Essays on Small Open Economies

Dissertation

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Abstract

This dissertation research puts a focus on small open economies, whose policies do not affect world prices and interest rates. In the first chapter, it is shown that recent Canadian data from 2001 to 2013 feature a notable procyclical trade balance, which contrasts with the countercyclical trade balance in 1981-2000. By using a dynamic small open economy model built based upon Mendoza's (1991) framework, driven by correlated domestic productivity shocks and world credit spread shocks, I can generate the observed trade balance pattern in the pre-2000 and post-2000 periods. In addition, my analysis shows that the world credit spread shocks explain a large portion of the considerable change in the cyclicality of trade balance, and that the low world real risk-free interest rate after 2000 partially accounts for the procyclical trade balance in the same time period. Applications of the model to other developed small open economies, such as Australia and New Zealand, yield similar results, suggesting that the world credit spread shocks have an impact on macroeconomic dynamics and help improve model performance.

The second chapter concerns an innovative exchange rate policy implemented by the Reserve Bank of Australia (RBA). From 2013 to mid-2015, in order to achieve balanced economic growth, the RBA tried to bring down the Australian dollar by presenting public speeches and monetary policy statements that expressed a strong preference for a lower exchange rate, which is known as jawboning down the currency.
To investigate the effectiveness of the central bank's jawboning strategy, I analyze the Australian economy with a structural vector autoregressive (SVAR) model, in which the Exchange Rate Stance Index (ERSI) is constructed to measure the magnitude of jawboning. The empirical results show that an unanticipated increase in the ERSI, which is equivalent to strengthened jawboning by the RBA, will lead to a significant and lasting fall in the real exchange rate. However, the ERSI shock fails to improve GDP over the medium term, suggesting that the jawboning strategy is not an effective exchange rate policy tool to boost GDP growth.

The third chapter investigates how the global and local financial shocks would contribute to the large fluctuations of the unemployment rates in the emerging markets. We use a panel structural vector autoregressive (VAR) model to analyze monthly data from six emerging countries between 1999 and 2015. The results show that the local financial risk factors, including the country spread and the dividend yield, account for a larger portion of unemployment movements than the global financial risks, including the U.S. risk-free real interest rate and the global financial risk proxied by the U.S. Baa corporate spread.
This is dedicated to my father, Liuhan Zhong, who constantly encourages me to pursue the PhD study, and to my mother Qiai, my parents-in-law Zuojun and Weiping, my wife Yisi and my daughters Sophie and Athena, who support me wholeheartedly.
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Chapter 1: The Effect of World Credit Spread Shocks on Business Cycles in A Small Open Economy

Introduction

The cyclicity pattern of Canada’s trade balance has evolved over the past few decades. Mendoza (1991) points out that the correlation between output and the ratio of trade balance over output was -0.13 in the post-war period 1946-1985 for Canada. From 1981 to late 1990s, Canada’s trade balance remained countercyclical (see Figure 1). However, the trade balance turned procyclical since late 1990s, as can be seen from Figure 1. The change in the cyclicity is even more pronounced for the current account (see Figure 1 and Table 1). This raises the question that what could have caused the change in the cyclicity of Canada’s trade balance. The first candidate that comes to mind is the world real interest rate shocks, as changes in the world interest rate can affect domestic households’ consumption decision and portfolio allocation decision between domestic capital and foreign assets.

The effects of world real interest rate shocks on a small open economy have been discussed in recent macroeconomic literature, yet there is no agreement whether the effects are important in explaining model dynamics. On one hand, Mendoza (1991), Correia, Neves, and Rebelo (1995), and Schmitt-Grohé (1998) suggest that the world interest rate shocks

---

\[\text{Footnote: Ledendre (2004) also shows that the trade balance and current account of Canada are countercyclical in the 1981-2001 period. The correlation between output and trade balance ratio, and that between output and current account ratio, are -0.29 and -0.26, respectively. The results are slightly from those in this paper because Ledendre (2004b) uses the Hodrick-Prescott filter with the smoothing parameter of 1600 on quarterly data while I follow Mendoza (1991) and use the quadratic detrending method on annual data.}\]
Figure 1. Canada’s Output and Trade Balance/Current Account, 1981-2013

Note: The data is per capita, logged (except for the ratio of trade balance/current account over output) and detrended by the quadratic filter.

have minimal effects on the model performance. On the other hand, Blankenau, Kose, and Yi (2001), Nason and Rogers (2003) and Letendre (2004a) argue that the shocks to the world interest rate can improve their model fits; Letendre (2004b) finds that the world interest rate shocks can sometimes, but not always, improve model performance, depending on model specifications. Furthermore, Uribe and Yue (2006), and Neymeyer and Perri (2005) both point out that, the country spreads play an important role in business cycle fluctuations in emerging countries.

In order to investigate the impact of the world real interest rate shocks on the cyclicity of trade balance, I split the full sample of Canadian data into two sub-samples: 1981-2000 and 2001-2013, during which the trade balance has changed from countercyclical to procyclical (see Table 1). The sample cut-off year is not entirely arbitrary. It is set

2The change in the cyclicity of trade balance is robust to a different cut-off year that is a few years before or after the year 2000.
at the year 2000 to ensure the volatilities of the world interest rate shocks are similar in the two sub-samples, so that the possibility that the change of trade balance cyclicality is due to different variabilities of the world interest rate disturbances in the two samples is eliminated.

In this paper, the world real interest rate is decomposed into two components: the risk-free rate and the credit spread, which is the difference in yield between a risky asset and a risk-free asset. The risk-free rate faced by Canada is assumed to be constant, as is common in the literature due to its low volatility. It is represented by Canada’s bank rate. The credit spread is assumed to be stochastic and it is approximated by the U.S. Aaa 1-year corporate bond yield spread. Thus, the shocks to the world interest rate are essentially equivalent to the shocks to the credit spread.

From the data, it is shown that there is a mildly positive correlation between Canada’s detrended TFP and the world credit spread shocks in the 1981-2000 period while there is a strong negative correlation between the two in the 2001-2013 period (see Figure 2).

Table 1. Correlation between Canada’s Output and Trade Balance in Different Periods

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>Trade-balance-over-output ratio</td>
<td>-0.13</td>
<td>-0.22</td>
<td>0.30</td>
</tr>
<tr>
<td>Trade-balance-over-output ratio N/A</td>
<td>-0.12</td>
<td>0.92</td>
<td></td>
</tr>
</tbody>
</table>

Contemporaneous Correlations with Output:

Mendoza (1991)
Figure 2. Canada’s TFP and U.S. Corporate Credit Spread

*Note:* Canada’s TFPs are constructed as Solow residuals as described in the Appendix. They are logged and detrended by the Hodrick-Prescott filter with smoothing parameter 50. The U.S. corporate credit spread is derived from data from the Economic Research website of the Federal Reserve Bank of St. Louis and the Reuters corporate bond spread tables.
Figure 3. The Financial Cycle and Business Cycles in the United States
*Source:* Drehmann, Borio, and Tsatsaronis (2012)
One possible explanation as to why the correlation has changed significantly around the year 2000 may lie in the interaction of the financial cycle and the business cycle. Drehmann, Borio, and Tsatsaronis (2012) define and characterize the financial cycle and compare it with the business cycle (see Figure 3). As suggested by Voss (2004), the Canadian business cycle is highly correlated with the U.S. business cycle.\(^3\) Thus, the U.S. business cycle can be used to approximate the Canadian business cycle. Furthermore, since Canada has a large negative net international investment position in the United States,\(^4\) it is reasonable to use the U.S. capital market as a proxy for the world market environment faced by Canada. As a result, it is sensible to use Figure 3 to illustrate the comovement between the Canadian business cycle and the world financial cycle. Figure 3 clearly shows that from 1981 to early 2000s, in the boom (bust) phase of the financial cycle, there are both ups and downs of the business cycle; while from early 2000s on, the boom (bust) phase of financial cycle coincides with the boom (bust) phase of the business cycle. The latter period is of particular interest. The boom phase of the business cycle is accompanied by positive TFP shocks; and the boom phase of the financial cycle leads to expanding credit and low credit risk, giving rise to negative credit spread shocks. This results in a strong negative correlation between domestic TFP shocks and world credit spread shocks.

