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South Africa's real business cycles: The cycle is the trend*

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Abstract

This paper tests the 'cycle is the trend' hypothesis. We investigate how far permanent and transitory productivity shocks can account for the dynamics observed in the South African business cycle over the period 1946–2014. By estimating a standard small open economy real business cycle model and its financial frictions augmented counterpart, we show that permanent productivity shocks are more important than transitory ones in explaining this country's business cycle fluctuations. This finding supports the 'cycle is the trend' hypothesis in the South African business cycle. The model with financial frictions successfully mimics the downward-sloping high autocorrelation of trade balance to output ratio observed in the data, whereas the benchmark model produces a flat autocorrelation function. Financial frictions such as country risk premium shocks help to explain the fluctuations in investment and in the trade balance to output ratio.

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Keywords: Small open economy, real business cycle, permanent shock, transitory shock, financial frictions, Bayesian

1 Introduction

It has been argued that business cycles in emerging economies are subject to substantial volatility in trend growth, while the volatility of developed economies' cycles has moderated in recent decades, and further, that the high volatility in trend growth observed in emerging economies is the

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result of large and frequent changes in fiscal, monetary and trade policies (Stock and Watson, 2005; Aguiar and Gopinath, 2007). Thus, shocks to trend growth may be the main cause of business cycle fluctuations in emerging economies, while fluctuations in developed economies' cycles are caused mostly by transitory shocks. Consequently, the volatility of aggregates such as consumption and investment is greater than that of output in emerging economies, while current accounts are countercyclical (Mendoza, 1991). Emerging economies further exhibit large changes in trade patterns during periods of economic crisis, so it is important to understand how the trade balance to output ratio behaves in these economies (Uribe and Yue, 2006; Garcia-Cicco et al., 2010).

The hypothesis that 'emerging markets are characterized by a volatile trend that determines the behavior of the economy at business cycle frequencies' is known as the 'cycle is the trend' hypothesis (Aguiar and Gopinath, 2007, page no. 70), and also as the 'stochastic trend' hypothesis (Chang and Fernandez, 2013). The hypothesis is often supported by the data in emerging economies. This is because the response of consumption to a shock in income varies and is based on the persistence of the shock, as specified by the permanent income hypothesis (Friedman, 1957). When the economy enters a period of high growth, a permanent shock to income growth will induce economic agents to increase current and future output growth. Consumption will respond more than income, reducing savings and hence generating a current account deficit. However, a transitory shock will induce agents to increase savings, resulting in little increase in consumption and hence less decrease in the current account. Thus, a permanent productivity shock means a larger response of consumption to income and a corresponding substantial decrease in the current account. The opposite is true in the case of a transitory productivity shock. Figure 1 presents the evolution of South Africa's GDP per capita for the period 1946–2014.

