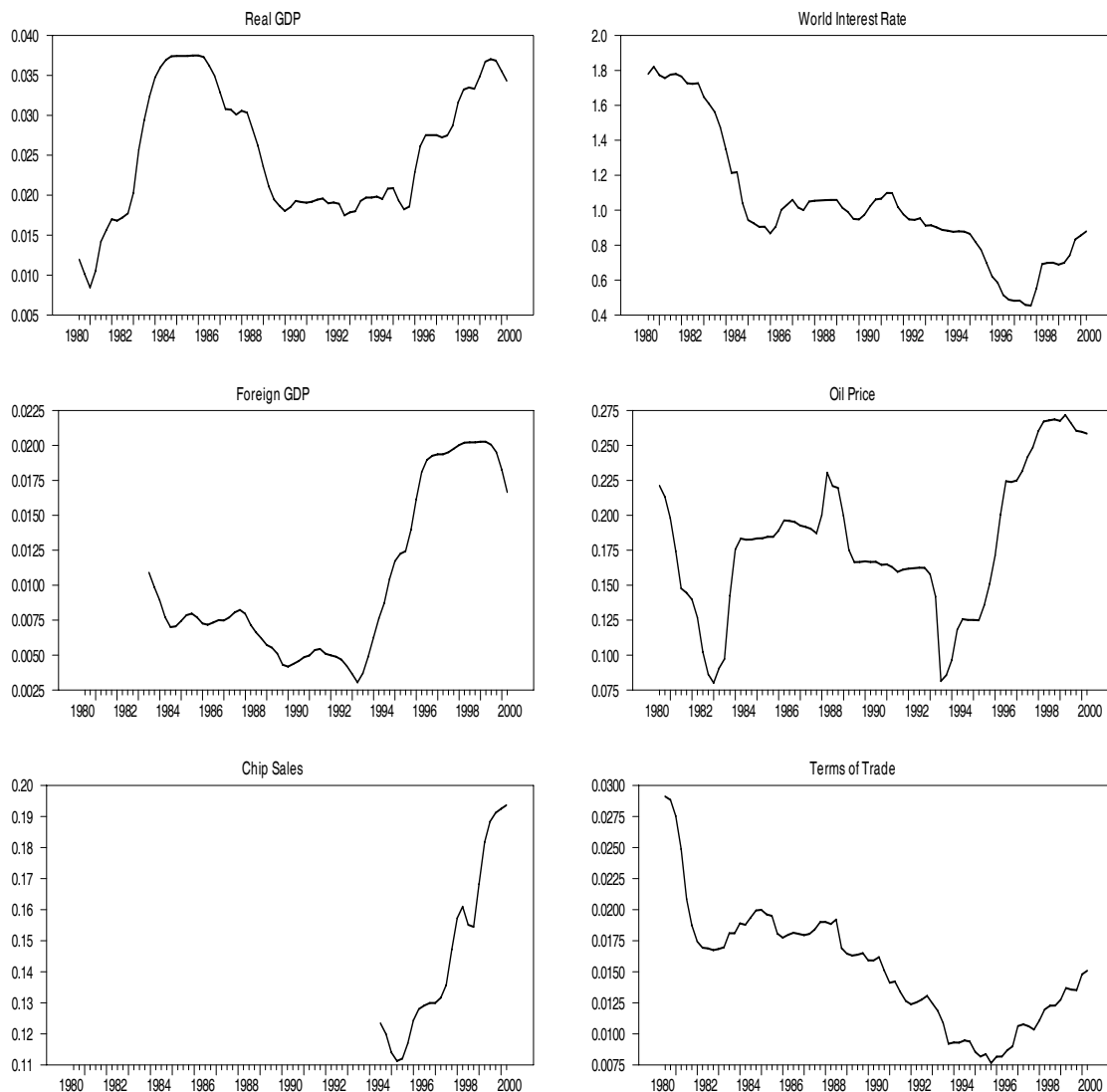


Figure 4. Rolling standard deviations of filtered foreign variables.

Sceptics might caution that one should not read too much into these graphs but for us, when viewed in conjunction with Table 1, they provide incontrovertible evidence to suggest that the increase in the volatility of real GDP growth during the late 1990s—also noted by many analysts though regrettably without much rigorous analysis of the phenomena—can be attributed squarely to the same culprits of external demand and world semiconductor sales. Consider the other unlikely suspects: oil price volatility has been high throughout the sample except for brief lull periods in 1983 and 1993; fluctuations in the world interest rate and the terms of trade, as we discovered earlier, are only nebulously tied to

Singapore's growth cycles, if at all, and this is also true of their volatilities. We are forced to remark that the increased variance of economic activity in Singapore contrasts sharply with the experience of the G7 countries, where business cycles have moderated in terms of output volatility over the past 40 years (Stock and Watson, 2005). Whether this is a quintessential feature of a small open economy in a globalized world is something we will discuss at the end.

Meanwhile, in Table 2 is found an assemblage of the most relevant price and related variables conceivable for a small and exposed economy like Singapore. Real GDP is not the reference series here, but is featured because we wish to examine the cyclical behaviour of prices. This is why the cross-correlations in the table are computed with respect to the consumer price index (CPI) instead of the output-based GDP deflator. The other variables are the foreign producer price index, its local equivalent known as the domestic supply price index (DSPI), the import price index, non-oil commodity prices, the oil price, the Singapore dollar nominal effective exchange rate expressed in foreign currencies (NEER), and M1 money supply.¹⁰ The first-order autocorrelation coefficients imply very persistent cycles in these series, as are typical of nominal variables.

Take the most basic business cycle correlation of them all first, the relationship between the general price level and domestic output. The second row of Table 2 indicates that prices are unambiguously procyclical and clearly lagging in Singapore, much to the disappointment of RBC fans and the delight of Phillips curve followers.¹¹ The largest cross-correlation occurs at a lead of 3 quarters (from the perspective of GDP), although everything from $k = 0$ to 4 is significant. Figure 5 confirms that the cyclical component of the CPI has invariably declined during and after each of the economic downturns. Since this relation has been a bone of contention for such a long time, we computed moving cross-correlations for overlapping periods of 5 years to check for signs of instability. It turns out that output and the price level have seldom co-moved in opposite directions. For the time being, however, we will resist the temptation to jump to the conclusion that shocks to the economy emanate predominantly from the demand side.

Table 2. Foreign Shocks and the Price Level.