The correlation between TFP shocks and world credit spread shocks can potentially affect the trade balance cyclicality. The effects of TFP shocks and credit spread shocks are examined individually. First, for the TFP shocks, when Canada experiences a positive productivity shock, the households will have a spike in income; as a result, they will smooth their intertemporal consumption by increasing savings, which indicates they will increase investments in both domestic capital and foreign assets. The increase in foreign assets can

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\(^3\)In the two sub-sample periods of 1981-2000 and 2001-2013, the correlations between U.S. and Canada’s detrended output are 0.94 and 0.97, respectively.

\(^4\)At the end of 2011, Canada had 45.4% of its foreign assets and 60% of its foreign liabilities in the U.S. (Statistics Canada, CANSIM Table 376-0037)
be viewed as the income effect of the TFP shock. At the steady state, the return on domestic capital minus the depreciation rate is equal to the return on foreign assets. And the positive TFP shock will made domestic capital more attractive than the foreign assets and thus the substitution effect will cause the households to reallocate their portfolio by selling some of their foreign assets and increasing domestic capital investments. Generally, the substitution effect dominates the income effect and the TFP shock will result in a reduction of foreign asset holdings. But in rare cases, for instance, when the interest rate is close to zero, the substitution effect will become minimal. The reason is that under a very low interest rate level, as households try to increase domestic capital, the capital adjustment costs will quickly outweigh the benefits of an improvement in the marginal product of capital due to the TFP shock. With the substitution effect being smaller than the income effect, the TFP shock can lead to an accumulation of foreign assets.

Second, for the world credit spread shocks, when a positive credit spread shock occurs, it indicates the default risks for foreign bonds have increased, which effectively lowers the return on the bonds. This makes domestic capital more appealing to Canadian households, and thus they will reduce their foreign asset positions and increase the investments in domestic capital.

When the TFP shocks and the world credit spread shocks hit the economy simultaneously, their combined effects on the repositioning of foreign assets will determine whether there is a net capital outflow or a net capital inflow for Canada. A net increase in foreign assets, equivalent to a net capital outflow, must be balanced by a trade surplus, according to economic theory. Likewise, a net decrease in foreign assets must be balanced by a trade deficit. In extreme cases, suppose there is a perfectly positive correlation between the TFP shocks and the world credit spread shocks. Under normal interest rate levels (far from zero interest rate), a positive TFP shock leads to above-trend output and a decrease in foreign
assets, and thus a trade deficit. A positive credit spread shock also leads to a downsize of foreign investments, and thus a trade deficit. It is therefore predicted that highly positively correlated shocks will more likely cause a countercyclical trade balance. On the other hand, suppose there is a perfectly negative correlation between the two shocks. When the interest rate is far from zero, a positive TFP shock causes a cutback in foreign assets and a negative credit spread shock causes an increase in foreign assets. The net effect is hence ambiguous. But when the interest rate is near zero, the positive TFP shock could cause an increase in foreign asset purchase. Together with the credit spread shock, it is predicted that foreign asset holding will increase and thus a trade surplus. It follows that highly negatively correlated shocks will more likely cause a procyclical trade balance at near-zero interest rate levels.

This paper shows that the empirical results support the above theoretical reasoning. For one, the world credit spread shocks indeed have significant effects on the cyclicality of trade balance. In particular, the larger the negative (positive) correlation between the TFP shocks and the credit spread shocks, the more procyclical (countercyclical) is the trade balance generated by the model. For another, when the real risk-free interest rate is close to zero, the households would purchase foreign assets at the impact date of a positive TFP shock, which leads to a larger trade surplus. That is, the procyclical trade balance in the post-2000 period is partially explained by the low real risk-free interest rate level in the same period.

Existing literature has shown that dynamic small open economy models can successfully explain many important stylized facts observed in the data, including the countercyclical trade balance in some of the developed and developing countries. For example, Mendoza (1991) and Correia, Neves, and Rebelo (1995) both successfully generate slightly countercyclical trade balance in their models. Letendre (2004b) shows that a small open
economy model with the added features of endogenous capital utilization and habit formation can improve the model fit and produce sufficiently large countercyclical trade balance. Recent work by Guo and Janko (2009) proposes a modified model with endogenous capital utilization and habit formation in labor hours, which has success in producing large countercyclical trade balance as well.\(^5\)

Although these models provide satisfactory results of matching many of the empirical regularities in a small open economy, the new challenge is to reproduce countercyclical trade balance consistent with the Canadian data in 1981-2000, as well as procyclical trade balance in 2001-2013. I find that once the world credit spread shocks that correlate with the productivity shocks are introduced in the model, it can reproduce the observed trade balance pattern in the two different sample periods.

In this paper, the model is built upon Mendoza’s (1991) canonical small open economy model. The model has the following main features: Greenwood, Hercowitz and Huffman (GHH, 1988) utility function, correlated productivity shocks and world credit spread shocks and convex capital adjustment costs. This model can generate many of the business cycle moments that match the observed data. More importantly, it reproduces the countercyclical trade balance in the 1981-2000 period and the sufficiently procyclical trade balance in the 2001-2013 period. A further testing of the model by applying it to the Australia and New Zealand’s economies shows that the model produces satisfactory results and outperforms Mendoza’s (1991).

This paper is organized as follows. Section 2 presents the model economy and defines the equilibrium conditions. Section 3 describes the data and calibrates the model’s structural parameters. Section 4 discusses the quantitative results. Section 5 tests the model performance on Australia and New Zealand and Section 6 concludes.

\(^5\) All models from Mendoza (1991), Letendre (2004b) and Guo and Janko (2009) are calibrated to Canadian data.
The Small Open Economy

The main building blocks of the model analyzed in this paper come from Mendoza’s (1991) one-sector, dynamic small open economy model with technological disturbances and capital adjustment costs. The new feature I incorporate into the model is the world credit spread shocks that are correlated to the technological shocks.

Preference and Technology

The economy has a unit measure of identical and infinitely-lived households, who are endowed with one unit of time. The households’ preferences can be described by the utility function as follows:

\[
E_0 \sum_{t=0}^{\infty} \theta_t U(c_t, h_t)
\]

\[
\theta_0 = 1
\]

\[
\theta_{t+1} = \beta(c_t, h_t) \theta_t, t \geq 0
\]

where \(E_0\) denotes the expectation operator conditional on information at time \(t = 0\). \(\theta_t\), \(c_t\) and \(h_t\) denote the subjective discount factor, consumption and labor, respectively. This Uzawa (1968) endogenous time preference was used in Mendoza (1991) and explained in Schmitt-Grohé and Uribe (2003) as one approach to close the model, such that the steady-state is independent of initial conditions. I follow Mendoza (1991) and use GHH preferences. The functional forms for the utility function and the subjective discount factor are as follows:
where $\gamma$ is the risk aversion coefficient, $\omega$ is the intertemporal elasticity of substitution in labor supply. Since $\beta_1 > 0$, $\beta_c$ is negative and $\beta_h$ is positive, implying the function $\beta(\cdot)$ decreases in consumption and increases in labor. Thus, an increase in consumption will lower the marginal utility as well as the subjective discount factor; and accordingly, future consumption will increase less due to the impatient effect caused by the smaller discount factor.

The adoption of the GHH utility has several advantages. Correia, Neves, and Rebelo (1995) point out that the class of small open economy models utilizing GHH preferences can provide better model fits than standard preferences used in Hansen’s (1985) model. Furthermore, with GHH utility specification, there is no wealth effect on the labor supply and the labor decision only depends on the real wage rate.

In each period, the representative household is subject to the following budget constraint:

$$
    c_t + i_t + \Phi(k_{t+1} - k_t) + b_{t+1} = y_t + (1 + r_t)b_t
$$

where $k_t$ is physical capital and $i_t$ is investment in physical capital, and $b_t$ is the international asset obtained at $t - 1$ that receives a payoff of $1 + r_t$ at time $t$. In this paper, I define
the international asset as a composition of a large number of various international bonds including risk-free government bonds and risky municipal and corporate bonds. As a result, it will have the following features: 1) it has a higher expected return than the risk-free bond due to additional risk premium, 2) the return on the foreign composite asset depends on the international financial market condition - when a positive credit spread shock hits the international market, market conditions worsen and the default rates for risky bonds become higher, and consequently, the return from the composite bond purchased in the previous period will be lower at the current period.