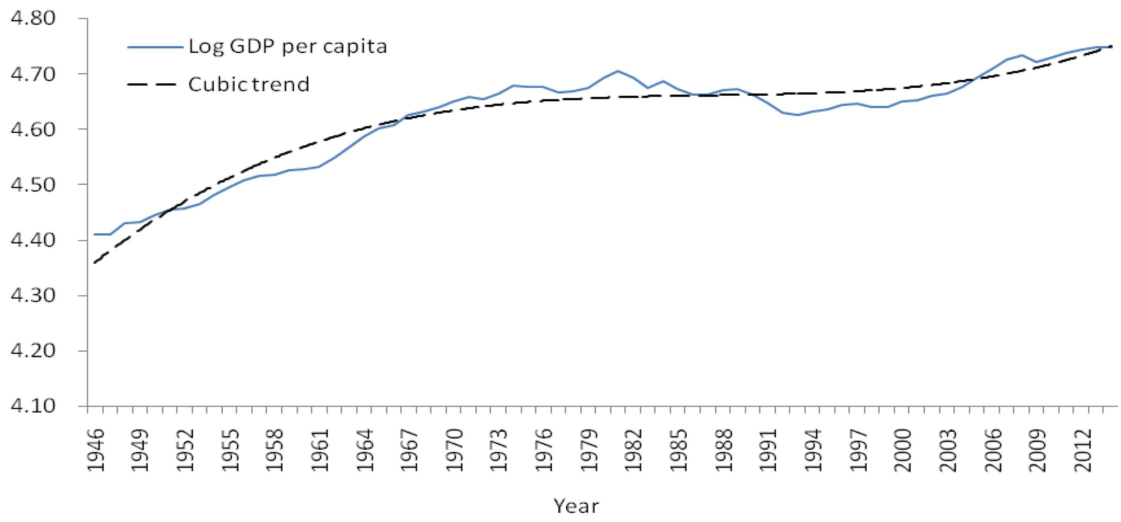

Figure 1: Output per capita in South Africa, 1946–2014

This paper tests the cycle is the trend hypothesis by investigating the ability of permanent and transitory productivity shocks to account for the dynamics observed in the South African business cycle over the period 1946–2014. To do this, we estimate a standard Small Open Economy Real Business Cycle (SOE-RBC) model and its financial frictions augmented counterpart using Bayesian techniques. The standard SOE-RBC model with permanent and transitory productivity shocks, also referred to as the benchmark SOE-RBC model, is augmented with a preference shock, a domestic spending shock, a country risk premium shock and debt elasticity of the country risk premium. This augmented model is referred to as the financial frictions SOE-RBC model. Similar models have also been estimated by Schmitt-Grohe and Uribe (2003), Uribe and Yue (2006), Aguiar and Gopinath (2007) and Garcia-Cicco et al. (2010). To the best of our knowledge, this is the first attempt to test the cycle is the trend hypothesis for the South African economy using a SOE-RBC model.

Our results show that permanent productivity shocks are more important than transitory ones in explaining business cycle fluctuations. The variance decompositions and the posterior estimates show that although the transitory, or stationary, productivity shock is more persistent than the permanent, or nonstationary, productivity shock in the model with financial frictions, it is the nonstationary productivity shock that explains most of the fluctuations in output growth observed in the data. Thus, the estimated results from the model with financial frictions overwhelmingly support the cycle is the trend hypothesis in the South African business cycle. The model also successfully mimics the downward sloping autocorrelation of the trade balance to output ratio observed in the data, whereas the benchmark model produces a flat autocorrelation function. The results further show that financial frictions such as the country risk premium shocks play an important role in explaining the fluctuations in investment and trade balance to output ratio.

The rest of paper is organized as follows. The next section presents the SOE-RBC model, Section 3 reports the estimated results, Section 4 discusses the performance of the model and Section 5 concludes.

2 An SOE-RBC model with financial frictions

The modeling framework is the standard single good, single asset SOE-RBC model following Schmitt-Grobe and Uribe (2003), Uribe and Yue (2006), Aguiar and Gopinath (2007) and Garcia-Cicco et al. (2010). In addition to the stationary and nonstationary productivity shocks, the model is augmented with a preference shock, a domestic spending shock, a country risk premium shock and debt elasticity of the country risk premium.

The model economy consists of firms that use a Cobb-Douglas type production technology:

$$Y_t = a_t K_t^{\alpha} \left(X_t h_t\right)^{1-\alpha}, \tag{1}$$

where Y_t is output in period t, K_t is capital and h_t is the number of hours worked. α is the capital income share. a_t is the stationary productivity shock, which follows an AR(1) process, $lna_{t+1} = \rho_a \ln a_t + \epsilon_{a,t+1}$ where $\epsilon_{a,t} \sim i.i.d.\left(0, \sigma_a^2\right)$. X_t is the non-stationary productivity shock. The upper case and lower case letters denote the variables that follow a trend in equilibrium, and those that do not respectively. The growth rate of X_t is given by $g_t \equiv \frac{X_t}{X_{t-1}}$, which is nonstationary and follows an AR(1) process $ln\frac{g_{t+1}}{g} = \rho_g \ln \frac{g_t}{g} + \epsilon_{g,t+1}$ where $\epsilon_{g,t} \sim i.i.d.\left(0, \sigma_g^2\right)$. g is the deterministic gross growth rate of the stochastic trend X_t. The nonstationarity feature is evident given that an improvement in g_t has a permanent effect on the level of X_t. The parameters ρ_a and ρ_g measure the persistence of the stationary and nonstationary productivity shocks, respectively.

The model economy is populated by a large number of homogeneous households that maximize their expected lifetime utility function:

$$E_o \sum_{t=0}^{\infty} \nu_t \beta^t \frac{\left[C_t - \theta\omega^{-1} X_{t-1} h_t^{\omega}\right]^{1-\gamma} - 1}{1-\gamma}, \tag{2}$$

where β^t is the discount factor, C_t is real consumption, θ is the proportion of time that households allocate to work, ω is the elasticity of labor supply and γ is the inverse of the elasticity of substitution. ν_t is an exogenous stochastic preference shock that follows an AR(1) process, $\ln \nu_{t+1} = \rho_\nu \ln \nu_t + \epsilon_{\nu,t+1}$ where $\epsilon_{\nu,t} \sim i.i.d.\left(0, \sigma_\nu^2\right)$. Households accumulate debt D_t and pay the domestic interest rate r_t, and face the following budget constraint:

$$\frac{D_{t+1}}{1+r_t} = D_t - Y_t + C_t + S_t + I_t + \frac{\phi}{2}\left(\frac{K_{t+1}}{K_t} - g\right)^2 K_t, \tag{3}$$

where I_t is gross investment. $S_t \equiv \frac{S_t}{X_{t-1}}$ is the domestic spending shock, which follows an AR(1) process, $\ln \frac{s_{t+1}}{s} = \rho_s \ln \frac{s_t}{s} + \epsilon_{s,t+1}$ where $\epsilon_{s,t} \sim i.i.d.\left(0, \sigma_s^2\right)$. ϕ denotes the quadratic capital adjustment cost coefficient. The law of motion for physical capital is given by:

$$K_{t+1} = (1-\delta)K_t + I_t, \tag{4}$$

where $\delta \in (0,1)$ is the depreciation rate.

