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The Impact of International Spillovers on the South African Economy

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Abstract

This paper estimates a multi-country vector autoregressive model (VAR) using South African, the euro area, the United States, Japan and China industrial production in order to determine the impact of business cycle spillovers on South Africa and the synchronisation of business cycles. The spillover index methodology of Diebold and Yilmaz is applied, using forecast error variance decompositions implemented over seven-year rolling windows in order to get a time evolution of the variables of interest. The results show that the South African economy has been significantly affected by international spillovers over the sample period, with the variation in South African industrial production due to spillovers from other countries or common shocks averaging 37,6 per cent. This variation peaked to an average of 62,2 per cent over the financial crisis period and remains significantly high.

JEL classification: E32, F41, C32

Keywords: business cycles, industrial production, spillovers

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Abbreviations

IP	industrial production
OIR	orthogonalised impulse response
US	United States
VAR	vector autoregression

1. Introduction

The financial crisis of 2008, which had its origins in the United States (US), significantly affected the South African economy. After growing by an average of 4,2 per cent from 2000 to 2008, the economy contracted by 1,5 per cent in 2009. Since then, growth has been unable to recover to its pre-crisis level and the economy remains with a significant negative output gap. The fiscal crisis in Europe that followed the financial crisis is again affecting the entire world and having a significant impact on the ability of South Africa to grow. These crises, coupled with globalisation of the world economy through stronger trade and financial linkages since the early 1990s, have meant that macroeconomic shocks in one country propagate more powerfully to the rest of the world. Hence, the spillovers from these crises have become more important for South Africa.

In order to quantify these spillovers, this paper studies the impact of business cycle spillovers (proxied by industrial production) from South Africa's biggest trading partners, including the US, euro area, China and Japan on the South African economy over the past two decades (1991 to 2012). A business cycle spillover index is calculated, following Diebold and Yilmaz (2009), which uses forecast error variance decompositions from a vector autoregression (VAR) model to distinguish between own shocks (referring to domestic country shocks) and the spillover of shocks. The results show that the variation in South African industrial production due to spillovers from other countries, or common shocks, averaged 37,6 per cent during the past two decades. This variation peaked to an average of 62,2 per cent over the financial crisis (2009 to the present) period and remains significantly high.

There is an abundance of empirical evidence that supports the increased synchronisation of the global economy and indicate that many economies (particularly developed economies) share common characteristics (see, for example, Backus, Kehoe and Kydland (1995); Baxter (1995); Canova and Marrinan (1998); Harding and Pagan (2002); Kose, Otrok and Whiteman (2003, 2005); Canova, Ciccarelli and Ortega (2007); and Altug and Bildirici (2010)). For example, Canova et al. (2007) indicate that global business cycles become more synchronised during recession periods compared to expansion periods as there is common timing and dynamics. Altug and Bildirici (2010) find evidence of a world factor that drives the cyclical fluctuations in both developed and developing countries. However, they also find that there is an important degree of heterogeneity among the countries studied.

Literature that recognises this increased synchronisation and attempts to quantify the spillovers that affect the financial and real economy (see for example Diebold and Yilmaz, 2009 and 2012; Yilmaz, 2010; Antonakakis and Badinger, 2012) is growing. However, most of this literature has focused on the Group of Seven (G-7) economies and little attention has been paid to emerging markets such as South Africa. Notable exceptions to this are Duncan and Kabundi (2013) who apply the spillover methodology to equity prices in South Africa, and Kavli and Kotze (2012) who apply this methodology to emerging-market exchange rate returns and volatility.

In the South African context, papers that investigate the synchronisation of the South African business cycle with the rest of the world include that of Botha (2004), du Plessis (2006), Kabundi and Loots (2007), Kabundi (2009), Botha (2010), Boshoff (2010), and Duncan and

Kabundi (2013). Kabundi (2009), for example, using a structural dynamic factor model, finds evidence of co-movement between the US and South African output. Botha (2010) finds evidence of increased synchronisation during common shock periods (e.g. during the financial crisis) and that the synchronisation of emerging markets, such as South Africa, and the world business cycle have increased since globalisation. Finally, Boshoff (2010) finds evidence of strong co-movement between South African and a number of developed economies, using a high-frequency cycle with correlations increasing in the more recent period of 1980 to 2010.

The paper proceeds as follows: section 2 covers the methodological issues surrounding the spillover index; section 3 provides the data and transformation; section 4 presents the results, section 5 looks at a number of policy considerations, and section 6 offers a conclusion.