The output $y_t$ is produced using the Cobb-Douglas production function commonly used in the real business cycle literature:

$$y_t = z_t k_t^\alpha h_t^{1-\alpha}, 0 < \alpha < 1$$

(7)

where $z_t$ denotes the technology shock and $\alpha$ is the capital’s share in output.

The law of motion for capital is:

$$k_{t+1} = i_t + (1 - \delta)k_t$$

(8)

where $\delta$ is the capital depreciation rate.

$\Phi(k_{t+1} - k_t)$ represents the capital adjustment costs. Mendoza (1991) shows that moderate adjustment costs for capital stock can improve the model such that it better matches the stylized facts of business cycles. I use the same functional form of capital adjustment costs as in Mendoza (1991):
\( \Phi(k_{t+1} - k_t) = \frac{\phi}{2}(k_{t+1} - k_t)^2, \phi > 0 \) \hfill (9)

where \( \phi \) is the capital adjustment cost parameter.

Let \( \eta_t \) and \( \lambda_t \) denote the Lagrange multipliers on equations (2.3) and (2.6). The first order conditions and the associated transversality conditions (TVC) are:

\[
[c_t]: \quad \lambda_t = U_c(c_t, h_t) - \eta_t \beta_c(c_t, h_t) \hfill (10)
\]

\[
[h_t]: \quad -U_h(c_t, h_t) + \eta_t \beta_h(c_t, h_t) = \lambda_t z_t(1 - \alpha)k_t^{\alpha}h_t^{-\alpha} \hfill (11)
\]

\[
[k_{t+1}]: \quad \lambda_t [1 + \Phi'(k_{t+1} - k_t)] = \beta(c_t, h_t)E_t[\lambda_{t+1}z_{t+1}\alpha k_{t+1}^{\alpha - 1}h_{t+1}^{1-\alpha} + 1 - \Phi'(k_{t+2} - k_{t+1})] \hfill (12)
\]

\[
[b_{t+1}]: \quad \lambda_t = \beta(c_t, h_t)E_t[\lambda_{t+1}(1 + r_{t+1})] \hfill (13)
\]

\[
[\theta_{t+1}]: \quad \eta_t = -E_tU(c_{t+1}, h_{t+1}) + E_t[\eta_{t+1}\beta(c_{t+1}, h_{t+1})] \hfill (14)
\]

\[
TVC_1: \quad \lim_{j \to \infty} E_t \left[ \frac{b_{t+j}}{\prod_{s=0}^{j-1}(1 + r_{t+s})} \right] \geq 0 \hfill (15)
\]

\[
TVC_2: \quad \lim_{j \to \infty} E_t[\theta_{t+j}\lambda_{t+j}k_{t+1+j}] = 0 \hfill (16)
\]

The optimal labor supply decision is given by (2.10) and (2.11):

\[
h_t^{\omega-1} = (1 - \alpha)z_t k_t^{\alpha} h_t^{-\alpha} \quad \hfill (17)
\]

This clears states that the labor supply depends only on the marginal productivity of labor and is independent of wealth.
The Shock Processes

Before specifying the shock processes, I define the interest return on the foreign composite bond by the following equation:

\[ r_t = r^f + \bar{r}^{cs} - \mu \hat{r}_t^{cs} \]

where \( r^f \) is the constant risk-free interest rate faced by Canada, \( \bar{r}^{cs} \) is the sample average credit spread between the risk-free bond and the risky composite bond, and \( \hat{r}_t^{cs} \) is the deviation from the steady-state credit spread. Because the credit spread is a small number close to zero, one basis point increase in the credit spread is approximately equal to one basis point decrease in the ex-post return from the bond obtained in the last period. This explains the minus sign before the credit spread deviation. Lastly, \( \mu \) is the proportion of the credit spread explained by default risk. There are two components, namely the default component and the non-default component, that explain the credit spread. As suggested by Longstaff, Mithal and Neis (2005), the non-default component of credit spread, which is mainly the liquidity premium, can account for 49% of the credit spread for Aaa/Aa-rated bonds. The liquidity premium, in this paper, does not affect the return on the composite bond, as the bond is held until its maturity and no transactions are involved. In other words, when a credit spread shock occurs, only part of it is attributed to default risk, and thus the decrease in the ex-post return on the composite risky bond due to higher default rates is not as large as it initially appears. Empirically, \( \mu \) is time-varying during different economic times. For example, Bao, Pan and Wang (2011) demonstrate that the liquidity risk overshadowed the credit risk for high-rated bonds during the 2008 financial crisis. However, for simplicity reasons, I assume the default risk, as well as the liquidity premium, is a fixed proportion of
the credit spread.

The small open economy is driven by two exogenous shock processes, which are the domestic productivity shocks and the world credit spread shocks.

The joint processes are given by:

\[
\begin{pmatrix}
\hat{z}_{t+1} \\
\hat{r}^{cs}_{t+1}
\end{pmatrix} =
\begin{pmatrix}
\rho_z & 0 \\
0 & \rho_{cs}
\end{pmatrix}
\begin{pmatrix}
\hat{z}_t \\
\hat{r}^{cs}_t
\end{pmatrix} +
\begin{pmatrix}
\varepsilon^z_{t+1} \\
\varepsilon^{cs}_{t+1}
\end{pmatrix}
\tag{18}
\]

where \( \hat{z}_t \) and \( \hat{r}^{cs}_t \) denote the percentage deviation from the steady state of \( z_t \) and \( r^{cs}_t \), respectively. \( \rho_z \) and \( \rho_{cs} \) are the coefficients, and \( \sigma^2_z \) and \( \sigma^2_{cs} \) are the variances on the AR(1) processes for productivity and credit spread, respectively. The innovations in the two AR(1) processes are allowed to correlate with each other. This correlation is to mimic the comovement pattern between Canada’s TFP processes and the fluctuations of credit spread in the international market. As illustrated in Figure 2, there is a strong negative correlation between TFP and world credit spread since the early 2000s.

How I handle the interest rate disturbance process is different from Mendoza (1991) in that the interest rate in my paper has a constant risk-free rate component for the composite bond and a variant credit spread component that is correlated to the domestic productivity disturbance, while Mendoza (1991) assumes an interest rate disturbance process that is independent from the productivity process.

**Competitive Equilibrium**

A competitive equilibrium is a set of quantities \( \{c_t, h_t, y_t, i_t, k_{t+1}, b_{t+1}\}_{t=0}^{\infty} \) and prices \( \{r_t, \lambda_t, \eta_t\}_{t=0}^{\infty} \), which satisfies (2.6) - (2.14) and the transversality conditions (2.15) and (2.16), given initial conditions \( z_0, k_0 \) and \( b_0 \), and the disturbances (2.18), such that households maximize
utility and all markets clear.

I use perturbation methods to solve the general equilibrium model. The numerical solution is based on second-order Taylor approximation.

**Data and Calibration**

The data used in this paper are taken from the Canadian Socio-economic Information and Management (CANSIM) database. All the data series including output, consumption, investment, employment and trade balance, are annual observations divided by Canada’s population, then logged (except for the trade balance over output ratio) and detrended by the quadratic detrending method. The credit spread data for U.S. bonds come from the Economic Research website of the Federal Reserve Bank of St. Louis and the Reuters corporate bond spread tables.

The values of structural parameters are calibrated so that the model is roughly consistent with some of the key empirical regularities in Canadian’s economy over the two sample periods of 1981-2000 and 2001-2013. As is in Mendoza (1991), the capital share of output, $\alpha$, is set to be 0.32; the relative risk aversion coefficient, $\gamma$, is set at 2; and the value of $\omega$, which governs the intertemporal elasticity of substitution in labor supply, is chosen to be 1.455. The capital depreciation rate, $\delta$, is set equal to 0.1, which is commonly used in the real business cycle literature. The capital adjustment cost parameter $\phi$ is set to be 0.025 in both samples, which is within the range provided in Mendoza (1991).