Households also face a no Ponzi game constraint:

$$\underset{j\to\infty}{lim}\, E_t\left(\frac{D_{t+j}}{\Pi_{s=0}^{j}\left(1+r_{t+s}\right)}\right) \leq 0.$$

The model economy is assumed to face a constant debt elastic interest rate premium:

$$r_t = r^* + \psi\left(e^{\widetilde{D}_{t+1}/X_t - \bar{d}} - 1\right) + e^{\mu_t - 1} - 1, \tag{5}$$

where $\widetilde{D}_t$ is the exogenous aggregate level of external debt per capita and $\widetilde{D}_t = D_t$ in equilibrium since all households are identical. The world interest rate r^* is assumed to be constant. $\bar{d}$ is a parameter to induce a steady state trade balance to output ratio. μ_t is the exogenous stochastic country risk premium shock that measures the disparity in the country spread, $\ln \mu_{t+1} = \rho_\mu \ln \mu_t + \epsilon_{\mu,t+1}$ where $\epsilon_{\mu,t} \sim i.i.d.\left(0, \sigma_\mu^2\right)$.

Letting $\lambda_t X_{t-1}^{-\gamma}$ be the Lagrange multiplier associated with the budget constraint, the households' first order conditions are as follows:

$$\nu_t\left[\frac{C_t}{X_{t-1}} - \theta\omega^{-1}h_t^\omega\right]^{-\gamma} = \lambda_t, \tag{6}$$

$$\nu_t\left[\frac{C_t}{X_{t-1}} - \theta\omega^{-1}h_t^\omega\right]^{-\gamma}\theta h_t^{\omega-1} = (1-\alpha)\,a_t\left(\frac{K_t}{X_{t-1}h_t}\right)^\alpha\left(\frac{X_t}{X_{t-1}}\right)^{1-\alpha}\lambda_t, \tag{7}$$

$$\lambda_t = \beta\frac{1+r_t}{g_t^\gamma}E_t\lambda_{t+1}, \tag{8}$$

$$\left[1+\phi\left(\frac{K_{t+1}}{K_t}-g\right)\right]\lambda_t=\frac{\beta}{g_t^{\gamma}}E_t\lambda_{t+1}\left[\begin{array}{c}1-\delta+\alpha a_{t+1}\left(\frac{X_{t+1}h_{t+1}}{K_{t+1}}\right)^{1-\alpha}+\\ \phi\left(\frac{K_{t+2}}{K_{t+1}}\right)\left(\frac{K_{t+2}}{K_{t+1}}-g\right)-\frac{\phi}{2}\left(\frac{K_{t+2}}{K_{t+1}}-g\right)^2\end{array}\right]. \tag{9}$$

The necessary equilibrium conditions are obtained following Schmitt-Grohe and Uribe (2003) where details can be found. Setting $y_t=\frac{Y_t}{X_{t-1}}, c_t=\frac{C_t}{X_{t-1}}, s_t=\frac{S_t}{X_{t-1}}, d_t=\frac{D_t}{X_{t-1}}$ and $k_t=\frac{K_t}{X_{t-1}}$, the stationary equilibrium is given by the following equations:

$$\nu_t\left[c_t-\theta\omega^{-1}h_t^{\omega}\right]^{-\gamma}=\lambda_t, \tag{10}$$

$$\theta h_t^{\omega-1}=(1-\alpha)\,a_t g_t^{1-\alpha}\left(\frac{k_t}{h_t}\right)^{\alpha}, \tag{11}$$

$$\lambda_t=\frac{\beta}{g_t^{\gamma}}\left[1+r_t^*+\psi\left(e^{d_t-\bar{d}}-1\right)\right]E_t\lambda_{t+1}, \tag{12}$$

$$\left[1+\phi\left(\frac{k_{t+1}}{k_t}g_t-g\right)\right]\lambda_t=\frac{\beta}{g_t^{\gamma}}E_t\lambda_{t+1}\left[\begin{array}{c}1-\delta+\alpha a_{t+1}\left(\frac{g_{t+1}h_{t+1}}{k_{t+1}}\right)^{1-\alpha}\\ +\phi\left(\frac{k_{t+2}}{k_{t+1}}g_{t+1}\right)\left(\frac{k_{t+2}}{k_{t+1}}g_{t+1}-g\right)-\frac{\phi}{2}\left(\frac{k_{t+2}}{k_{t+1}}g_{t+1}-g\right)^2\end{array}\right], \tag{13}$$

$$\frac{d_{t+1}}{1+r_t}g_t=d_t-y_t+c_t+s_t+i_t+\frac{\phi}{2}\left(\frac{k_{t+1}}{k_t}g_t-g\right)^2k_t, \tag{14}$$

$$r_t=r^*+\psi\left(e^{\widetilde{D}_{t+1}/X_t-\bar{d}}-1\right)+e^{\mu_t-1}-1, \tag{15}$$

$$k_{t+1}g_t=(1-\delta)\,k_t+i_t, \tag{16}$$

$$y_t=a_tk_t^{\alpha}\left(g_th_t\right)^{1-\alpha}. \tag{17}$$

The financial frictions version of the SOE-RBC model displays a balanced growth property given the transformation of variables as presented above and summarized in the appendix. We also tested the benchmark SOE-RBC model by excluding debt elasticity of the country risk premium and shutting off the three augmented shocks (the preference shock, the domestic spending shock and the country risk premium shock).