2. The spillover index: Some methodological issues

Let $y_{it} = y_{1,t}, \dots, y_{N,t}$ be a vector of *N* variables of length *t*, where *y* is industrial production and *i* represents countries. This vector can be modelled using a general VAR such that

$$y_{it} = x_{it}\beta + \varepsilon_t \quad (1)$$

where x_{it} is a matrix of lagged dependent variables, β is a matrix of coefficients and $\varepsilon_t \sim i.i.d.(0, \sigma^2)$ is an independently and identically distributed error. This has a moving average representation, namely

$$y_t = \Theta(L)\varepsilon_t \quad (2)$$

Variance decompositions from the VAR can be used to construct a total spillover index as well as directional spillover indices. The total spillover index measures the total proportion of variation in industrial production of country *i*, which is due to common spillovers. In contrast, the directional spillovers (which can be gross or net) measure the spillovers to industrial production of country *i* received from all other economies in the sample. However, in order to define the variance decomposition for the VAR, the errors need to be orthogonal. Generally, this is done using orthogonalised impulse responses (OIRs), such as the Cholesky, introduced by Sims (1980). Such orthogonalisation imposes a set structure on the evolution of shocks and requires *a priori* information on the ordering of countries. This approach has been critiqued by Cooley and LeRoy (1985). To overcome this problem, the generalised VAR framework of Koop, Pesaran and Potter (1996), and Pesaran and Shin (1998) is used. This produces variance decompositions that are invariant to the order of the variables and more robust directional spillover estimates.

Following Diebold and Yilmaz (2012), let the own variance share be defined as the proportion of H-step-ahead error variances in forecasting y_i due to shocks to y_i, for *i=1,2,…,N*. Also let the cross variance share, or spillovers, be defined at the proportion of H-step-ahead error variances in forecasting y_i due to shocks to y_j, for *i≠j*. When the generalised framework of Koop, Pesaran and Potter (1996),), and Pesaran and Shin (1998) is used, the H-step-ahead error variance decomposition $\theta_{ij}(H)$ is not dependent on the ordering of the variables and can be specified as

$$\theta_{ij}(H) = \frac{\sigma_{ii}^{-1} \sum_{h=0}^{H-1} (e_i' A_h \Sigma e_j)^2}{\sum_{h=0}^{H-1} (e_i' A_h \Sigma A_h' e_i)} \quad (3)$$

where Σ is the variance-covariance matrix of the idiosyncratic error, σ_{ii} is the standard deviation of the idiosyncratic error for the *i*th equation, e_i is a selection vector with 1 as the *i*th element and 0 elsewhere and A_h is a $N \times N$ matrix of coefficient estimates. Therefore, $\theta(H) = [\theta_{ij}(H)]_{i,j=1,2,\ldots,N}$ is an $N \times N$ matrix where each element indicates the contribution of country *j* to the forecast error variance of country *i*. Since the variance contributions do not sum to one under the generalised decomposition, $\theta_{ij}(H)$ is normalised by the row sum yielding $\tilde{\theta}_{ij}(H)$.

Therefore, the total spillover index can be calculated as

$$S(H) = \frac{\sum_{i,j=1,i \neq j}^{N} \tilde{\theta}_{ij}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}(H)} \times 100 \quad (4)$$

which provides the proportion of total forecast error variance of common shocks, or shocks to all countries. The methodology also allows for the calculation of the direction of the spillovers, that is, from country *i* to and from all other countries *j*. This can be defined as

$$S_{i \leftarrow j}(H) = \frac{\sum_{j=1,j \neq i}^{N} \tilde{\theta}_{ij}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ij}(H)} \times 100 \quad (5)$$

for spillovers to *i* from *j* and as

$$S_{i \rightarrow j}(H) = \frac{\sum_{j=1,j \neq i}^{N} \tilde{\theta}_{ji}(H)}{\sum_{i,j=1}^{N} \tilde{\theta}_{ji}(H)} \times 100 \quad (6)$$

for spillovers from *i* to *j*. The difference (6)–(5) between the directional spillovers provides a net spillover index which indicates whether a country is a net originator or net receiver of shocks.

Finally, a synchronisation index can be constructed as the ratio between the total spillover index at time 0 (contemporaneously) and at time *H*

$$Sync(H) = \frac{S(H)_{H=0}}{S(H)} \quad (7)$$

which takes on values between 0 (indicating no synchronisation or the absence of common shocks) and 100 (indicating strong synchronisation). This index will gauge the extent to which developments in the total spillover index is due to increased cross-correlations hitting all economies, that is, the impact of common shocks and stronger transmission dynamics.

3. Data

In order to capture the co-movement in the business cycles, monthly seasonally adjusted industrial production (IP) data over the sample period 1991M01 to 2012M03 are used. The countries included are the US, euro area, Japan, South Africa and China. The data is sourced from the Organization of Economic Co-operation and Development (OECD) and various country statistical agencies.

Figure 1 plots the 84-month rolling window bi-lateral correlations of log IP (left) and the first differenced log IP (right) between South African and the rest of the countries in our analysis.