The real risk-free interest rate faced by Canada is given by 0.0447 in the first sample, which is close to 0.04 used in Mendoza (1991). However, it is at a much lower level of 0.0056 in the second sample. The surprisingly small number is mainly due to the low interest rate policy set by central banks in the 2000s. The average credit spread of the U.S. Aaa-rated corporate bond with 1-year maturity is used to act as a proxy for the credit
spread of the foreign composite bond in the model. This is a reasonable choice, because on one hand its low risk level is a good approximation of Canada’s overall risk exposure of its foreign bond holdings, which consists of a large amount of U.S. government risk-free bonds; on the other hand, it has a small but significant credit spread that affects bond purchase decisions.

The average credit spread data of the U.S. Aaa-rated 1-year bond are limited from the Reuters corporate bond spread tables. Therefore, the complete data are derived from the credit spread data of the U.S. 30-year Aaa corporate bond yield, which is the difference between the Moody’s seasoned Aaa corporate bond yield and the 30-year Treasury constant maturity rate.  

For the joint stochastic processes, the persistence parameter, $\rho_z$, and the standard deviation, $\sigma_z$, for the productivity process, are estimated to be 0.5486 and 0.0107 in the first sample of 1981-2000, respectively, and 0.4144 and 0.0079 in the second sample of 2001-2013, respectively, based on Solow residuals. The estimation differs from how Mendoza (1991) did, though. Mendoza (1991) argues that the Solow residual method would not reproduce data consistent with the Canadian stylized facts and he sets $\rho_z$ and $\sigma_z$ such that the standard deviation and the first-order autocorrelation of output generated by the model would match those in the data. The disadvantage of his method is that the parameters for the TFP process do not utilize the data of output, capital and employment. To remedy the problem encountered by Mendoza (1991), I use the Solow residual method to retrieve the parameters $\rho_z$ and $\sigma_z$ using data detrended by the Hodrick-Prescott filter with a smoothing parameter of 50, 7 rather than by the quadratic detrending method. In this way, the model generated data match quite well with the observed Canadian data.

6The ordinary least least square (OLS) regression is run between the Aaa-rated 30-year bond yield and the limited Aaa-rated 1-year bond yield data. The estimated coefficient is then used compute the missing 1-year bond yield data based on the 30-year bond yield data. The data are available upon request.

7According to Ravn and Uhlig (2002), the values for the smoothing parameter of the Hodrick-Prescott filter on annual data that have been used in the literature range between 6.25 to 400.
The sample average U.S. 1-year Aaa corporate bond spreads are 0.14% and 0.17% in the two samples, respectively. As for the AR (1) process of the U.S. 1-year Aaa bond’s credit spread shocks, the persistence parameter, $\rho_{cs}$, is estimated to be 0.6921 in the first sample and 0.4741 in the second one. The standard deviation of the error term, $\sigma_{cs}$, is estimated to be 0.0012 in the first sample and 0.0014 in the second. The correlation coefficients between the productivity shocks and the credit spread shocks are approximated to be 0.20 and $-0.49$ in the two samples, respectively. $^8$

The parameter $\mu$ is set to be 0.51, so that the default risks account for 51% of the credit spread and the liquidity premium accounts for the other 49%. This is based upon the estimate taken from Longstaff, Mithal and Neis (2005).

Lastly, given $\alpha$, $\delta$, $\omega$ and the steady-state value of $r_t$, the parameter $\beta_1$ in the endogenous discount factor is calibrated to match the sample mean of trade-balance-to-output ratio in the sample periods (see Schmitt-Grohé and Uribe (2003)), which is 0.01 in the first sample and 0.026 in the second. The values of $\beta_1$ are then computed to be 0.0977 and 0.0176 in the two samples, respectively. Since both values of $\beta_1$ are less than the risk aversion parameter $\gamma$, it is guaranteed that a unique limiting distribution of state variables exists and consumption is a normal good in every period, which is pointed out in Mendoza (1991),

All parameter values are summarized in Table 2.

**Results**

This section presents results for the three different model specifications in both sub-samples. In Model 1, the world credit spread shocks are absent, and thus the world real interest rate is the sum of the constant risk-free rate and the average credit spread taken from the sample.

$^8$Because $\rho_z$ is approximately equal to $\rho_{cs}$ in both samples, the correlation coefficient between the detrended TFP and the deviations of the credit spreads from the sample average obtained from the data can be used to approximate the correlation coefficient between the productivity shocks and the credit spread shocks.
<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
<th>1981-2000</th>
<th>2001-2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>Capital share of output</td>
<td>0.32</td>
<td>0.32</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>Relative risk aversion coefficient</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>$\omega$</td>
<td>GHH exponent of labor supply</td>
<td>1.455</td>
<td>1.455</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Capital depreciation rate</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>$\phi$</td>
<td>Capital adjustment cost parameter</td>
<td>0.025</td>
<td>0.025</td>
</tr>
<tr>
<td>$r_f^d$</td>
<td>Real risk-free interest rate</td>
<td>4.47%</td>
<td>0.56%</td>
</tr>
<tr>
<td>$\bar{r}^{cs}$</td>
<td>Average credit spread on US 1-year Aaa corporate bond</td>
<td>0.14%</td>
<td>0.17%</td>
</tr>
<tr>
<td>$\mu$</td>
<td>The proportion of the credit spread explained by default risk</td>
<td>0.51</td>
<td>0.51</td>
</tr>
<tr>
<td>$\rho_z$</td>
<td>First-order autocorrelation of $\hat{z}_t$</td>
<td>0.5486</td>
<td>0.4144</td>
</tr>
<tr>
<td>$\sigma_z$</td>
<td>Standard deviation of $\varepsilon_t^z$</td>
<td>0.0107</td>
<td>0.0079</td>
</tr>
<tr>
<td>$\rho_{cs}$</td>
<td>First-order autocorrelation of $\hat{r}^{cs}$</td>
<td>0.6921</td>
<td>0.4741</td>
</tr>
<tr>
<td>$\sigma_{cs}$</td>
<td>Standard deviation of $\varepsilon_t^{cs}$</td>
<td>0.0012</td>
<td>0.0014</td>
</tr>
<tr>
<td>$\rho(\varepsilon_t^z,\varepsilon_t^{cs})$</td>
<td>Correlation between TFP shocks and credit spread shocks</td>
<td>0.20</td>
<td>-0.49</td>
</tr>
<tr>
<td>$\beta_1$</td>
<td>Subjective discount factor exponent parameter</td>
<td>0.1277</td>
<td>0.0191</td>
</tr>
</tbody>
</table>

Table 2. Calibration for Canada

This setting is the same as the one in Mendoza (1991) without the interest rate disturbances and that in Schmitt-Grohe (2003). For that reason, I consider Model 1 the baseline model. Model 2 builds on Model 1 and adds a shock process for the world credit spread, but this shock process is independent from the productivity shock process. Model 3 is the benchmark where the productivity shocks and the credit spread shocks are allowed to correlate, featuring a positive correlation in the first sample and a negative correlation in the second.

Table 3 and Table 4 shows the statistical moments calculated from Canadian data, as well as the moments generated by the three models.