3 Estimation

The model is estimated using Bayesian techniques with annual South African data on output growth, consumption growth, investment growth and the trade balance to output ratio. The data used are real time series data obtained from the South African Reserve Bank's Quarterly Bulletin. Prior to estimation, real variables are de-trended.

3.1 Calibration

Table 1 lists the parameters that are calibrated prior to estimation. The discount factor β is set to 0.98 as in the real business cycle literature. The elasticity of labor supply ω is set to 1.5. The inverse of the elasticity of substitution γ is 2. The annual aggregate capital depreciation rate δ is 0.15 and is obtained from annual values of $\frac{I}{Y}$. The capital income share α is equal to 0.26 as in Liu and Gupta (2007). Parameter d is set to 0.007. The preference parameter ν is 0.3, implying that South African households prefer to spend $\frac{1}{3}$ of their time on labor.

Table 1: Calibration

Parameter	β	δ	α	γ	ν	d	ω	ϕ
Value	0.98	0.15	0.26	2	0.3	0.007	1.5	2

3.2 Prior distributions and posterior estimates

Table 2 presents the key statistics of the prior and posterior distributions of the financial frictions SOE-RBC model and the benchmark SOE-RBC model. The mean of the capital adjustment cost ϕ is set to 2 with a standard deviation of 0.1. The persistence of the AR(1) process of $\rho_a, \rho_g, \rho_\nu, \rho_s$ and ρ_μ has a mean of 0.75 and a standard deviation of 0.1. Standard deviations of the shocks $\sigma_a^2, \sigma_g^2, \sigma_\nu^2, \sigma_s^2$ and σ_μ^2 have a mean of 0.01 and a standard deviation of 0.1. The mean of the country risk premium ψ is set to 0.115 with a standard deviation of 5. As in Garcia-Cicco et al. (2010), all parameters are assumed to follow a uniform distribution. The reported posterior distributions are calculated using 2,000,000 iterations of the Monte Carlo Markov Chain (MCMC) with a burn-in of 100,000.

The posterior distributions of the estimated parameters are largely consistent with those of the prior distributions for both the financial frictions model and the benchmark model. The parameter measuring the growth rate of productivity g is estimated at 1.0067 for the financial frictions model which is marginally lower than that of 1.0136 for the benchmark model. The parameters measuring the capital adjustment costs ϕ and the country risk premium ψ are estimated at 5.0169 and 0.2203 respectively, implying relatively higher capital adjustment costs and a somewhat low responsiveness of the country risk premium to external debt. Garcia Cicco et al. (2010) find comparable results in Argentina for the parameter measuring the growth rate of productivity, but a slightly lower parameter measuring capital adjustment costs ϕ of 4.6 and a much higher parameter for the country risk premium ψ of 2.8.

Most shocks show relatively high persistence except for the shock to domestic spending ρ_s at 0.5171. The persistence of the nonstationary productivity shock ρ_g is higher in the benchmark model at 0.9684 than in the financial frictions model at 0.7824. The opposite is true for the stationary productivity shock ρ_a at 0.8939 in the benchmark model and 0.9448 in the financial frictions model. These estimates point to a relatively important role of the nonstationary productivity shock in the benchmark model, which implies that most forecast error variance in the benchmark model is explained by this shock at long horizons. The opposite is true for the financial frictions model, where the stationary productivity shock tends to be more important in explaining the error variance. Lastly, the log likelihood of the financial frictions SOE-RBC model is 518.0965, while that of the benchmark SOE-RBC model is 499.7855. Thus, we conclude that the data favor the financial frictions model over the benchmark model. The data also reinforce the observation that the posterior distributions are tighter around the mean values in the financial frictions model than in the benchmark model, suggesting relatively weak identification by the benchmark model.