Figure 1: Eighty-four-month bi-lateral rolling correlations

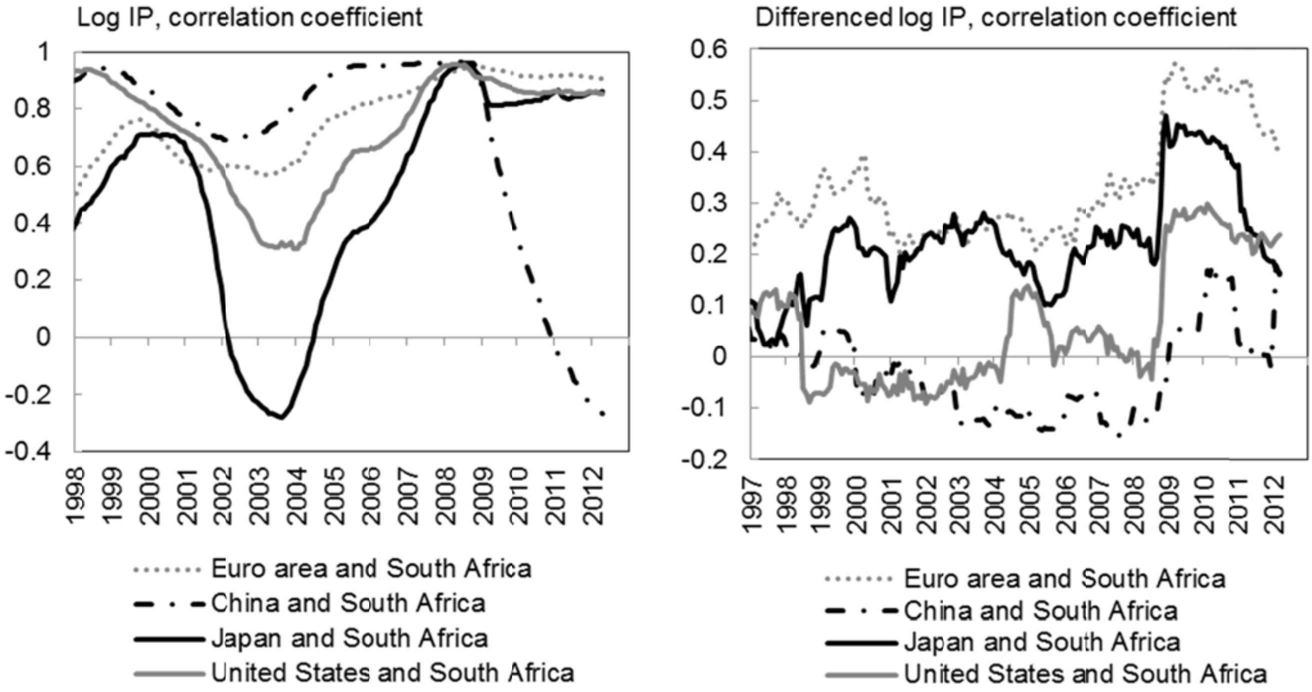


Figure 1 shows a strong co-movement between the countries included in this analysis, both in levels and in first differences. In line with Botha (2010), the South African economy has become more synchronised with global developments during periods of common shocks. Correlations in both levels and first differences show an increase with the onset of the financial crisis in 2008, with the correlation in levels between South Africa and the US increasing from 0,76 in the 84 months up to December 2006 to a peak of 0,96 in early 2008. A similar pattern is visible between South Africa and the euro area and Japan. An interesting divergence occurred in the case of South Africa and China, where the correlation coefficient of log IP went from 0,96 in late 2008 to -0,26 in March 2012. Much of this can be attributed to the two-paced growth that has occurred since the financial crisis between advanced and emerging economies. South African economic growth dynamics during this period mimicked advanced economies rather than that of emerging markets.

4. Results

4.1 Model selection

A VAR using log IP is estimated in levels despite the presence of non-stationary data in line with studies such as that of Sims (1992), Ramaswamy and Sloek (1997), Kim and Roubini (2000), Peersman and Smets (2003), and Elbourne and de Haan (2006). Although this estimation means a loss of efficiency, the dangers of inconsistency from imposing incorrect co-integrating restrictions (Sims, Stock and Watson, 1990) are avoided. Furthermore, any potential co-integrating relationships become implicitly determined in the model (Hamilton 1994). The VAR is estimated with two autoregressive lags according to the Bayesian information criterion (BIC) over the entire sample.