The results for the 1981-2000 period is examined first. As can be seen, Model 1 generates moments that match most of the data well, which confirms the strong capability of Mendoza’s (1991) small open economy model to reproduce Canada’s stylized business cycle facts. Of particular interest is the ability of the model to generate weakly countercyclical trade balance that is qualitatively consistent with the data. Nevertheless, it suffers a few drawbacks, which are also present in Mendoza (1991). Specifically, the serial autocorrelation of investment is lower than that in the data; and the procyclicality of consumption is
<table>
<thead>
<tr>
<th></th>
<th>Data</th>
<th>Model 1 (Mendoza (1991) ( \rho^{c^a} ) is absent)</th>
<th>Model 2 (( \rho(e^*_t, e^{c^a}_t) = 0 ))</th>
<th>Model 3 (( \rho(e^*_t, e^{c^a}_t) = 0.20 ))</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard deviations (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>3.44</td>
<td>3.14</td>
<td>3.20</td>
<td>3.28</td>
</tr>
<tr>
<td>Consumption</td>
<td>1.74</td>
<td>2.46</td>
<td>2.49</td>
<td>2.54</td>
</tr>
<tr>
<td>Investment</td>
<td>9.25</td>
<td>11.47</td>
<td>12.44</td>
<td>13.28</td>
</tr>
<tr>
<td>Labor (employment)</td>
<td>2.59</td>
<td>2.16</td>
<td>2.20</td>
<td>2.25</td>
</tr>
<tr>
<td>Trade balance over output</td>
<td>1.21</td>
<td>2.10</td>
<td>2.39</td>
<td>2.54</td>
</tr>
<tr>
<td><strong>Autocorrelations:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>0.74</td>
<td>0.76</td>
<td>0.77</td>
<td>0.78</td>
</tr>
<tr>
<td>Consumption</td>
<td>0.69</td>
<td>0.82</td>
<td>0.82</td>
<td>0.83</td>
</tr>
<tr>
<td>Investment</td>
<td>0.71</td>
<td>0.15</td>
<td>0.17</td>
<td>0.17</td>
</tr>
<tr>
<td>Labor (employment)</td>
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<td>0.76</td>
<td>0.77</td>
<td>0.78</td>
</tr>
<tr>
<td>Trade balance over output</td>
<td>0.42</td>
<td>0.26</td>
<td>0.25</td>
<td>0.24</td>
</tr>
<tr>
<td><strong>Contemporaneous Correlations with Output:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumption</td>
<td>0.80</td>
<td>0.94</td>
<td>0.94</td>
<td>0.94</td>
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<tr>
<td>Investment</td>
<td>0.87</td>
<td>0.53</td>
<td>0.48</td>
<td>0.48</td>
</tr>
<tr>
<td>Labor (employment)</td>
<td>0.94</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Trade balance over output</td>
<td>-0.22</td>
<td>-0.01</td>
<td>0.02</td>
<td>-0.01</td>
</tr>
</tbody>
</table>

Table 3. Moments from Canadian Data and the Three Model Specifications: 1981-2000
### Table 4. Moments from Canadian Data and the Three Model Specifications: 2001-2013

<table>
<thead>
<tr>
<th></th>
<th>Data</th>
<th>Model 1 Mendoza (1991) $\rho^{*}$ is absent</th>
<th>Model 2 $\rho(\epsilon_r^{zx}, \epsilon_r^{zx}) = 0$</th>
<th>Model 3 Benchmark $\rho(\epsilon_r^{zx}, \epsilon_r^{zx}) = -0.49$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard deviations (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>1.39</td>
<td>1.78</td>
<td>1.84</td>
<td>1.73</td>
</tr>
<tr>
<td>Consumption</td>
<td>0.59</td>
<td>1.30</td>
<td>1.34</td>
<td>1.24</td>
</tr>
<tr>
<td>Investment</td>
<td>6.07</td>
<td>3.54</td>
<td>5.37</td>
<td>3.85</td>
</tr>
<tr>
<td>Labor (employment)</td>
<td>0.76</td>
<td>1.23</td>
<td>1.26</td>
<td>1.19</td>
</tr>
<tr>
<td>Trade balance over output</td>
<td>0.58</td>
<td>0.68</td>
<td>1.43</td>
<td>1.24</td>
</tr>
<tr>
<td><strong>Autocorrelations:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>0.36</td>
<td>0.56</td>
<td>0.57</td>
<td>0.49</td>
</tr>
<tr>
<td>Consumption</td>
<td>0.25</td>
<td>0.59</td>
<td>0.61</td>
<td>0.53</td>
</tr>
<tr>
<td>Investment</td>
<td>0.37</td>
<td>0.15</td>
<td>0.18</td>
<td>0.18</td>
</tr>
<tr>
<td>Labor (employment)</td>
<td>0.21</td>
<td>0.56</td>
<td>0.57</td>
<td>0.49</td>
</tr>
<tr>
<td>Trade balance over output</td>
<td>0.11</td>
<td>0.55</td>
<td>0.26</td>
<td>0.31</td>
</tr>
<tr>
<td><strong>Contemporaneous Correlations with Output:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumption</td>
<td>0.59</td>
<td>0.98</td>
<td>0.98</td>
<td>0.98</td>
</tr>
<tr>
<td>Investment</td>
<td>0.98</td>
<td>0.77</td>
<td>0.47</td>
<td>0.29</td>
</tr>
<tr>
<td>Labor (employment)</td>
<td>0.81</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Trade balance over output</td>
<td>0.30</td>
<td>0.10</td>
<td>0.10</td>
<td>0.43</td>
</tr>
</tbody>
</table>
overstated while the procyclicality of investment is underestimated.

In Model 2 where the credit spread disturbances are added, the results are almost identical to those in Model 1. The only exception is that the correlation between output and trade balance has changed from -0.01 to 0.02. Although there is a sign change on the correlation, the change per se is minuscule quantitatively. This suggests that modest credit spread shocks have negligible effects on output, consumption, employment, investment and trade balance.

In Model 3, when the credit spread shocks and the domestic productivity shocks are set to be moderately correlated at 0.20, the trade balance turns countercyclical when compared to Model 2, being -0.01. The intuition behind this change is as follows.

First, at the impact date of a positive TFP shock, output will be higher, which leads to higher consumption and higher savings due to the income effect. Additionally, the higher income will induce the consumers to save more today because of the intertemporal consumption smoothing motive. Thus, savings will go up, which means the investments on domestic capital and foreign bonds will both increase. This is the income effect on foreign bonds. There is also the substitution effect on foreign bonds, which is caused by the TFP shock. A positive productivity shock makes the marginal product of capital higher, which will make the return on domestic capital better than foreign bonds, motivating the Canadians to sell foreign assets and put into domestic capital investments. In most cases, the substitution effect on foreign bonds is stronger than the income effect. And therefore, there will be net selling of foreign bonds when the TFP shock occurs, which is equivalent to a trade deficit. This is consistent with the impulse response functions in Figure 4.

Second, a positive credit spread shock implies worse international asset market conditions and the return on foreign bonds is lower than that on domestic capital, which will force Canadians to rebalance their portfolio by selling foreign assets and investing in do-
mestic capital. This net capital inflow, equivalent to a trade deficit, is also confirmed by the impulse response functions in Figure 5.

Combining a positive TFP shock and a positive credit spread shock, it can be seen that there will be a trade deficit at the impact date when the output is above trend. In other words, a positive correlation tends to lead to a more countercyclical trade balance. This explains the sign change from Model 2 to Model 3, when the correlation between the two shocks changes from 0 to 0.20.

When the results from Model 1 and Model 3 are compared, there are no evident benefits from Model 3 in terms of matching the moments of Canadian data. In fact, the standard deviations of investment and trade balance ratio are higher than that in the data to some
extent. Nevertheless, the advantage of the benchmark model will be clearly seen in the second sample.

In the 2001-2013 period, Model 1 gives results that match the statistical moments of empirical data reasonably well, but worse than in the first sample. This is somewhat expected as the second period’s sample size of thirteen years is relatively small, and thus the summary statistics it yields are not as reliable as those in the first sample and are harder to match. Model 1 also shows that it can produce procyclical trade balance, yet the trade balance procyclicality is not sufficiently large enough.

Model 2 does not do a much better job than Model 1, either. This again confirms the neutrality of small credit spread shocks in a small open economy model.
Figure 6. Impulse Response Functions - TFP Shocks (2001-2013)

Model 3, however, outperforms all the other two, in which the procyclicalities of the trade balance have increased significantly to 0.43, quantitatively closer to the observed data than Model 1 and Model 2. To investigate what has caused the improvement in the trade balance cyclicality, the impulse functions of TFP shocks and the credit spread shocks are examined separately. For the TFP shocks, as discussed previously, a positive TFP shock will usually result in net selling of foreign bonds. However, Figure 6 shows the opposite result - there is net purchase of foreign bonds in response to a positive productivity shock. This is mainly because of the near-zero world real interest rate during the 2001-2013 period. At the steady state, the interest return on the foreign bonds is equal to the marginal product of capital minus the depreciation rate. The close-to-zero interest rate implies the marginal
product of capital is also very low. Therefore, the TFP shock will barely increase the marginal product of capital much. When households increase domestic capital, the capital adjustment costs will soon exceed the benefits of the TFP shock-induced higher marginal product of capital, limiting the increase of the capital. This makes the substitution effect of adjusting the portfolio from foreign assets to domestic capital especially weak. It can been from the impulse response of capital to the TFP shock in Figure 6, which shows a very small increase of capital at the shock’s impact date. Consequently, it is not surprising that the income effect is larger than the substitution effect on the foreign bonds and there is a net increase of foreign assets at the impact date of the TFP shock, as is shown in the impulse response of international bond to the TFP shock (see Figure 6). For the credit

Figure 7. Impulse Response Functions - Credit Spread Shocks (2001-2013)
spread shocks, Figure 7 shows that a positive shock leads to a reduction of foreign assets, which has been reasoned above. The negative correlation between the TFP shocks and credit spread shocks in Model 3 indicates that a positive TFP shock tends to come with a negative credit spread shock, which will collectively result in a higher output and a net increase in international bonds at the impact date of the shocks. This creates a procyclical trade balance.