Table 2: Prior and posterior distributions

Parameter description	Prior distribution Min	Max	Posterior distribution: Financial frictions model Mean	90% HPD interval		Benchmark model Mean	90% HPD interval	
Parameters								
g	1.0000	1.0300	1.0067	1.0048	1.0080	1.0136	1.0117	1.0145
ρ_g	0.0000	0.9900	0.7824	0.7424	0.8097	0.9684	0.9628	0.9782
ρ_a	0.0000	0.9900	0.9448	0.9080	0.9841	0.8939	0.8881	0.9039
ρ_v	0.0000	0.9900	0.9649	0.9580	0.9702			
ρ_s	0.0000	0.9900	0.5171	0.4348	0.6027			
ρ_μ	0.0000	0.9900	0.9550	0.9220	0.9788			
ϕ	0.0000	8.0000	5.0169	4.6700	5.3128			
ψ	0.0000	5.0000	0.2203	0.1947	0.2488			
Standard deviation of shocks								
σ_g	0.0000	0.2000	0.0118	0.0108	0.0127	0.0057	0.0052	0.0063
σ_a	0.0000	0.2000	0.0037	0.0028	0.0045	0.0103	0.0096	0.0112
σ_v	0.0000	0.1000	0.2668	0.2467	0.2882			
σ_s	0.0000	0.2000	0.1283	0.0963	0.1515			
σ_μ	0.0000	0.2000	0.0122	0.0098	0.0132			
Standard deviation of measurement errors								
σ_y^{me}	0.0001	0.0130	0.0128	0.0126	0.0130	0.0127	0.0123	0.0129
σ_c^{me}	0.0001	0.0190	0.0028	0.0017	0.0037	0.0072	0.0065	0.0083
σ_i^{me}	0.0001	0.0510	0.0472	0.0462	0.0476	0.0501	0.0491	0.0505
σ_{tby}^{me}	0.0001	0.0130	0.0042	0.0033	0.0052	0.0124	0.0121	0.0125
Log data density				518.0965			499.7855	

4 Performance of the models

4.1 Second moments

Table 3 presents the second moments of the benchmark SOE-RBC model, the financial frictions SOE-RBC model and those implied by the data. The data show that investment growth is the most volatile variable, followed by trade balance to output ratio, consumption growth, and then output growth. Both the benchmark model and the financial frictions model mimic the data well except for the trade balance to output ratio in the benchmark model, which tends to be over-estimated (126.51). This is, however, consistent with the finding by Garcia-Cicco et al. (2010), who report a second moment of the trade balance to output ratio of 106.6 for Argentina. This is also in line with the findings in Aguiar and Gopinath (2007) for most emerging economies.

Table 3: Second moments, South Africa 1947–2014

Statistic	g^y	g^c	g^i	tby
Standard deviation				
Data	2.19	2.56	8.17	4.96
	(0.02)	(0.03)	(0.08)	(0.05)
Financial frictions model	6.23	10.29	16.42	13.78
Benchmark model	7.42	8.03	15.52	126.51
Correlation with g^y				
Data	1.00	0.63	0.54	0.07
	(0.00)	(0.02)	(0.07)	(0.05)
Financial frictions model	1.00	0.55	0.23	- 0.02
Benchmark model	1.00	0.86	0.73	- 0.02
Serial correlation				
Data	0.39	0.44	0.48	0.88
	(0.02)	(0.02)	(0.07)	(0.02)
Financial frictions model	0.02	- 0.07	- 0.10	0.84
Benchmark model	0.39	0.17	0.05	1.00

The correlation of output, in growth terms, with consumption and investment is positive in the data, and the correlation of output with the trade balance to output ratio is also positive even though it is almost zero. The benchmark model and financial frictions model show a positive correlation of output with consumption and investment and a slightly negative correlation of nearly zero with the trade balance to output ratio. This result is consistent with the findings in the literature. For instance, Aguiar and Gopinath (2007) find that the correlation of output with the trade balance to output ratio is 0.51 on average for emerging markets. Garcia-Cicco et al. (2010) also find a negative correlation of output with the trade balance to output ratio for Argentina and Mexico.

Compared with findings in related literature, both models perform reasonably well in terms of mimicking the correlation of output with the trade balance to output ratio for South Africa. The data show a significant positive autocorrelation of output growth, consumption growth, investment growth and trade balance to output ratio. The benchmark model reproduces a positive serial correlation of all variables, while the financial frictions model reproduces a positive autocorrelation of output growth and the trade balance to output ratio only.

4.2 Autocorrelation functions of the trade balance to output ratio

Figure 2 reports the autocorrelation functions of the trade balance to output ratio implied by the data and those implied by the benchmark SOE-RBC model and the financial frictions SOE-RBC model. The autocorrelation function predicted by the data is around 0.85 at the lag of 1 and deceases monotonically up to the lag of 4. The financial frictions model successfully reproduces the downward sloping high autocorrelation of the trade balance to output ratio observed in the data. The benchmark model, on the other hand, predicts the autocorrelation function that is close to unity up to the lag of 4, which implies a random walk. This is consistent with the finding by Garcia-Cicco et al. (2010) for Argentina. As argued by those authors, the autocorrelation function of the trade balance to output ratio that is flat and close to unity is not due to the presence of nonstationary productivity shocks, because keeping all the other parameters unchanged and reducing the value of the standard deviation of the nonstationary productivity shock σ_g to zero still achieves a flat autocorrelation function of the trade balance to output ratio.