Variable	SD	AR	AR	Cross-correlation at lead k								
	(%)	(1)	(2)	-4	-3	-2	-1	0	1	2	3	4
CPI	1.2	0.89* (0.92*)	0.68* (0.75*)									
Real GDP	2.7 (1.5)	0.83* (0.94*)	0.57* (0.80*)	-0.19 (-0.24)	-0.13 (-0.18)	-0.02 (-0.08)	0.15 (0.05)	0.33* (0.20*)	0.43* (0.31*)	0.48* (0.40*)	0.48* (0.44*)	0.43* (0.44*)
DSPI	4.5 (3.5)	0.84* (0.79*)	0.59* (0.50*)	-0.29 (-0.17)	-0.13 (-0.07)	0.05 (0.06)	0.26* (0.21*)	0.49* (0.38*)	0.63* (0.50*)	0.65* (0.54*)	0.63* (0.53*)	0.56* (0.48*)
Import prices	3.7 (3.0)	0.84* (0.80*)	0.61* (0.53*)	-0.38 (-0.22)	-0.24 (-0.13)	-0.07 (-0.01)	0.14 (0.13)	0.37* (0.31*)	0.52* (0.44*)	0.57* (0.50*)	0.59* (0.53*)	0.55* (0.51*)
Foreign price index	2.0 (0.9)	0.90* (0.69*)	0.74* (0.28*)	0.07 (-0.19)	0.24 (-0.02)	0.41* (0.14)	0.58* (0.30*)	0.71* (0.40*)	0.74* (0.42*)	0.70* (0.35*)	0.64* (0.27)	0.56* (0.19)
Commodity prices	6.7 (4.0)	0.85* (0.70*)	0.61* (0.26)	-0.42* (-0.37*)	-0.34 (-0.35*)	-0.23 (-0.27)	-0.13 (-0.15)	-0.04 (0.03)	0.05 (0.10)	0.16 (0.22)	0.25 (0.31*)	0.29 (0.34*)
Oil price	20.0 (9.1)	0.76* (0.85*)	0.42* (0.55*)	-0.31 (-0.22)	-0.25 (-0.19)	-0.14 (-0.12)	0.00 (-0.01)	0.20* (0.14)	0.36* (0.28*)	0.45* (0.37*)	0.46* (0.41*)	0.41* (0.40*)
NEER	3.5 (5.6)	0.82* (0.89*)	0.68* (0.70*)	0.52* (0.13)	0.56* (0.20)	0.59* (0.25*)	0.60* (0.28*)	0.53* (0.27*)	0.38* (0.20*)	0.20 (0.09)	0.02 (-0.03)	-0.13 (-0.16)
M1	3.8 (6.1)	0.71* (0.89*)	0.46* (0.80*)	-0.01 (0.11)	-0.03 (0.12)	0.01 (0.15)	0.09 (0.17)	0.18 (0.20*)	0.25* (0.25*)	0.27 (0.28)	0.29 (0.32)	0.30 (0.34)

Notes: The sample period is 1975:Q1–2005:Q4 for all variables except commodity prices (1980Q2–2005Q4). Note that unlike the other tables, CPI is the reference series here. Numbers on top are estimates from the filtered log series whereas those below in parentheses are the corresponding results from signal extraction (the standard deviation of CPI is too small to be reported). An asterisk denotes statistical significance at the 5% level.

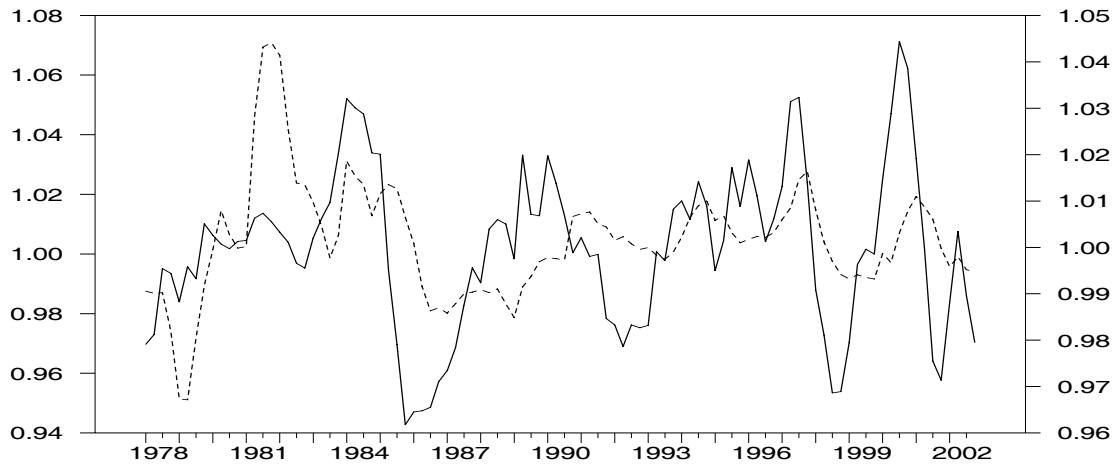


Figure 5. Filtered price level (dashed) versus aggregate output (solid).

There are a couple of questions we can sensibly ask about the nexus of prices. First and foremost, what are the origins of exogenous shocks to the CPI? Regardless of detrending method, we can be confident that they are not movements in non-fuel commodity prices, the NEER, or even money supply. The most likely impulse sources are foreign price disturbances and crude oil hikes, passed through in the first instance to import costs and henceforward onto domestic producer and consumer prices. All these variables qualify as leading indicators of inflation in Singapore, since the peaks in their cross-correlation functions occur at a positive value of k (the mode is 3 quarters).

Another critical question concerns what proportion of consumer price inflation is imported, and how much is domestically generated. In this case, it is difficult to decide one way or the other just by scrutinizing unconditional cross-correlation coefficients. The widely held belief is that inflation has an external genesis, though this might not be the full story, especially in view of the positive association we found between economic activity and the price level. Before leaving the discussion, however, a remarkable observation ought to be pointed out—the NEER has a strong proclivity to lag the CPI cycle in the same direction. The best explanation we can offer for this stylized fact is that the central bank reacts to visible inflation by tightening its monetary policy. We shall have more to say on this issue later.

Lastly, we turn to the rolling standard deviations graphed in Figure 6. Obvious affinities are present amongst the volatility patterns of the leading indicators of inflation but unfortunately, these would not have predicted the CPI's downward trajectory, except during the most recent period. As this latest rise in variability is shared by all series, it would be invidious to single out any one of them as the proximate cause. Still, the idea that outside shocks drive Singapore's growth cycles cannot be too far wrong. At the minimum, we have established empirical links between local output and prices and their international counterparts. To reach a final verdict, however, we need to investigate the internal dimensions of macroeconomic fluctuations, which is the next item on our agenda.