To have a deeper understanding of what contributes to the procyclical trade balance in the benchmark model, counterfactual experiments are conducted (see Table 5). There are three important findings. First of all, given a fixed world real interest rate, when the correlation between the TFP shocks and the credit spread shocks changes from a large negative number to a large positive number, the trade balance will become less and less procyclical and possibly eventually become countercyclical. Second, given a positive or zero correlation between the two shocks, a lower world interest rate tends to lead to a more procyclical trade balance. Third, in the period of 2001-2013, the trade balance cyclicity is accounted for largely by the negative correlation between the two exogenous shocks and partially accounted for by the low interest rate level.

Although the benchmark model is successful at producing an adequately procyclical

<table>
<thead>
<tr>
<th>Interest rate</th>
<th>$\rho(\varepsilon_{x}^{i}, \varepsilon_{x}^{es}) = 0$</th>
<th>$\rho(\varepsilon_{x}^{i}, \varepsilon_{x}^{es}) = -0.49$</th>
<th>$\rho(\varepsilon_{x}^{i}, \varepsilon_{x}^{es}) = 0.50$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\rho(\frac{tb}{Y}, \hat{y})$</td>
<td>$\rho(\frac{tb}{Y}, \hat{y})$</td>
<td>$\rho(\frac{tb}{Y}, \hat{y})$</td>
</tr>
<tr>
<td>5%</td>
<td>0.03</td>
<td>0.20</td>
<td>-0.07</td>
</tr>
<tr>
<td>4%</td>
<td>0.03</td>
<td>0.23</td>
<td>-0.08</td>
</tr>
<tr>
<td>3%</td>
<td>0.04</td>
<td>0.28</td>
<td>-0.10</td>
</tr>
<tr>
<td>2%</td>
<td>0.06</td>
<td>0.33</td>
<td>-0.11</td>
</tr>
<tr>
<td>1%</td>
<td>0.09</td>
<td>0.39</td>
<td>-0.12</td>
</tr>
<tr>
<td>0.50%</td>
<td>0.10</td>
<td>0.43</td>
<td>-0.12</td>
</tr>
</tbody>
</table>

Table 5. Effects of Changes in the Interest Rate Levels on the Cyclicality of Trade Balance: 2001-2013
trade balance, there are a few downsides. Specifically, the contemporaneous correlation between output and consumption is too high while the correlation between output and investment is understated.

In summary, the baseline model provides satisfactory performance when the credit spread shocks are only weakly correlated to the TFP shocks; nonetheless, the benchmark model is advantageous over the baseline model in that it is more generalized and perform well regardless there is a strong or weak correlation between the world credit spread shocks and the TFP shocks.

**Application of the Benchmark Model**

To better evaluate the performance of the benchmark model, I apply it to Australia and New Zealand, both of which are typical developed small open economies similar to Canada. The parameter calibration is similar to how it was done for the Canadian economy. All parameters calibrated to Australia and New Zealand are listed in Table 6 and Table 7, respectively.
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>Capital share of output</td>
<td>0.32</td>
<td>0.32</td>
<td>0.32</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>Relative risk aversion coefficient</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>$\omega$</td>
<td>GHH exponent of labor supply</td>
<td>1.455</td>
<td>1.455</td>
<td>1.455</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Capital depreciation rate</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>$\phi$</td>
<td>Capital adjustment cost parameter</td>
<td>0.025</td>
<td>0.025</td>
<td>0.025</td>
</tr>
<tr>
<td>$r_f$</td>
<td>Real risk-free interest rate</td>
<td>4.91%</td>
<td>1.87%</td>
<td>3.71%</td>
</tr>
<tr>
<td>$\bar{r}_{cs}$</td>
<td>Average credit spread on US 1-year Aaa corporate bond</td>
<td>0.14%</td>
<td>0.17%</td>
<td>0.15%</td>
</tr>
<tr>
<td>$\mu$</td>
<td>The proportion of the credit spread explained by default risk</td>
<td>0.51</td>
<td>0.51</td>
<td>0.51</td>
</tr>
<tr>
<td>$\rho_z$</td>
<td>First-order autocorrelation of $\tilde{z}_t$</td>
<td>0.2560</td>
<td>0.3413</td>
<td>0.2753</td>
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<tr>
<td>$\sigma_z$</td>
<td>Standard deviation of $\tilde{z}_t$</td>
<td>0.0093</td>
<td>0.0071</td>
<td>0.0085</td>
</tr>
<tr>
<td>$\rho_{cs}$</td>
<td>First-order autocorrelation of $\bar{r}_{cs}$</td>
<td>0.6921</td>
<td>0.4741</td>
<td>0.5530</td>
</tr>
<tr>
<td>$\sigma_{cs}$</td>
<td>Standard deviation of $\bar{r}_{cs}$</td>
<td>0.0012</td>
<td>0.0014</td>
<td>0.0012</td>
</tr>
<tr>
<td>$\rho(\varepsilon^z_t, \varepsilon^c_{cs})$</td>
<td>Correlation between TFP shocks and credit spread shocks</td>
<td>0.02</td>
<td>0.10</td>
<td>0.06</td>
</tr>
<tr>
<td>$\beta_1$</td>
<td>Subjective discount factor exponent parameter</td>
<td>0.1628</td>
<td>0.1402</td>
<td>0.1138</td>
</tr>
</tbody>
</table>

Table 6. Calibration for Australia
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>$\alpha$</td>
<td>Capital share of output</td>
<td>0.32</td>
<td>0.32</td>
<td>0.32</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>Relative risk aversion coefficient</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>$\omega$</td>
<td>GHH exponent of labor supply</td>
<td>1.455</td>
<td>1.455</td>
<td>1.455</td>
</tr>
<tr>
<td>$\delta$</td>
<td>Capital depreciation rate</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>$\phi$</td>
<td>Capital adjustment cost parameter</td>
<td>0.025</td>
<td>0.025</td>
<td>0.025</td>
</tr>
<tr>
<td>$r^f$</td>
<td>Real risk-free interest rate</td>
<td>5.62%</td>
<td>2.39%</td>
<td>3.94%</td>
</tr>
<tr>
<td>$\bar{r}^{cs}$</td>
<td>Average credit spread on US 1-year Aaa corporate bond</td>
<td>0.15%</td>
<td>0.17%</td>
<td>0.16%</td>
</tr>
<tr>
<td>$\mu$</td>
<td>The proportion of the credit spread explained by default risk</td>
<td>0.51</td>
<td>0.51</td>
<td>0.51</td>
</tr>
<tr>
<td>$\rho_c$</td>
<td>First-order autocorrelation of $\hat{z}_t$</td>
<td>0.3697</td>
<td>0.1628</td>
<td>0.2581</td>
</tr>
<tr>
<td>$\sigma_c$</td>
<td>Standard deviation of $\hat{z}_t$</td>
<td>0.0089</td>
<td>0.0055</td>
<td>0.0075</td>
</tr>
<tr>
<td>$\rho_{cs}$</td>
<td>First-order autocorrelation of $\hat{r}^{cs}$</td>
<td>0.8532</td>
<td>0.4741</td>
<td>0.6021</td>
</tr>
<tr>
<td>$\sigma_{cs}$</td>
<td>Standard deviation of $\hat{r}^{cs}$</td>
<td>0.0013</td>
<td>0.0014</td>
<td>0.0013</td>
</tr>
<tr>
<td>$\rho(e_i, e_{cs})$</td>
<td>Correlation between TFP shocks and credit spread shocks</td>
<td>0.44</td>
<td>0.06</td>
<td>0.28</td>
</tr>
<tr>
<td>$\beta_1$</td>
<td>Subjective discount factor exponent parameter</td>
<td>0.2047</td>
<td>0.0885</td>
<td>0.1402</td>
</tr>
</tbody>
</table>