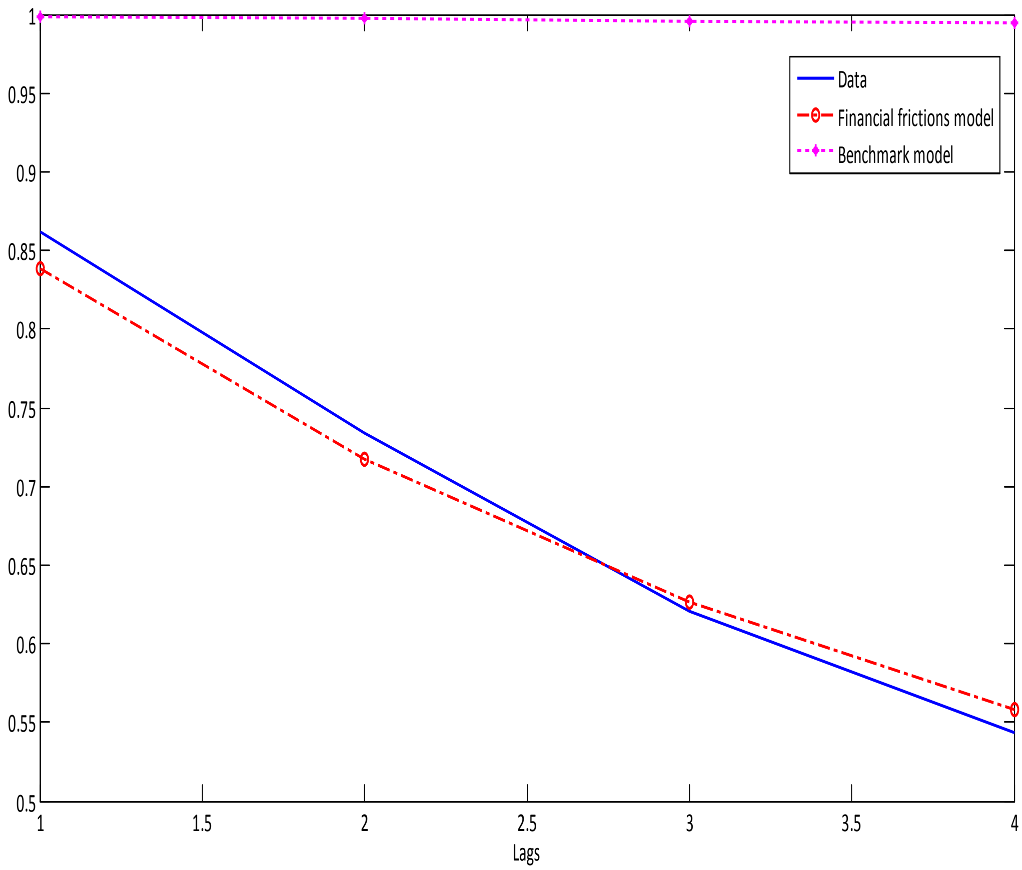

Figure 2: Predicted autocorrelation functions of the trade balance to output ratio

According to Garcia-Cicco et al. (2010), the autocorrelation function of the trade balance to output ratio that is flat and close to unity as predicted by the benchmark SOE-RBC model is a robust finding in emerging markets. This is because a relatively small value was assigned to the parameter that governs the sensitivity of the country risk premium ψ, which ensures the stationarity of the equilibrium. Garcia-Cicco et al. (2010) suggest a variety of ways to modify the benchmark SOE-RBC model to eliminate the near random walk behavior of the trade balance to output ratio. One way is to raise the value of the parameter that governs the sensitivity of the country risk premium. The other is to adopt either a higher subjective discount factor or a higher cost of adjusting the net foreign asset position, as done by Schmitt-Grohe and Uribe (2003) and Uribe and Yue (2006), respectively. Introducing these modifications into the benchmark SOE-RBC model will cause the net foreign debt position to rise, resulting in an increase in the country risk premium as the risk of a default increases, which then causes a decrease in the trade balance to output ratio by encouraging domestic savings and discouraging private investment.

In this study, the downward sloping trade balance to output ratio is achieved by introducing financial frictions into a standard SOE-RBC model. This approach differs from the standard SOE-RBC model by augmenting other sources of uncertainty such as shocks to domestic preference, spending and the country risk premium. This allows us to estimate the parameter that governs the sensitivity of the country risk premium, rather than fixing it as in the benchmark model, so that we can see how the model responds to aggregate disturbances. These augmented financial frictions enable the SOE-RBC model to reproduce a downward sloping autocorrelation function similar to that predicted by the data.