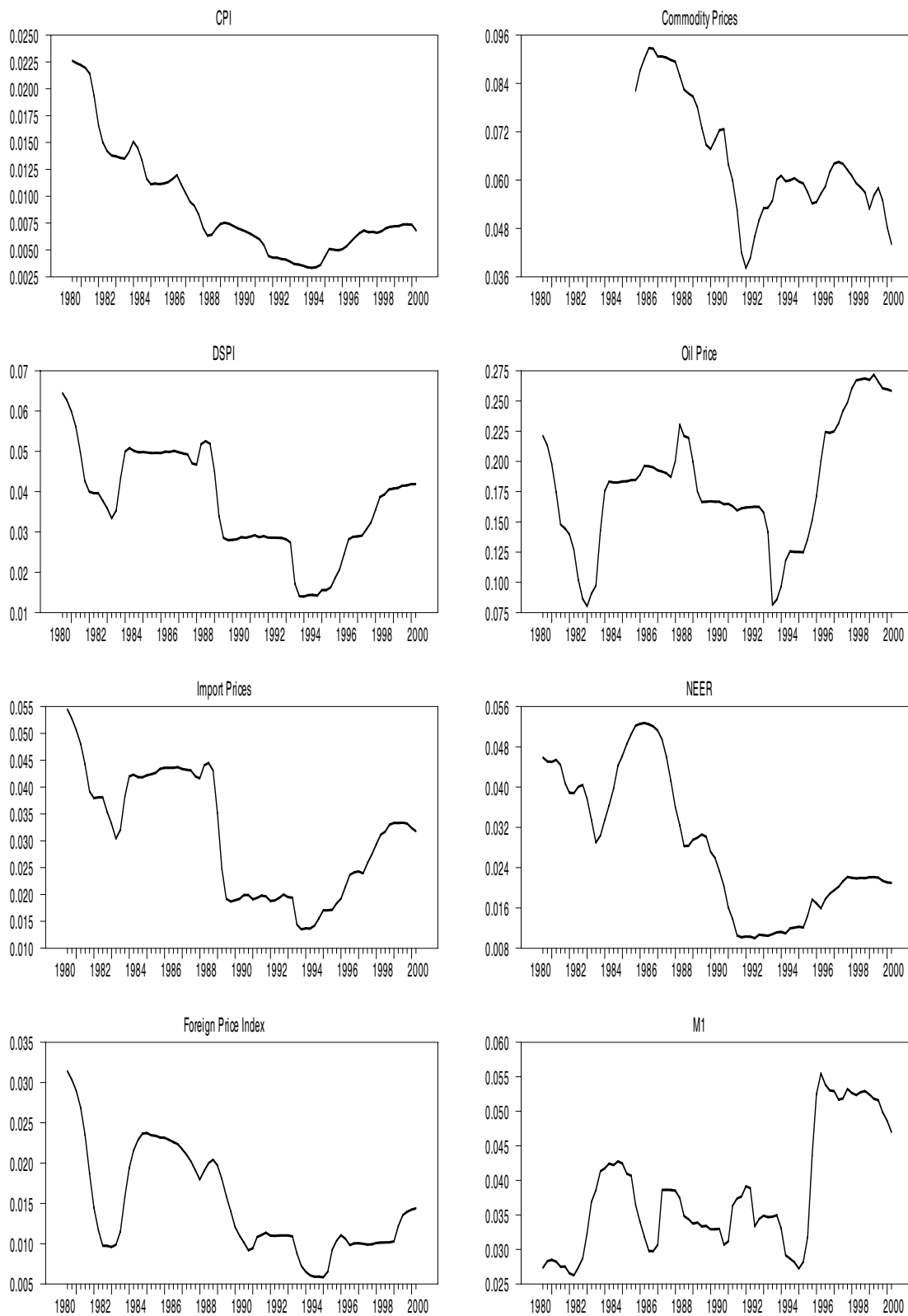


Figure 6. Rolling standard deviations of filtered prices.

4. Domestic Propagation: Facts and Idiosyncrasies

Like the flow and ebb of the tides, we have seen how business cycles are carried over the waves to Singapore’s shores by virtue of the international movements of goods, services, capital, and ideas across borders. Once here, foreign impulses naturally interact with domestic propagation mechanisms to create ripple effects that fan out across the economy and manifest themselves as systematic co-movements in all sorts of real, nominal and financial variables. Our task is to document these stylized features as well as the idiosyncratic factors peculiar to Singapore using the same tools as in the previous section. For purely expositional reasons, the macrovariables covered are split into three distinct categories.

4.1. *National income components*

The summary statistics for the first category, the national income components, are reported in Table 3. By now, the cyclical persistence of the real expenditure-based GDP components should not be startling to the reader.¹² Neither would the fact that private consumption and investment expenditures are procyclical, which is a standard conclusion in the literature. In Singapore, investment also lags the cycle slightly. Another common finding is the synchronous and procyclical behaviour of the inventories-to-output ratio (its contemporaneous cross-correlation with GDP based on signal extraction is significant at the 10% level), suggesting that firms’ desire to avoid ‘stock-outs’ dominates over the production smoothing motive. It is therefore left to overall government spending—a variable created through the aggregation of public consumption and investment expenditures—to act as a buffer to unexpected shocks in aggregate demand, and this it does with solid counter-cyclical leads, at least according to the filtered correlations. We chose to present the data in this unorthodox manner rather than lump the government’s investment with private capital expenditures because anyone who has lived in Singapore knows that public sector gross fixed capital formation in the guise of construction and infrastructure projects is routinely used to pump-prime the economy.

Table 3. National Income Components.

Variable	SD (%)	AR (1)	AR (2)	Cross-correlation at lead k								
				-4	-3	-2	-1	0	1	2	3	4
Private consumption	2.9 (5.0)	0.74* (0.92*)	0.56* (0.85*)	-0.02 (0.13)	0.21 (0.24)	0.44* (0.35*)	0.64* (0.42*)	0.72* (0.45*)	0.63* (0.42*)	0.46* (0.35*)	0.27 (0.26)	0.07 (0.16)
Private investment	11.2 (7.2)	0.54* (-0.01)	0.46* (-0.05)	0.37* (0.09)	0.51* (0.14)	0.60* (0.20*)	0.64* (0.22*)	0.59* (0.20*)	0.45* (0.12)	0.26 (0.05)	0.06 (-0.02)	-0.08 (-0.07)
Government expenditures	6.7 (4.5)	0.45* (-0.11)	0.33* (-0.29*)	0.13 (0.03)	0.05 (0.00)	0.00 (-0.01)	-0.08 (-0.03)	-0.18 (-0.06)	-0.29* (-0.09)	-0.30* (-0.09)	-0.31* (-0.09)	-0.27 (-0.08)
Inventories ratio	2.8 (2.2)	0.32* (0.14)	0.09 (-0.09)	-0.30* (-0.10)	-0.17 (-0.04)	-0.06 (0.02)	0.17 (0.11)	0.35* (0.17)	0.29* (0.16)	0.14 (0.11)	0.06 (0.06)	-0.06 (-0.01)
Net exports ratio	3.1 (1.7)	0.36* (-0.27*)	0.25* (-0.07)	-0.04 (-0.02)	0.03 (-0.04)	0.12 (-0.06)	0.11 (-0.09)	0.04 (-0.09)	0.09 (-0.05)	0.16 (0.01)	0.08 (0.03)	0.04 (0.07)
Exports	5.4 (10.6)	0.76* (0.94*)	0.52* (0.87*)	0.08 (0.05)	0.23 (0.16)	0.39* (0.27)	0.55* (0.36*)	0.65* (0.41*)	0.63* (0.41*)	0.56* (0.39*)	0.45* (0.35)	0.38 (0.30)
Imports	5.9 (10.6)	0.76* (0.93*)	0.46* (0.83*)	0.12 (0.08)	0.24 (0.20)	0.38* (0.32*)	0.55* (0.41*)	0.67* (0.45*)	0.62* (0.44*)	0.53* (0.39*)	0.44* (0.33)	0.38 (0.27)