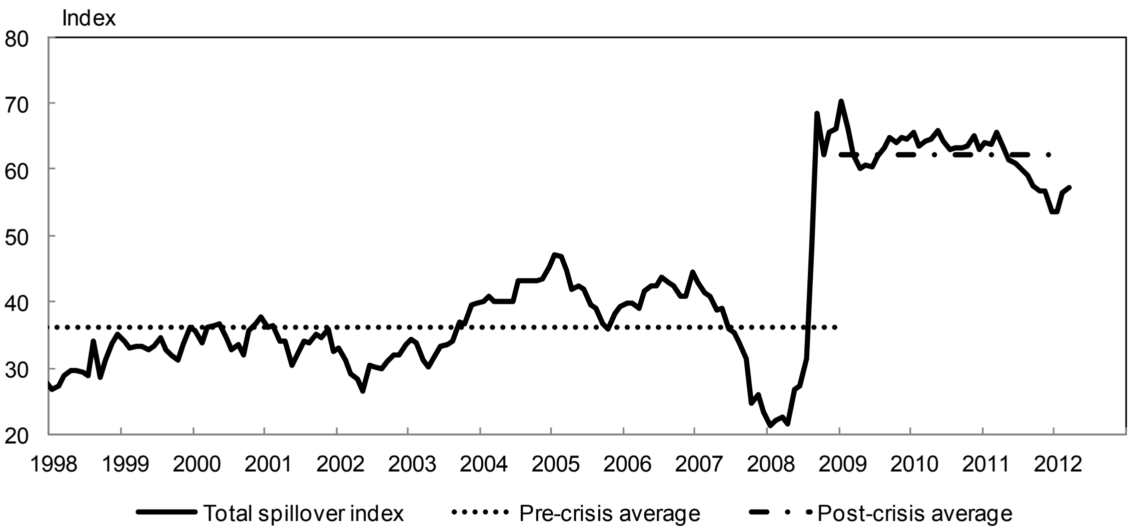
The VAR is estimated using 7-year rolling windows (i.e. 84 months) to provide a time-varying analysis of spillovers. This approach has two caveats. First, by censoring the sample to this window length significantly increases the likelihood of overfitting the VAR (i.e. the sample available to estimate the coefficients drops from 255 to 84). Therefore, the number of countries used and the lag length options becomes limited. Second, the spillover index becomes sensitive to the length of the window chosen. However, in order to test for robustness, estimates using various rolling window lengths, forecast horizons and lag lengths are undertaken (see appendix A). The forecast horizon for the error variance decompositions is 12 months.

4.2 Total spillover index

The total spillover index measures the extent to which economic activity is interconnected. Stated differently, the index measures the total share of the variation in industrial production that is explained by international spillovers. Figure 2 reflects the total spillover index together with the pre-crisis and post-crisis averages for the period 1998m1 to 2012m03.[2] Since the outbreak of the financial crisis, there has been a significant rise in the magnitude of international spillovers. Over the pre-crisis period (1998 to 2008) around 36 per cent of the 12-step-ahead error variance in industrial production of the sample was due to spillover effects. This increased to around to 62 per cent after the crisis (2009 to the present). This result is in line with Yilmaz (2010), who also finds a significant rise in spillovers with the onset of the financial crisis among the G-7 countries.

[2] The sample period begins in 1990m1 with the 7-year rolling window estimations meaning that the first value for the spillover index begins in 1997m12.

Figure 2: Business Cycle spillover index



Currently, the total spillover index remains at elevated levels despite having declined from its peak in 2009. Part of the explanation for this could be related to the impact of the euro area crisis on the countries in the sample and the possible impact of a slowdown in China.[3]

It is important to bear in mind that the model does not explicitly consider the channels through which the shocks are transmitted. However, the spillover effects are most likely directly related to global factors such as the rise in risk aversion in financial markets and the slowdown in economic growth in advanced countries adversely affecting export trends of the countries in the sample.

4.3 Net directional spillovers and spillovers to South Africa index

Net directional spillovers provide an indication of which countries are net originators of IP shocks and which countries are net receivers. Figure 3 plots the net directional spillovers for South Africa, the US, China, Japan and the euro area. The bars indicate the direction of spillovers – a positive value indicates that the country is a net originator of spillovers to the rest of the group, while a negative value indicates that the country is a net recipient of spillovers.

South Africa is a net receiver of IP spillovers throughout the sample period. The impact of shocks from the rest of world and common shocks increased substantially during the financial crisis period, with spillovers originating mainly from the US and, to a lesser extent, the euro area. This is consistent with the dynamics of the financial crisis, whose origin was the US subprime mortgage market, spreading to the rest of the US economy and then affecting the rest of the world. Emerging markets such as China and South Africa were net receivers of IP shocks at the peak of the financial crisis. More recently, however, China has been a net originator of IP shocks.

[3] High spillovers could also be due to sensitivity to the window length as the sample still includes the financial crisis period. However, this “lag effect” would only affect the persistence of the spillover index. At a window length of 36, the total spillovers index indicates a more significant drop in spillovers towards the end of 2012 before returning to the previous highs as 2012 progresses.