4.3 Variance decompositions

Table 4 presents the variance decompositions predicted by the financial frictions SOE-RBC model and the benchmark SOE-RBC model. The results show that fluctuations in output growth, consumption growth, investment growth and the trade balance to output ratio are mainly driven by nonstationary productivity shocks in the financial frictions model, while stationary productivity shocks play an equally important role in explaining business cycle fluctuations in the benchmark model. In particular, the estimated results from the financial frictions model show that the nonstationary productivity shock explains 87.76% of the fluctuations in output growth while its impact is 43.63% in the benchmark model. Even though the stationary productivity shock is more persistent than the nonstationary one, as suggested by the posterior estimates, it is the latter that explains most of the fluctuation in output growth in the financial frictions model. The stationary productivity shock only predicts about 4.27% of the output growth fluctuations in the financial frictions model. Finally, the domestic spending shock plays a relatively small role in explaining the fluctuations in all variables.

It is worth pointing out that in the financial frictions model the nonstationary productivity shock is only important in explaining the fluctuations in output growth where fluctuations in consumption growth are mainly explained by the preference shock. Variations in the trade balance to output ratio are mainly driven by the country risk premium shock and the preference shock. The country risk premium shock is the main driving force for the fluctuations in investment growth. Comparing the benchmark model with the financial frictions model, we find that in the former it is the stationary productivity shock that explains most of the dynamics of consumption growth, investment growth and trade balance to output ratio, which is consistent with the real business cycle literature. This implies that financial frictions play a significant role in explaining the fluctuations in investment growth and trade balance to output ratio.

Table 4: Variance decomposition

Shock	g^y	g^c	g^i	tby
Nonstationary tech.				
Financial frictions model	87.76	30.54	9.23	13.47
Benchmark model	43.63	18.89	11.59	4.13
Stationary tech.				
Financial frictions model	4.27	1.35	0.44	0.16
Benchmark model	56.37	81.11	88.41	95.87
Preference				
Financial frictions model	0.30	61.06	0.60	55.50
Benchmark model				
Country premium				
Financial frictions model	7.67	7.03	89.73	30.84
Benchmark model				
Domestic spending				
Financial frictions model	0.00	0.01	0.00	0.04
Benchmark model				

The most important finding in this study is that both models overwhelmingly support the cycle is the trend hypothesis (Aguiar and Gopinath, 2007), or the stochastic trend hypothesis (Chang and Fernandez, 2013). This implies that South Africa is subject to extremely volatile shocks to its stochastic trend. This finding is consistent with the findings by Aguiar and Gopinath (2007) and Bolaños and Wishart (2012), and contrasts with the findings by Garcia-Cicco et al. (2010) for Argentina and Chang and Fernandez (2013) for Mexico. Although findings of the literature on the cycle is the trend hypothesis are mixed, most of the studies support this hypothesis in emerging markets. Using a New Keynesian model similar to that used by Christiano et al. (2005), Cao et al. (2014) find that consumption is almost entirely explained by the nonstationary productivity shock. Miyamoto and Nguyen (2015) come to the same conclusion using panel methods for 10 developing economies and 7 small developed economies. Chang and Fernandez (2013) argue that trend shocks add relatively little to the ability of SOE- RBC models to explain fluctuations in the business cycles of emerging markets when compared with models with financial frictions.

5 Conclusion

By estimating a standard SOE-RBC model and its financial frictions augmented counterpart we show that both models overwhelmingly support the cycle is the trend hypothesis in South Africa's business cycles. Introducing financial frictions into a standard SOE-RBC model successfully mimics the downward-sloping autocorrelation of the trade balance to output ratio observed in the data, where the benchmark model produces a flat autocorrelation function. Moreover, the results show that financial frictions, such as country risk premium shocks, play an important role in explaining the fluctuations in investment and the trade balance to output ratio.

References

Aguiar, M., Gopinath, G., 2007. Emerging market business cycles: the cycle is the trend. Journal of Political Economy 115 (1), 69–102.

Bolaños, A. O., Wishart, J., 2012. Trend shocks and financial frictions in small open economies modeling. Mexico, D.F., Centre for Latin American Monetary Studies Working Paper, No. 5.

Cao, D., L'Huillier, J., Yoo, D., 2014. The New Keynesian model and the Small Open Economy RBC model: equivalence results for consumption. Washington D.C., Georgetown University, mimeo.

Chang, R., Fernandez, A., 2013. On the sources of aggregate fluctuations in emerging economies. International Economic Review 54 (4), 1265–1293.

Christiano, L., Eichenbaum, M. and Evans, C. 2005. Nominal rigidities and the dynamic effects of a shock to monetary policy. Journal of Political Economy 113 (1), 1–45.

Friedman, M., The permanent income hypothesis. In: Friedman, M., A theory of the consumption function. Princeton, N.J., Princeton University Press, pp. 20–37.

http://www.nber.org/chapters/c4405.pdf.

Garcia-Cicco, J., Pancrazi, R. and Uribe, M. 2010. Real business cycles in emerging countries? The American Economic Review 100 (5), 2510–2531.

Liu, G., Gupta, R., 2007. A small scale DSGE model for forecasting the South African economy. South African Journal of Economics 75 (2), 1–15.