Notes: The sample period is 1975:Q1–2005:Q4. Instead of logs, changes in inventories and net exports are taken as ratios of real GDP. Numbers on top are estimates from the filtered series whereas those below in parentheses are the corresponding results from signal extraction. An asterisk denotes statistical significance at the 5% level.

Also of great interest is the behaviour of the trade balance in merchandise goods and services, including re-exports. Referred to as ‘net exports’ in the national accounts, the series is converted to a share of GDP instead of logarithms as it took on negative values before 1986. Surprisingly enough, small autocorrelation coefficients and insignificant cross-correlations prove that the trade balance is essentially acyclical. But what most people suspect is borne out by the breakdown of net exports into its constituents in Table 3—export volumes fluctuate procyclically. Not many realize, however, that due to Singapore’s almost total dependence on externally produced raw materials and intermediate inputs, imports rise and fall *pari passu* with exports (note the similarity in the cross-correlation patterns), thus purging their net difference of any cycles whatsoever. In developed economies, on the other hand, imports typically tend to be more strongly correlated with domestic output than exports, resulting in a counter-cyclical trade balance (Basu and Taylor, 1999).

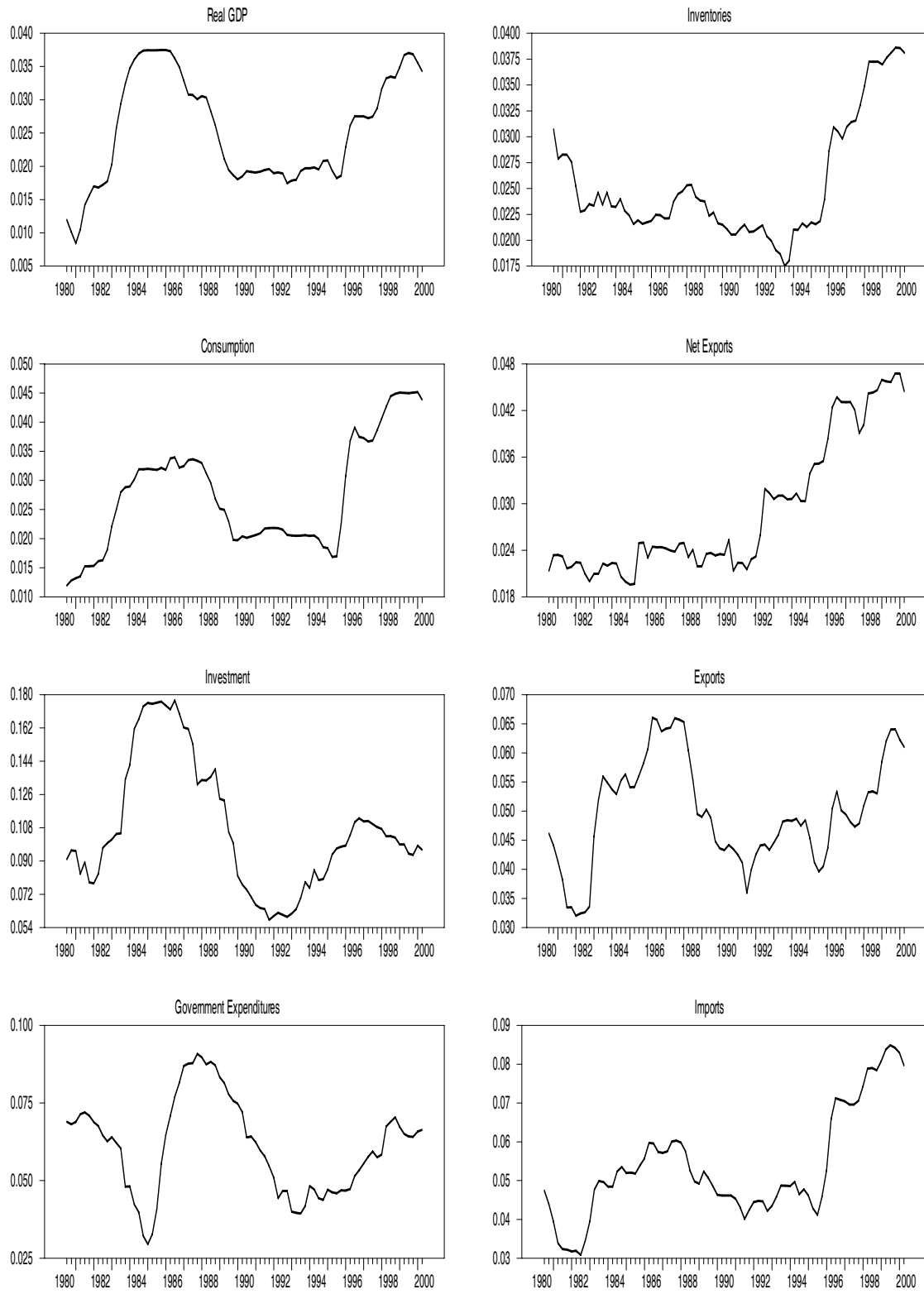


Figure 7. Rolling standard deviations of filtered national income components.

So does this mean that trade cycles are still responsible for Singapore’s economic fluctuations? As far as we are concerned, exports, imports and output all co-vary positively with our proxies for overseas demand. The dynamic volatilities displayed in Figure 7 do not help us settle the direction of causality between these variables either as they closely follow the paths of the foreign variables (cf. Figure 4).¹³ Furthermore, since GDP is by definition the sum of its components, most of the volatilities mimic that of aggregate output. This is particularly true of private consumption expenditures, though its average standard deviation is actually higher than that of income in Table 1. Superficially, the consumption smoothing hypothesis seems to be contradicted, but in reality it might not be because the published data does not distinguish between household spending on non-durable goods and non-storable services on the one hand, and more volatile purchases of durable goods on the other.