Table 7. Calibration for New Zealand
Table 8. Moments from the Benchmark Model for Australia (1981-2000 and 2001-2013)

<table>
<thead>
<tr>
<th></th>
<th>1981-2000</th>
<th></th>
<th>Benchmark</th>
<th>2001-2013</th>
<th></th>
<th>Benchmark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Data</td>
<td>Mendoza (1991)</td>
<td>$\rho(\xi_t, \xi_t^{\pi}) = 0.02$</td>
<td>Data</td>
<td>Mendoza (1991)</td>
<td>$\rho(\xi_t, \xi_t^{\pi}) = 0.10$</td>
</tr>
<tr>
<td>$\hat{r}$ cs is absent</td>
<td>$\rho(\xi_t, \xi_t^{\pi}) = 0.02$</td>
<td>$\rho(\xi_t, \xi_t^{\pi}) = 0.10$</td>
<td>$\rho(\xi_t, \xi_t^{\pi}) = 0.02$</td>
<td>$\rho(\xi_t, \xi_t^{\pi}) = 0.10$</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard deviations (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>2.64</td>
<td>1.91</td>
<td>2.01</td>
<td>2.32</td>
<td>1.52</td>
<td>1.60</td>
</tr>
<tr>
<td>Consumption</td>
<td>2.06</td>
<td>1.49</td>
<td>1.56</td>
<td>3.47</td>
<td>1.11</td>
<td>1.16</td>
</tr>
<tr>
<td>Investment</td>
<td>9.05</td>
<td>4.58</td>
<td>6.90</td>
<td>6.91</td>
<td>3.04</td>
<td>5.55</td>
</tr>
<tr>
<td>Labor (hours worked)</td>
<td>2.50</td>
<td>1.31</td>
<td>1.38</td>
<td>1.71</td>
<td>1.04</td>
<td>1.10</td>
</tr>
<tr>
<td>Trade balance over output</td>
<td>1.08</td>
<td>0.67</td>
<td>1.34</td>
<td>1.63</td>
<td>0.53</td>
<td>1.36</td>
</tr>
<tr>
<td>Autocorrelations:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>0.63</td>
<td>0.40</td>
<td>0.45</td>
<td>0.92</td>
<td>0.48</td>
<td>0.52</td>
</tr>
<tr>
<td>Consumption</td>
<td>0.80</td>
<td>0.54</td>
<td>0.57</td>
<td>0.89</td>
<td>0.55</td>
<td>0.59</td>
</tr>
<tr>
<td>Investment</td>
<td>0.57</td>
<td>-0.10</td>
<td>0.08</td>
<td>0.63</td>
<td>0.05</td>
<td>0.12</td>
</tr>
<tr>
<td>Labor (hours worked)</td>
<td>0.56</td>
<td>0.40</td>
<td>0.45</td>
<td>0.60</td>
<td>0.48</td>
<td>0.52</td>
</tr>
<tr>
<td>Trade balance over output</td>
<td>0.61</td>
<td>0.48</td>
<td>0.27</td>
<td>0.47</td>
<td>0.62</td>
<td>0.21</td>
</tr>
<tr>
<td>Contemporaneous Correlations with Output:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumption</td>
<td>0.71</td>
<td>0.94</td>
<td>0.94</td>
<td>0.97</td>
<td>0.96</td>
<td>0.96</td>
</tr>
<tr>
<td>Investment</td>
<td>0.91</td>
<td>0.73</td>
<td>0.46</td>
<td>0.80</td>
<td>0.77</td>
<td>0.43</td>
</tr>
<tr>
<td>Labor (hours worked)</td>
<td>0.67</td>
<td>1.00</td>
<td>1.00</td>
<td>0.46</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Trade balance over output</td>
<td>0.02</td>
<td>0.11</td>
<td>0.11</td>
<td>-0.29</td>
<td>0.21</td>
<td>0.10</td>
</tr>
</tbody>
</table>
Table 8 and Table 9 compare the statistical moments generated from Mendoza’s (1991) model and the benchmark model with the Australian data for three different time frames, which are the two sub-samples of 1981-2000 and 2001-2013 and the full sample from 1981 to 2013. Overall, across all three samples, the benchmark model outperforms Mendoza’s (1991) model in many aspects, including a better match of the observed moments for the standard deviations and autocorrelations of almost all macroeconomic variables. It is noteworthy that Australia has a slightly procyclical trade balance before 2000 and a countercyclical trade balance after 2000, which is the opposite to Canada. The benchmark model generates a procyclical trade balance for the pre-2000 period but fails to replicate the countercyclical trade balance for the post-2000 period. Anyhow, its result is still closer to the data than that from Mendoza’s (1991) model, possibly due to the positive correlation of 0.10 between the TFP shocks and credit spread shocks.

Table 10 and Table 11 show the results for New Zealand for three samples, which are 1989-2000, 2001-2013 and 1989-2013. And it again suggests that the benchmark model provides more satisfactory model fits than Mendoza’s (1991) model. In terms of the trade balance cyclicality, it can be seen that New Zealand has a similar pattern to that of Canada. The trade balance cyclicality was countercyclical in the pre-2000 period and turns to procyclical after 2000. Both the benchmark model and Mendoza’s (1991) model can yield countercyclical trade balance and procyclical trade balance in the pre-2000 and post-2000 sub-samples, respectively. Yet the benchmark model has better data matches. Based on the conclusions from the previous section, the positive correlations between the two shocks in both time periods should have helped produce numbers that are more consistent with the observed data. The same is true is for the results in the full sample of 1989-2013, in which Mendoza’s (1991) model is even unsuccessful in reaching a countercyclical trade balance.
<table>
<thead>
<tr>
<th></th>
<th>1981-2013</th>
<th>Data</th>
<th>Mendoza (1991) $\hat{\rho}_{c\xi}$ is absent</th>
<th>Benchmark $\rho(\varepsilon_t^c, \varepsilon_t^\xi) = 0.06$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Standard deviations (%)</strong>:</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Output</td>
<td>2.55</td>
<td>1.75</td>
<td>1.82</td>
<td></td>
</tr>
<tr>
<td>Consumption</td>
<td>2.77</td>
<td>1.33</td>
<td>1.38</td>
<td></td>
</tr>
<tr>
<td>Investment</td>
<td>8.19</td>
<td>3.84</td>
<td>6.05</td>
<td></td>
</tr>
<tr>
<td>Labor (hours worked)</td>
<td>2.19</td>
<td>1.21</td>
<td>1.25</td>
<td></td>
</tr>
<tr>
<td>Trade balance over output</td>
<td>1.30</td>
<td>0.60</td>
<td>1.26</td>
<td></td>
</tr>
<tr>
<td><strong>Autocorrelations</strong>:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>0.75</td>
<td>0.42</td>
<td>0.45</td>
<td></td>
</tr>
<tr>
<td>Consumption</td>
<td>0.86</td>
<td>0.53</td>
<td>0.56</td>
<td></td>
</tr>
<tr>
<td>Investment</td>
<td>0.58</td>
<td>−0.05</td>
<td>0.07</td>
<td></td>
</tr>
<tr>
<td>Labor (hours worked)</td>
<td>0.55</td>
<td>0.42</td>
<td>0.45</td>
<td></td>
</tr>
<tr>
<td>Trade balance over output</td>
<td>0.57</td>
<td>0.57</td>
<td>0.23</td>
<td></td>
</tr>
<tr>
<td><strong>Contemporaneous</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Correlations with Output</strong>:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumption</td>
<td>0.81</td>
<td>0.94</td>
<td>0.95</td>
<td></td>
</tr>
<tr>
<td>Investment</td>
<td>0.87</td>
<td>0.75</td>
<td>0.47</td>
<td></td>
</tr>
<tr>
<td>Labor (hours worked)</td>
<td>0.60</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>Trade balance over output</td>
<td>−0.12</td>
<td>0.17</td>
<td>0.11</td>
<td></td>
</tr>
</tbody>
</table>