Figure 3: Net directional spillovers

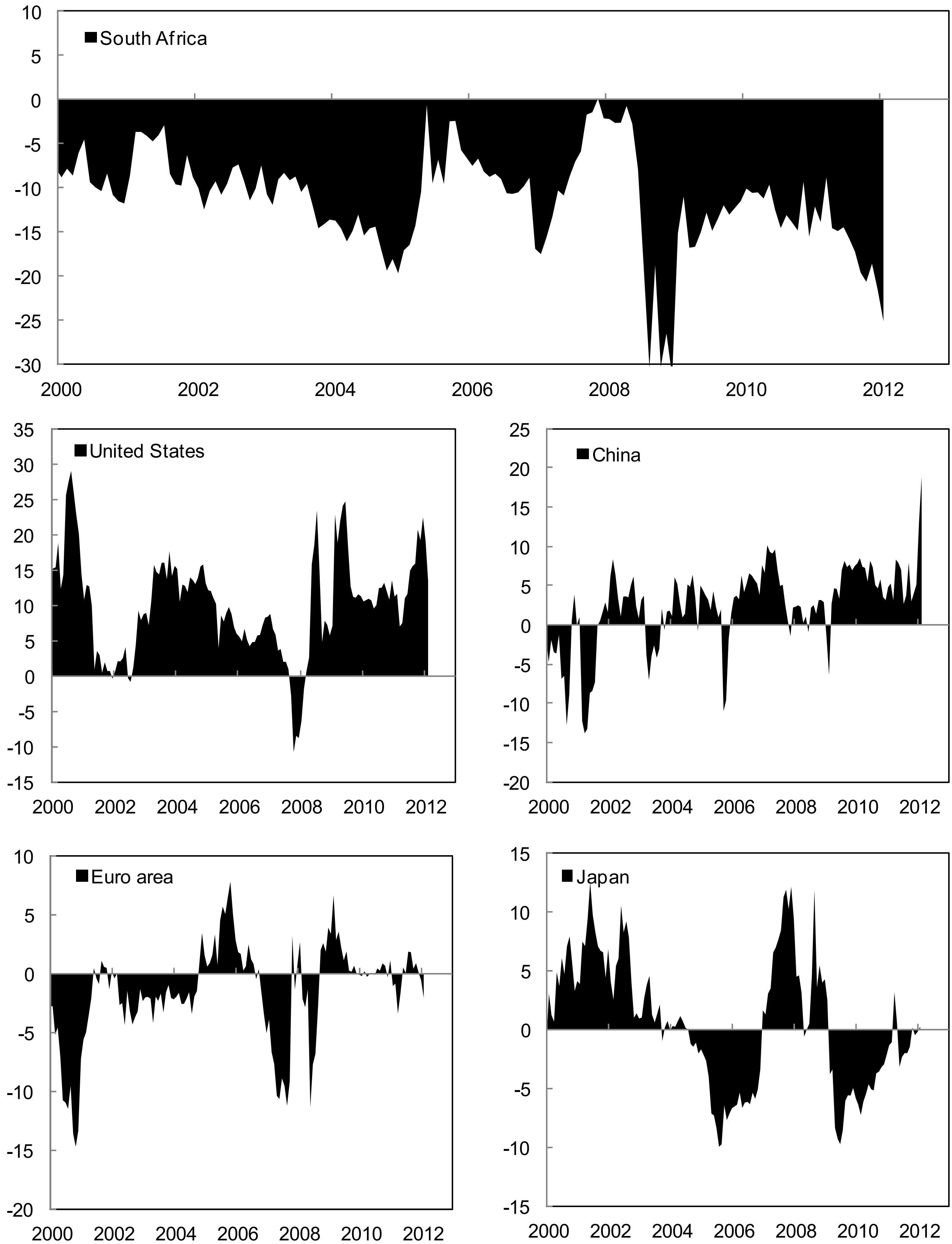
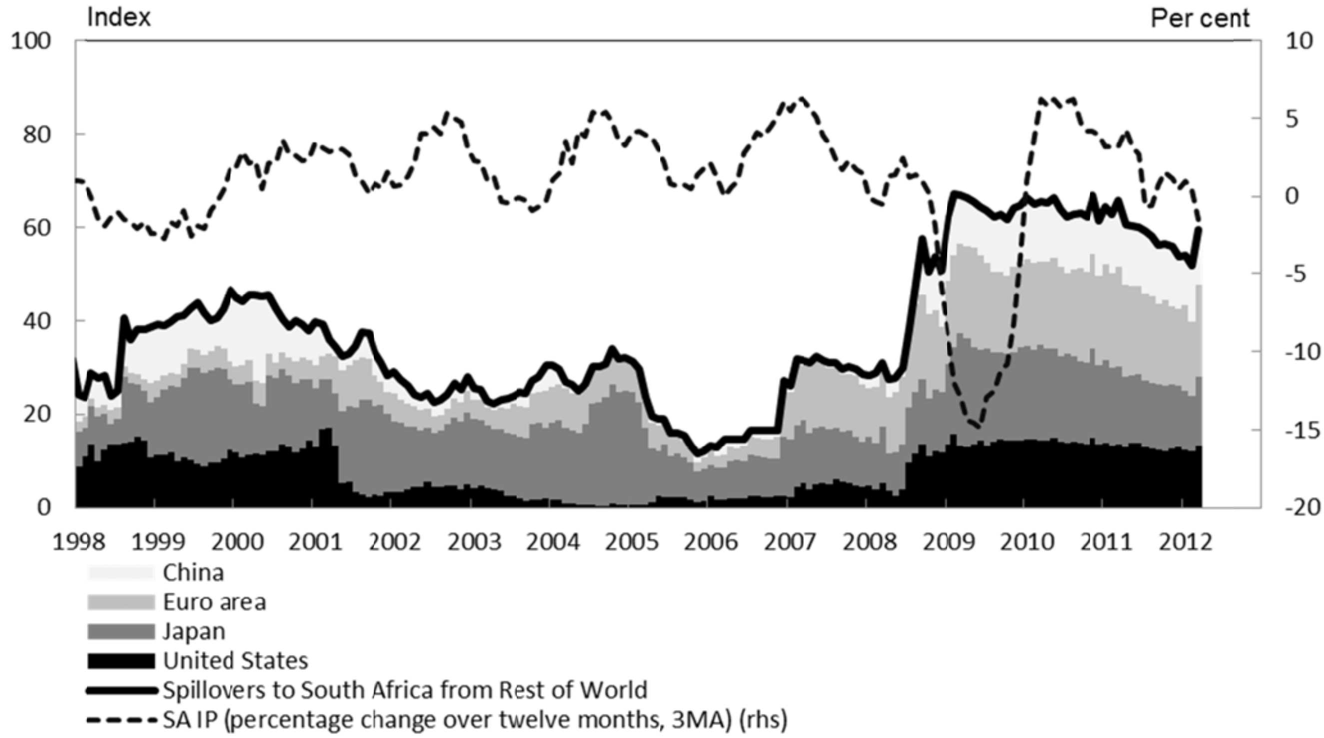