Of the domestic demand components, private fixed investment expenditures are the most plausible candidate for being a source of business cycle shocks, partly on account of its high volatility of 11.2% (according to the filtering result). However, it is the least likely. Its variability behaved differently from the rest during the 1990s, rising early and then dipping just before the currency crisis struck in 1997, seemingly oblivious to the bouts of pessimism sweeping subsequently through the region. We should also not forget that it lags the economic cycle. The volatility of inventory investment, by contrast, seems to be (deceptively) low as we have taken it as a ratio of output; a mechanistic calculation shows in fact that its cyclical standard deviation in absolute terms is approximately 10% of the corresponding deviation in real GDP (Stock and Watson, 1999 reported a figure of 25% for the US). In other words, abrupt changes in stocks are unlikely to be an originator of disturbances to the economy, although they are still large enough to play a substantial role in propagating and amplifying external impulses. Finally, the variability of government outlays, averaging 4–7% over the sample period, is relatively high by international standards. No doubt due to our adding investment spending to the picture, this fact probably also reflects the authorities’ pro-active demand management philosophy.

Table 4. Labour Market Variables.

Variable	SD (%)	AR (1)	AR (2)	Cross-correlation at lead k								
				-4	-3	-2	-1	0	1	2	3	4
Employment	2.3 (0.9)	0.94* (0.93*)	0.79* (0.73*)	0.41 (0.16)	0.59* (0.24)	0.71* (0.30)	0.73* (0.32*)	0.65* (0.29*)	0.49* (0.22*)	0.30 (0.13)	0.13 (0.02)	-0.02 (-0.08)
Unemployment rate	0.4 (0.4)	0.60* (0.48*)	0.34 (0.23)	-0.17 (-0.16)	-0.40 (-0.33)	-0.63* (-0.48*)	-0.68* (-0.53*)	-0.53* (-0.48*)	-0.25 (-0.35*)	0.04 (-0.22)	0.18 (-0.13)	0.26 (-0.03)
Labour productivity	2.3 (1.0)	0.76* (0.84*)	0.44* (0.52*)	-0.32 (-0.20)	-0.19 (-0.06)	0.03 (0.13)	0.35* (0.31*)	0.65* (0.46*)	0.59* (0.48*)	0.44* (0.42*)	0.27 (0.31)	0.11 (0.17)
Real producer wage	3.5 (3.2)	0.64* (0.60*)	0.31* (0.25)	0.09 (-0.07)	-0.15 (-0.23)	-0.29 (-0.34*)	-0.37* (-0.41*)	-0.44* (-0.45*)	-0.45* (-0.44*)	-0.36* (-0.37*)	-0.26 (-0.28)	-0.11 (-0.16)
Real consumer wage	1.8 (1.3)	0.52* (0.07)	0.30* (-0.06)	0.45* (0.19)	0.48* (0.21*)	0.44* (0.20)	0.28* (0.14)	0.09 (0.06)	-0.10 (0.00)	-0.16 (-0.02)	-0.24 (-0.05)	-0.28 (-0.06)
Nominal wage	2.2 (1.0)	0.68* (-0.27*)	0.53* (-0.16)	0.59* (0.08)	0.65* (0.11*)	0.61* (0.12)	0.45* (0.08)	0.23* (0.02)	-0.03 (-0.05)	-0.16 (-0.05)	-0.29 (-0.07)	-0.36 (-0.07)

Notes: The sample period is 1980:Q1–2005:Q4 for all variables except the unemployment rate (1986Q1–2005Q4), which is not converted to logs. Numbers on top are estimates from the filtered series whereas those below in parentheses are the corresponding results from signal extraction. An asterisk denotes statistical significance at the 5% level.

4.2. Labour market variables

If there are idiosyncrasies in domestic macroeconomic fluctuations, nowhere are they more likely to be found than in the labour market. This is a uniquely Singaporean institution, involving a large pool of foreign workers (making up 28% of the labour force in 2004); the National Wages Council (NWC), a tripartite arbiter of wages with representation from the government, employers and employees; and state intervention in industrial relations. Table 4 surveys the labour market and finds in the first instance a familiar stylized fact: employment creation and destruction trail behind the growth cycle by 3 to 6 months, thereby making the net number of jobs taken up a lagging indicator of economic activity. By the same token, the unemployment rate has been consistently counter-cyclical since 1986 and lags by 1 quarter, thus verifying Okun’s Law for Singapore. As a change in GDP is not accompanied by a simultaneous adjustment in employment—witness the latter’s higher degree of persistence and lower variability—output per worker must be procyclical, a deduction confirmed by the contemporaneous cross-correlation coefficient for average labour productivity.

Our results up until this point have conformed to the stylized labour market regularities in industrial countries. However, the next co-movement spelled out in Table 4 is certainly idiosyncratic: the robust counter-cyclical of the real producer wage, obtained by deflating average nominal earnings after deducting social security contributions by the DSPI. While not unheard of—see for example Hassler et al., 1994 for the case of Sweden during the post-war period—it contradicts the more frequent finding of a (weakly) procyclical real wage, which has been marshalled as evidence of productivity shocks by macroeconomists of the RBC persuasion. The observation is consistent rather with a Keynesian-style demand curve for labour along which firms moved as the real wage rate fluctuated, with a large standard deviation as it were (we did establish that there was a negative correlation between the level of employment and the price of labour). On the upswing phase of the business cycle, firms might have benefited from increases in money wages falling behind rises in producer prices, leading to new hiring; on the downswing, wages may decrease less or increase more than prices, prompting worker layoffs.

To probe this last hypothesis a bit deeper, we added the cross-correlations for the cyclical components of nominal wages and real GDP to Table 4. The statistically significant coefficients are positively signed and their maximum is located at the non-contemporaneous lag of 3 quarters, hinting at sticky wages indeed. The information contained in the bivariate correlations is hence sufficient to rule out wage-setting shocks as an admissible source of fluctuations; on the contrary, it suggests that NWC wage ‘guidelines’ possibly responded with a delay to changing economic conditions.¹⁴ Whatever the reason for the wage inertia, it is inherited by the movements in real wages adjusted for consumer inflation, which have a whole string of positive correlations with band-passed filtered GDP at the negative phase shifts. Even their variabilities are similar, so we omitted the rolling standard deviations of nominal wages from Figure 8. Except for productivity, the plots in the figure share the same inverse hump shape, with volatility being low during the economic boom of the early 1990s. Apart from that, they are not very revealing but we include them in the paper anyway for completeness sake.