Mendoza, E., 1991. Real business cycles in a small open economy. American Economic Review

81 (4), 797–818.

Miyamoto, W., Nguyen, T. 2015. Business cycles in small open economies: evidence from panel data between 1900 and 2013. International Economic Review, forthcoming.

Schmitt-Grohe, S., Uribe, M., 2003. Closing small open economy models. Journal of International Economics 61 (1), 163–185.

Stock, J., Watson, M., 2005. Understanding changes in international business cycle dynamics. Journal of the European Economic Association 3 (5), 968–1006.

Uribe, M., Yue, V. Z., 2006. Country spreads and emerging countries: who drives whom? Journal of International Economics 69 (1), 6–36.

Appendix

This appendix recaps the full nonlinear financial frictions SOE-RBC model consisting of 19 endogenous variables and 5 exogenous AR(1) stochastic shock process. The 19 endogenous variables in the financial frictions model are as follows:

$C_t, K_t, a_t, h_t, D_t, Y_t, S_t, I_t, r_t, r^*, g_t, tb_t, tb\_y_t, g\_y_t, g\_c_t, g\_invest_t, \lambda_t, \mu_t, \nu_t,$

These variables jointly solve the following 19 equations.

Households:

$$\nu_t \left[\frac{C_t}{X_{t-1}} - \theta \omega^{-1} h_t^{\omega} \right]^{-\gamma} = \lambda_t. \tag{A.1}$$

$$\lambda_t = \beta \frac{1 + r_t}{g_t^{\gamma}} E_t \lambda_{t+1}. \tag{A.2}$$

Market clearing conditions:

$$\nu_t \left[c_t - \theta \omega^{-1} h_t^{\omega} \right]^{-\gamma} = \lambda_t. \tag{A.3}$$

$$\theta h_t^{\omega - 1} = (1 - \alpha) a_t g_t^{1-\alpha} \left(\frac{k_t}{h_t} \right)^{\alpha}. \tag{A.4}$$

$$\lambda_t = \frac{\beta}{g_t^{\gamma}} \left[1 + r_t^* + \psi \left(e^{d_t - \bar{d}} - 1 \right) \right] E_t \lambda_{t+1}. \tag{A.5}$$

$$\left[1+\phi\left(\frac{k_{t+1}}{k_t}g_t-g\right)\right]\lambda_t=\frac{\beta}{g_t^{\gamma}}E_t\lambda_{t+1}\left[\begin{array}{c}1-\delta+\alpha a_{t+1}\left(\frac{g_{t+1}h_{t+1}}{k_{t+1}}\right)^{1-\alpha}\\ +\phi\left(\frac{k_{t+2}}{k_{t+1}}g_{t+1}\right)\left(\frac{k_{t+2}}{k_{t+1}}g_{t+1}-g\right)-\frac{\phi}{2}\left(\frac{k_{t+2}}{k_{t+1}}g_{t+1}-g\right)^2\end{array}\right]. \tag{A.6}$$

$$\frac{d_{t+1}}{1+r_t}g_t=d_t-y_t+c_t+s_t+i_t+\frac{\phi}{2}\left(\frac{k_{t+1}}{k_t}g_t-g\right)^2k_t. \tag{A.7}$$

$$r_t=r^*+\psi\left(e^{\widetilde{D}_{t+1}/X_t-\overline{d}}-1\right)+e^{\mu_t-1}-1. \tag{A.8}$$

$$k_{t+1}g_t=(1-\delta)\,k_t+i_t. \tag{A.9}$$

$$y_t=a_tk_t^{\alpha}\left(g_th_t\right)^{1-\alpha}. \tag{A.10}$$

Definitions:

$$\log tb\_y_t=\log\frac{tb_t}{y_t}. \tag{A.11}$$

$$g\_y_t=\left(\frac{y_t}{y_{t-1}}\right)g_{t-1}. \tag{A.12}$$

$$g\_c_t=\left(\frac{c_t}{c_{t-1}}\right)g_{t-1}. \tag{A.13}$$

$$g\_invest_t=\left(\frac{invest_t}{invest_{t-1}}\right)g_{t-1}. \tag{A.14}$$

Exogenous AR(1) shock processes:

$$lna_{t+1}=\rho_a\ln a_t+\epsilon_{a,t+1}. \tag{A.15}$$

$$ln\frac{g_{t+1}}{g}=\rho_g\ln\frac{g_t}{g}+\epsilon_{g,t+1}. \tag{A.16}$$

$$\ln\nu_{t+1}=\rho_\nu\ln\nu_t+\epsilon_{\nu,t+1}. \tag{A.17}$$

$$\ln \frac{s_{t+1}}{s} = \rho_s \ln \frac{s_t}{s} + \epsilon_{s,t+1}. \tag{A.18}$$

$$\ln \mu_{t+1} = \rho_\mu \ln \mu_t + \epsilon_{\mu,t+1}. \tag{A.19}$$