Figure 4 plots the magnitude of spillovers to South Africa (i.e. spillovers to South Africa index) from the rest of world and from common shocks decomposed into the country of origin against the evolution of South Africa's annual growth in industrial production (calculated as a three-month moving average). The 12-step-ahead error variance of South African IP due to shocks from the rest of world and common shocks averaged 30,4 per cent from 1998 to 2008. Much of this variation is due to South Africa being a small open economy subject to large capital flows, a volatile exchange rate and a significant proportion of trade to gross domestic product. The plot also indicates the amount of IP variation due to domestic shocks as 100 less the spillovers to South Africa. Over the pre-crisis period (1998 to 2008) domestic shocks explained most of the variation in IP, which was close to 70 per cent. This decreased to 37,8 per cent during the crisis period.

Figure 4: Spillovers to the South African economy



An important period in the South African business cycle is during the financial crisis where annual growth in IP slowed from an average growth rate of 3,4 per cent during 2007 to contract by 16,2 per cent in April 2009. This coincided with a significant rise in the spillovers to South Africa index, which increased from a 30 per cent average in 2007 to just over 67 per cent in February 2009. The decomposition of spillovers to South Africa indicates that during the financial crisis, spillovers rose from all countries included in the sample period despite the indication from the directional spillovers that the US was the main originator of these spillovers.

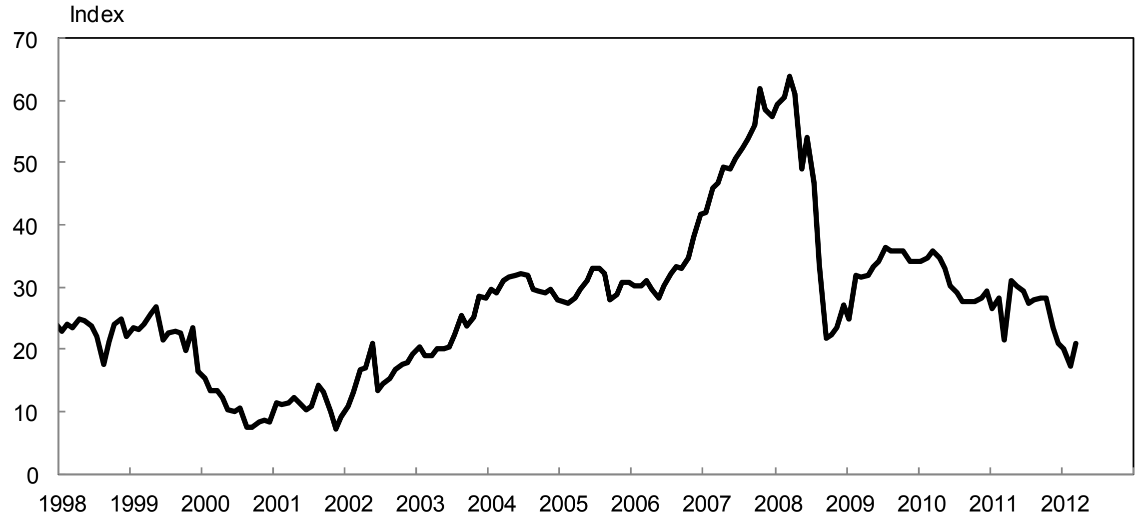
Net spillovers to South Africa have begun to increase again since late 2011 as shocks from the rest of the world impact on the pace of industrial production. Annual growth in South African IP slowed from 5,8 per cent in April 2011 to contract by 3,5 per cent in April 2012.