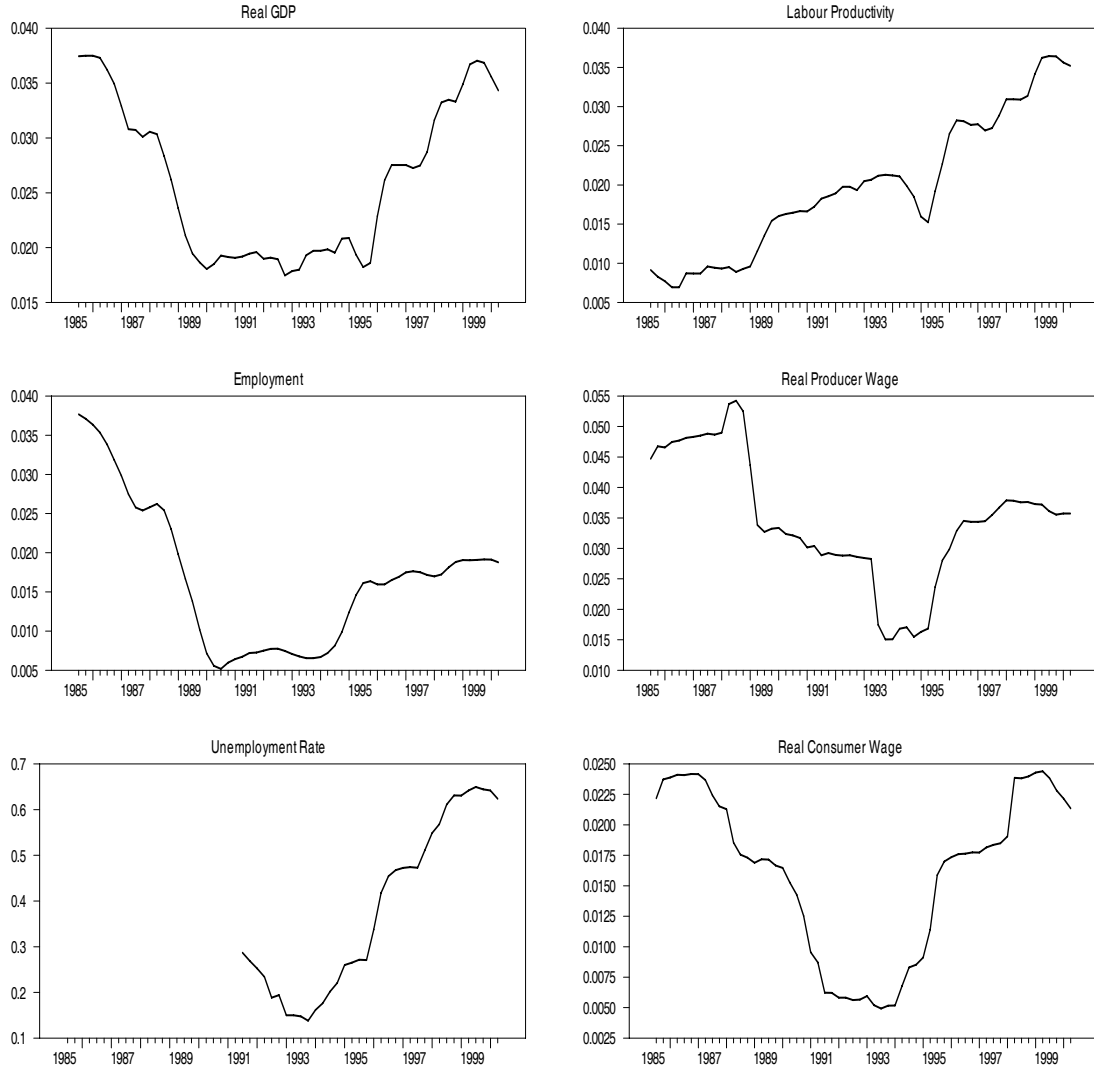


Figure 8. Rolling standard deviations of filtered labour market variables.

4.3. Monetary and financial indicators

The behaviour of monetary and financial indicators has traditionally been the subject of much attention in business cycle research. Studies in this genre usually conclude that the nominal money stock is procyclical and the same goes for velocity. Interest rates are procyclical too and quite often presage output in a counter-cyclical fashion. Below, we shall examine the cyclical properties of the narrow and broad monetary aggregates in Singapore (M1 and M2 respectively), the nominal and real three-month interbank rates, with the latter based on *ex post* CPI inflation, and the trade-weighted exchange rate (NEER).¹⁵

Table 5. Monetary and Financial Indicators.

Variable	SD (%)	AR (1)	AR (2)	Cross-correlation at lead k								
				-4	-3	-2	-1	0	1	2	3	4
M1	3.8 (6.1)	0.71* (0.89*)	0.46* (0.80*)	-0.09 (0.03)	0.04 (0.14)	0.22 (0.25)	0.36* (0.34*)	0.52* (0.41*)	0.63* (0.46*)	0.55* (0.45*)	0.45* (0.42*)	0.30 (0.35)
M2	3.5 (5.2)	0.85* (0.93*)	0.66* (0.82*)	0.23 (0.27)	0.24 (0.30)	0.25 (0.33*)	0.26* (0.35*)	0.29* (0.35*)	0.31* (0.35*)	0.30 (0.32*)	0.29 (0.28)	0.25 (0.22)
Nominal interest rate	1.1 (1.3)	0.69* (0.67*)	0.43* (0.52*)	0.39* (0.36)	0.54* (0.43*)	0.59* (0.46*)	0.53* (0.44*)	0.37* (0.37*)	0.13 (0.25*)	-0.03 (0.14)	-0.19 (0.02)	-0.28 (-0.07)
Real interest rate	1.0 (1.1)	0.62* (0.48*)	0.37* (-0.18)	0.26 (0.08)	0.14 (0.04)	0.01 (0.00)	-0.11 (-0.04)	-0.21 (-0.05)	-0.26* (-0.05)	-0.20 (-0.03)	-0.16 (-0.02)	-0.04 (-0.01)
NEER	3.5 (5.6)	0.82* (0.93*)	0.66* (0.86*)	0.63* (0.53*)	0.60* (0.51*)	0.49* (0.44*)	0.36* (0.34*)	0.16 (0.22*)	-0.03 (0.09)	-0.16 (-0.03)	-0.26 (-0.13)	-0.30 (-0.22)

Notes: The sample period is 1975:Q1–2005:Q4 for all variables except interest rates (1980Q1–2005Q4), which are not converted to logs. Numbers on top are estimates from the filtered log series whereas those below in parentheses are the corresponding results from signal extraction. An asterisk denotes statistical significance at the 5% level.