Much of this is due to the slowdown in the euro area and in the US, which is impacting on growth in China and South Africa.

4.4 Synchronisation

The index of business cycle synchronisation measures the impact common shocks have on the evolution of the total spillovers index and to what extent this is due to strengthening transmission dynamics. Figure 5 plots the index of business cycle synchronisation over the sample period.

Figure 5: Index of business cycle synchronisation



The plot shows that the synchronisation of business cycles started increasing steadily from 2002 with the rise in globalisation. The index then significantly increased with the onset of the financial crisis as the economies of the euro area and the US entered recession. The index increased from 42 index points at the beginning of 2007 to 64 index points at its peak in 2008. The index then drops significantly in late 2008 as emerging markets growth remained relatively robust and the dual growth path emerged with emerging market growth averaging 6 per cent and advanced economy growth remaining flat.

However, during the recovery phase of 2009 to 2011 this index increased again as all economies began to grow. In 2010 advanced economies' growth averaged 3,2 per cent, while emerging market growth was 7,5 per cent. Recently, the synchronisation index has been declining, mainly due to the divergence in IP growth between China and the rest of the economies in this analysis. This divergence in growth can be seen in Figure 1 with the correlation between South Africa and China moving negative.

5. Policy considerations

This paper has a number of policy implications. The evolution of South African IP since the financial crisis has been significantly more dependent on economic outcomes in economies such as the US, Europe and China. The increased propagation of spillovers to the South African economy requires both fiscal and monetary policy to be more countercyclical in order to mitigate the likely effects from these spillovers. For monetary policy, the trade-off between rising inflation and subdued growth became more acute in the South African context towards the end of 2012, requiring a clear understanding of the likely impact developments in the rest of the world would have on South Africa. This trade-off and the significant impact of spillovers may require monetary policy to be more growth-biased in the medium term to promote sustainable economic growth.

For fiscal policy, the slowdown of the South African economy due to spillovers requires automatic stabilisers to continue performing their countercyclical function. However, as public debt levels rise and sovereign ratings threaten debt sustainability, the domestic policy space may not be sufficient to accommodate these spillovers. Fiscal policymakers may be able to promote sustainable economic growth through switching consumption expenditure towards investment expenditure, maintaining public debt levels and improving debt sustainability.

6. Conclusion

This paper estimated the total spillovers index and directional spillovers for the US, euro area, Japan, China and South Africa. The results show that South Africa has been a net receiver of spillovers from the rest of the world, especially since the onset of the 2007 financial crisis. These spillovers remain elevated and continue to affect the growth prospects of South Africa adversely. The increased synchronisation of the world economy and the openness of South Africa mean that spillovers from the rest of the world are likely to remain above pre-crisis levels in the medium term. However, spillovers can be both positive and negative in nature, suggesting that a recovery in the rest of the world is likely to bring about positive spillovers to South Africa. By introducing emerging markets such as South Africa and China, this paper provides a new take on the analysis of spillovers. The results in this paper support the findings of Botha (2010) and Canova et al. (2007) that business cycles are more synchronised during periods of common shocks.

Future research should look at the possibility of including a greater number of countries in this analysis to ensure a more accurate representation of country-specific shocks. This could be achieved through Bayesian techniques or the introduction of factor analysis to exploit the common factor that drives some of these spillovers. Further work could focus on the impact that spillovers have on the conduct on monetary policy in South Africa.

Appendix A: Robustness

In order to test the robustness of the spillovers to South Africa index, the window length (between 60 and 96 months) of the rolling regression, the forecast horizon used (from 6 to 24) and the lag length chosen (one to three lags) are varied. Figures A1, A2 and A3 plot the spillover to South Africa index for these three examples over the period 1999 to 2012, indicating the minimum, maximum and mean values.

The figures show that the spillovers to South Africa index does not differ substantially when changing the forecast horizon, window length or lag length in the analysis. Although there is a degree of dispersion in the different indices, the trend and cyclical dynamics remain consistent. The same results are found when testing the robustness of the total spillover index.

Figure A1: Sensitivity of the spillovers to South Africa index to rolling window size (from 60 to 96 months)