It has become customary to argue from the open nature of the Singapore economy and the existence of a managed floating exchange rate regime that the money supply will be endogenously determined, adapting itself passively to changes in demand. However, money is not to be thought of as only an effect, and not a cause, of GDP fluctuations, for Table 5 shows that M1 and M2 can paradoxically be both. Of course, it is possible that reverse causation is at work. But this does not explain why the volatilities of money supplies and output tended to diverge in Figure 9, with money being more volatile than output on average. Observe also that the nominal interest rate is procyclical and lagging the reference cycle—an artifact of the tendency of local interest rates to co-move with US rates and the closely linked Singaporean and American economies. As for the real interest rate, the little pairwise correlation there is with GDP means that at best, it is a weak monetary transmission mechanism (see Chow, 2006). Compare this with Neumeyer and Perri’s (2004) revelation that real interest rates are counter-cyclical and lead the cycle in small emerging economies. Singapore’s interest rates are less cyclically sensitive than most of the series we have dealt with anyway and their variabilities measured in percentage points were relatively subdued until recently (Figure 9).

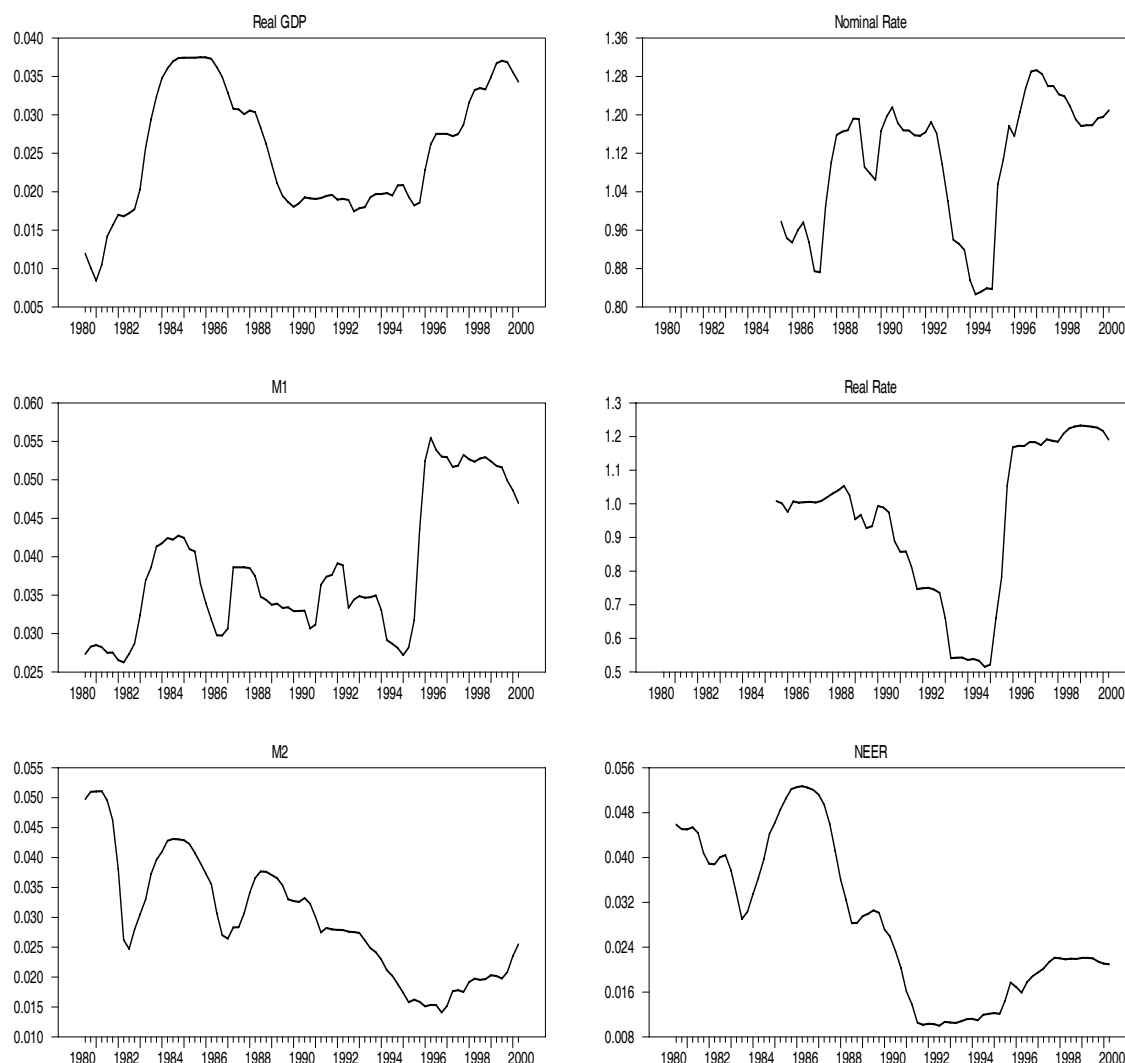


Figure 9. Rolling standard deviations of filtered monetary and financial indicators.

The exchange rate has been held up alternatively as an insulator against, as well as a propagator of, random economic shocks from abroad. Which characterization fits Singapore? Although short-term movements in the NEER can be expected to embody changes in monetary policy over the business cycle, there is no indication in Table 5 that the exchange rate leads output counter-cyclically. There is *prima facie* evidence, however, of a policy reaction on the part of the monetary authority, reminiscent of its response to inflation we saw earlier, which compels it to stabilize the economy by appreciating the NEER whenever the economy has shown signs of overheating and depreciating in the face of recessions. If we are right about there being such a feedback loop with real GDP, fluctuations in the nominal exchange rate at the cyclical frequencies should be more pronounced in

the second half of the 1990s as a consequence of heightened policy interventions to counter the increased volatility of economic growth. The 21-quarter moving windows constructed for the standard deviation of NEER in Figure 9 vindicates us on this score.

5. Stylized Facts for Small Open Economies

It is now time to take stock of what we have learnt about Singapore business cycles in particular and economic fluctuations in small open economies more generally. While it would be overstating our case to claim that Singapore does not fit into the extant historical record of business cycles, it is also incorrect to treat her as just another newly industrialized economy. To be sure, we have uncovered sufficient evidence to surmise that the bulk of the cross-country regularities in macroeconomic aggregates extend to Singapore with hardly any qualifications. But we have also documented several respects in which the country's macroeconomic fluctuations are idiosyncratic in an international context and even when compared with Hong Kong: the counter-cyclicity of government expenditures and the real product wage, plus the procyclicality of the overall price level. By contrast, Leung and Suen (2001) noted that all these variables are acyclical in Hong Kong. In the light of these idiosyncrasies, those readers who are more theoretically inclined should be forgiven for concluding that this paper provides empirical support for demand-driven models of business cycles in Singapore.

Putting macroeconomic implications to one side, we firmly believe there are stylized facts on the origination and propagation of business cycles in small open economies to be gleaned from Singapore's experience. The first has been pointed out by Tinbergen (1937) seventy years ago: in a small country, shocks are likely to be dominated by disturbances imported from the movements of larger economies whilst fluctuations in the internal economy will merely be propagated impulses. There is no convincing evidence of self-fulfilling cycles driven by the 'animal spirits' of local investors, nor of self-inflicted cycles stemming from wage cost increases that have spiralled out of control. The Granger causality test results in Leung and Suen (2001) reach essentially the same conclusion in Hong

Kong. Specifically, these authors do not find volatile property prices to be a cause of the economy's booms and slumps.

A fanciful way of expressing the matter is to say that country-specific shocks play a negligible role in the growth cycles of small open economies. However, global shocks are not created equal: clearly, transnational output impulses have much more significant effects on the GDPs of our two chosen economies than, say, world interest rate disturbances (in Hong Kong, interest rates are procyclical for the same reason as in Singapore viz., the connection with US rates). Moreover, the correlations between the domestic and foreign outputs of both countries are large at the contemporaneous quarter, suggesting that business cycles in these economies are synchronized with those of their major trading partners, individually or taken as a group. With respect to prices, the most crucial foreign influence on Singapore's CPI is the average price level in the same trade partners, followed by oil market developments.

Another qualitative feature worth noting is that the trade balance in resource-deficient city-states like Singapore and Hong Kong is acyclical because exports and imports co-move together over the business cycle. This finding should be contrasted to the strong counter-cyclicality of net exports reported by Neumeyer and Perri (2004) for a group of small emerging economies, some of which are endowed with abundant natural resources. At the same time, the much-discussed relation between the terms of trade and the current account (the 'J-curve' effect) in the literature on advanced economies is simply non-existent, as both variables are devoid of cycles. The corollary is that terms of trade shocks could not be a source of economic fluctuations in Singapore, as they have been found to be in developing countries (Mendoza, 1995).

Last but not least, we have stumbled upon a stylized fact that is applicable to the open economies in East Asia who, like Singapore, are also important producers of electronics goods. One undesirable consequence of Singapore's over-reliance on the chip industry as a widely fluctuating source of export revenue is the rising volatility of real GDP growth in the nineties brought about by the increased frequency and amplitudes of global electronics cycles. In our opinion, a

painful lesson which Singapore has learnt and other small open economies should heed is that this vulnerability to the vagaries of foreign demand and IT product cycles is not an inescapable fact of economic life. The dependence can be broken through a conscious process of export product and market diversification. Although we know better than to declare that such efforts will eliminate business cycles entirely, they can certainly reduce the severity of macroeconomic fluctuations and mitigate their worst effects.

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Notes

¹ In practice, a minor adjustment is needed to accommodate the constraint that a zero weight be placed on the zero frequency to ensure that the filter has trend elimination properties. See Baxter and King (1999) for the details.

² This assumption results in the unsavoury possibility that the trend component can be more volatile than the original series. Despite this, Morley et al. (2003) argued in its favour.

³ Aided by a paraphernalia of technical apparatus, notably the Phase-Average Trend extraction method and the Bry-Boschan procedure for turning point determination.

⁴ Logarithms are taken of this and other variables included in the study, unless otherwise stated. All macroeconomic data on Singapore are downloaded from the Singapore Department of Statistics SingStat Time Series (STS) online system.

⁵ The estimates of the unobserved components models appearing in the paper, which are far too numerous to report, are available upon request from the author.

⁶ Readers might wonder why we do not compute rolling cross-correlations in the paper. The reasons are twofold: first, we do not want to proliferate the number of charts and second, we feel it is more instructive to plot rolling standard deviations because these give us good hints as to the causes of a recent increase in macroeconomic volatility.

⁷ Harvey and Jaeger (1993) pointed out that this common rule-of-thumb is misleading because it implicitly assumes that at least one of the cyclical series is white noise.

⁸ Further notes on data sources: the foreign GDP series is a merchandise export share-weighted geometric average of the real GDPs of Singapore's main trading partners viz., Indonesia, Malaysia, Philippines, Thailand, Hong Kong, South Korea, Taiwan, China, Japan, US, and the rest of the OECD as a single region. To reflect changes in the country composition of foreign trade, the export share matrix is computed as a 12-quarter moving average, as described in Abeyasinghe and Forbes (2005). Global chip sales data is compiled by the Semiconductor Industry Association and a series with consistent coverage starting from 1989 is posted at its website. The US treasury bill rate and Brent oil price are extracted from the *International Financial Statistics* CD-ROM, as are the non-oil commodity prices and Singapore NEER series used later.

⁹ Using VAR models, both Abeyasinghe (2001) and Choy (2003) found that oil price increases have a relatively small negative impact on Singapore's economic growth.

¹⁰ Like foreign GDP, the foreign price index is a geometric average in local currency terms of either producer or wholesale price indices of Singapore's major import sources in Asia and beyond: Malaysia, Thailand, South Korea, Taiwan, Japan, US, UK, France, Germany, Netherlands and Australia. The weights used are the 12-quarter moving averages of merchandise import shares. For full details on how it is constructed, refer to Appendix A of Abeyasinghe and Choy (2006). The DSPI monitors the prices of imports which are retained for use in the domestic economy and of locally manufactured goods. It is compiled as a weighted composite of the IPI and the Singapore Manufactured Products Price Index (SMPI)—another producer price index for manufacturing output.

¹¹ Strictly speaking, it is price inflation that is negatively correlated with the unemployment rate in the Phillips curve relation but we shall not belabour this point.

¹² The first and second-order autocorrelation coefficients from the unobserved components models for private investment, government spending, inventory changes and net exports are much smaller and some of them have negative signs implying oscillatory cycles.

¹³ Khalid and Bay (1997) found support for the export-led growth hypothesis.

¹⁴ Note that we are not discounting the role of autonomous wage shocks—epitomized by the ‘high wage’ policy implemented by the NWC from 1979 to 1982—in instigating the 1985 recession, as most observers argue. Over the historical period we covered in this study, however, such disturbances could not have been very important for output fluctuations, something Choy (2003) had discovered earlier.

¹⁵ An adjustment was made to M2 to smooth over an additive outlier in 1998Q4 caused by the transfer of post office savings bank deposits, previously classified under M3.