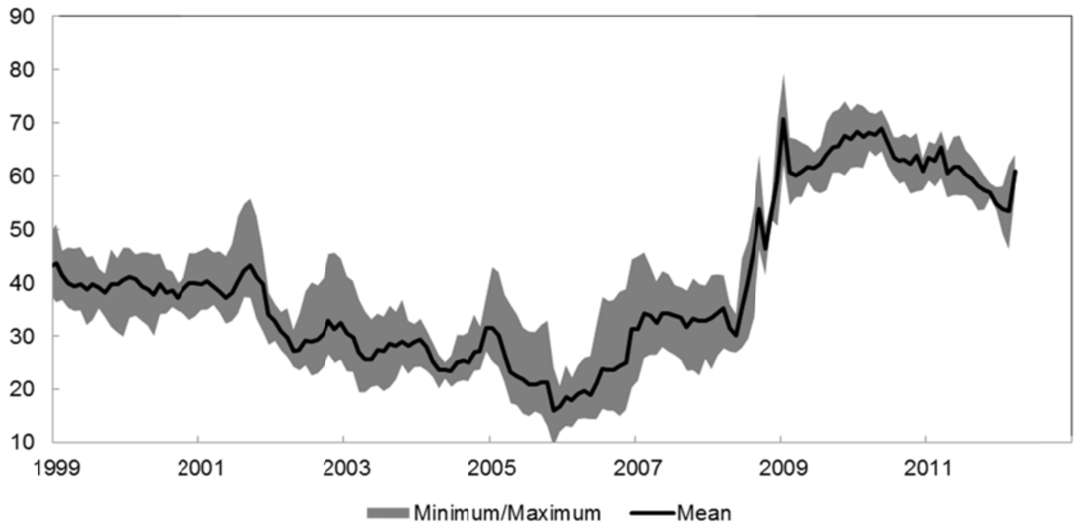


Figure A2: Sensitivity of the spillovers to South Africa index to forecast horizon (from 6 to 24 months)

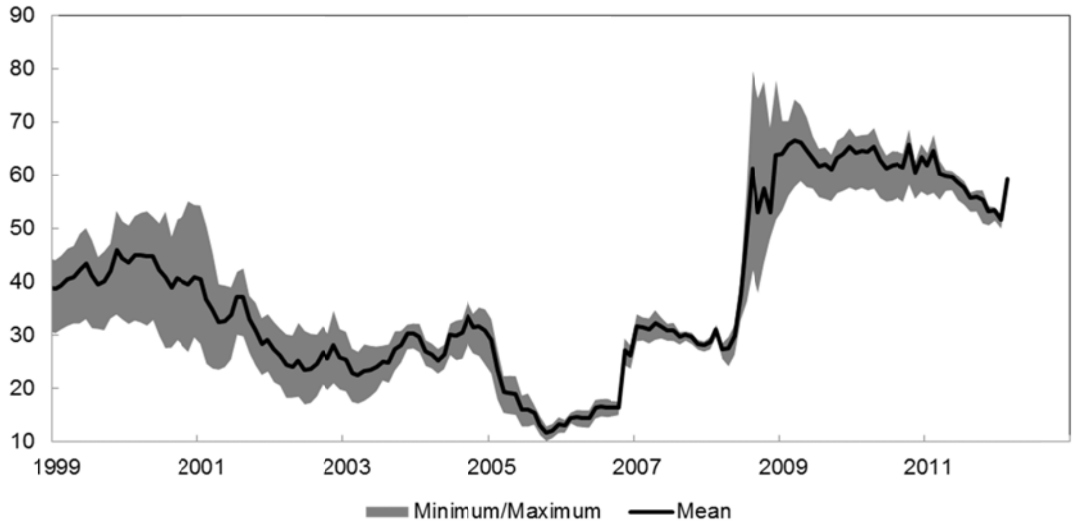
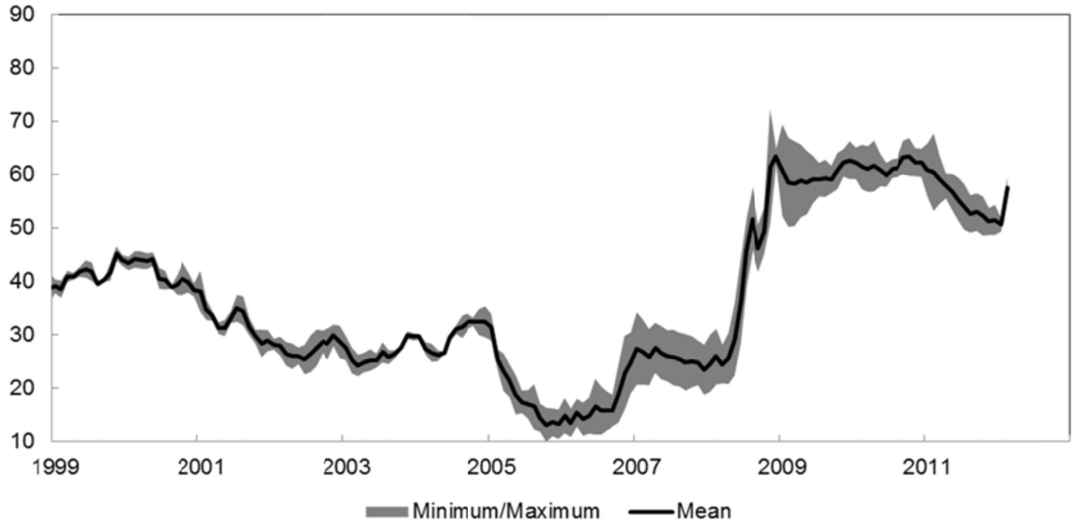


Figure A3: Sensitivity of the spillovers to South Africa index to lag length (from one to three months)



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