Table 9. Moments from the Benchmark Model for Australia (1981-2013)
<table>
<thead>
<tr>
<th></th>
<th>1989-2000</th>
<th>Benchmark $\rho(\varepsilon^c_t, \varepsilon^{ce}_t) = 0.44$</th>
<th>2001-2013</th>
<th>Benchmark $\rho(\varepsilon^c_t, \varepsilon^{ce}_t) = 0.06$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Data</td>
<td>Mendoza (1991) $\hat{\rho}^{cs}$ is absent</td>
<td>Data</td>
<td>Mendoza (1991) $\hat{\rho}^{cs}$ is absent</td>
</tr>
<tr>
<td>Standard deviations (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>2.57</td>
<td>2.05</td>
<td>2.45</td>
<td>1.10</td>
</tr>
<tr>
<td>Consumption</td>
<td>1.22</td>
<td>1.71</td>
<td>2.13</td>
<td>1.04</td>
</tr>
<tr>
<td>Investment</td>
<td>10.53</td>
<td>7.15</td>
<td>11.05</td>
<td>4.47</td>
</tr>
<tr>
<td>Labor (hours worked)</td>
<td>2.92</td>
<td>1.41</td>
<td>1.68</td>
<td>1.13</td>
</tr>
<tr>
<td>Trade balance over output</td>
<td>1.17</td>
<td>1.13</td>
<td>1.94</td>
<td>1.17</td>
</tr>
<tr>
<td>Autocorrelations</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>0.58</td>
<td>0.58</td>
<td>0.71</td>
<td>0.70</td>
</tr>
<tr>
<td>Consumption</td>
<td>0.44</td>
<td>0.68</td>
<td>0.79</td>
<td>0.49</td>
</tr>
<tr>
<td>Investment</td>
<td>0.54</td>
<td>−0.03</td>
<td>0.11</td>
<td>0.40</td>
</tr>
<tr>
<td>Labor (hours worked)</td>
<td>0.63</td>
<td>0.58</td>
<td>0.71</td>
<td>0.32</td>
</tr>
<tr>
<td>Trade balance over output</td>
<td>0.58</td>
<td>0.14</td>
<td>0.12</td>
<td>0.67</td>
</tr>
<tr>
<td>Contemporaneous Correlations with Output</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumption</td>
<td>0.58</td>
<td>0.93</td>
<td>0.96</td>
<td>0.91</td>
</tr>
<tr>
<td>Investment</td>
<td>0.96</td>
<td>0.62</td>
<td>0.52</td>
<td>0.36</td>
</tr>
<tr>
<td>Labor (hours worked)</td>
<td>0.85</td>
<td>1.00</td>
<td>1.00</td>
<td>−0.30</td>
</tr>
<tr>
<td>Trade balance over output</td>
<td>−0.49</td>
<td>−0.13</td>
<td>−0.19</td>
<td>0.46</td>
</tr>
</tbody>
</table>

Table 10. Moments from the Benchmark Model for New Zealand (1989-2000 and 2001-2013)
In short, empirical applications of the benchmark model to Australia and New Zealand demonstrate that the model is robust and has improved performance over the original Mendoza’s (1991) model, especially in reproducing the trade balance cyclicality.

Conclusion

Previous studies have documented countercyclical trade balance for Canada as a small open economy. But new evidence has emerged that Canadian’s trade balance has turned procyclical in the last two decades.

In this paper, I incorporate the correlated joint disturbance processes for TFP and world credit spread shocks into Mendoza’s (1991) model. And I find that this benchmark model can mimic many of the business cycle properties of Canada’s economy. More notably, the model not only produces a countercyclical trade balance in the sample of 1981-2000, but also produces a procyclical trade balance in 2001-2013. The procyclicality of the trade balance in 2001-2013 is achieved primarily through the negative correlation between the two external shocks, and partly through the low world interest rate level.

A further testing of the benchmark model by applying it to Australia and New Zealand suggests the correlated world credit spread shocks added to the original Mendoza’s (1991) model can improve model fits and produce a more precise contemporaneous correlation between output and trade-balance-over-output.

Nonetheless, a few aspects of the model fits are not satisfactory, such as the exaggerated procyclicality of consumption, the lower than expected procyclicality of investment. The model also has difficulties in producing a sufficiently large countercyclical trade balance. More efforts are required to improve the model by considering other features, such as variable capital utilization and habit formation. In addition, different functional forms of the utility function are worth a try.
<table>
<thead>
<tr>
<th></th>
<th>1989-2013 Data $\rho^{cs}$ is absent</th>
<th>Mendoza (1991) $\rho(\varepsilon^c, \varepsilon^{cs}) = 0.28$</th>
<th>Benchmark</th>
</tr>
</thead>
<tbody>
<tr>
<td>Standard deviations (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>1.91</td>
<td>1.53</td>
<td>1.67</td>
</tr>
<tr>
<td>Consumption</td>
<td>1.12</td>
<td>1.23</td>
<td>1.37</td>
</tr>
<tr>
<td>Investment</td>
<td>7.81</td>
<td>3.27</td>
<td>6.69</td>
</tr>
<tr>
<td>Labor (hours worked)</td>
<td>2.14</td>
<td>1.05</td>
<td>1.15</td>
</tr>
<tr>
<td>Trade balance over output</td>
<td>1.17</td>
<td>0.49</td>
<td>1.36</td>
</tr>
<tr>
<td>Autocorrelations:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Output</td>
<td>0.61</td>
<td>0.39</td>
<td>0.50</td>
</tr>
<tr>
<td>Consumption</td>
<td>0.50</td>
<td>0.52</td>
<td>0.61</td>
</tr>
<tr>
<td>Investment</td>
<td>0.51</td>
<td>-0.07</td>
<td>0.10</td>
</tr>
<tr>
<td>Labor (hours worked)</td>
<td>0.59</td>
<td>0.39</td>
<td>0.50</td>
</tr>
<tr>
<td>Trade balance over output</td>
<td>0.66</td>
<td>0.52</td>
<td>0.18</td>
</tr>
<tr>
<td>Contemporaneous Correlations with Output:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumption</td>
<td>0.64</td>
<td>0.94</td>
<td>0.94</td>
</tr>
<tr>
<td>Investment</td>
<td>0.86</td>
<td>0.76</td>
<td>0.47</td>
</tr>
<tr>
<td>Labor (hours worked)</td>
<td>0.67</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Trade balance over output</td>
<td>-0.16</td>
<td>0.09</td>
<td>-0.06</td>
</tr>
</tbody>
</table>

Table 11. Moments from the Benchmark Model for New Zealand (1989-2013)
Chapter 2: Does Jawboning on the Exchange Rate Work?

Evidence from Australia

Introduction

During 2013-2015, the Reserve Bank of Australia (RBA) has been very active in talking down the Australian dollar, considering a lower exchange rate would be helpful in bringing about more sustainable and more balanced growth in the economy. Specifically, members of the RBA used languages that expressed a strong preference for a lower level of exchange rate when giving speeches in various events and conferences, as well as presenting statements on monetary policy decision after monetary meetings. Below are some examples of the messages delivered by the RBA members in late 2013, taken directly from Kwek’s (2013) news article:

“A lower level of the currency than seen at present would assist in rebalancing growth in the economy.” from the RBA’s Governor Glenn Stevens’ statement on October monetary policy on October 1st, 2013.

“[A] lower currency than this would be helpful in rebalancing the growth sources of the economy.” from Glenn Stevens’ speech to the Australian British Chamber of Commerce on October 18th, 2013.

“It seems quite likely that at some point in the future the Australian dollar will be materially lower than it is today.” from Glenn Stevens’ speech at Citi investment conference
on October 29th, 2013.

“The Australian dollar, while below its level earlier in the year, is still uncomfortably high.” from Glenn Stevens’ statement on November monetary policy on November 5th, 2013.

“In Australia’s case, an exchange rate appreciation that is not in line with the fundamentals, if persistent enough, can lead to Dutch Disease.” from the RBA’s Assistant Governor Guy Debelle’s speech to the IMF Research on November 8th, 2013.

As is shown clearly above from the comments of RBA’s members, the motivation of the RBA’s aggressive stance towards bringing down the Australian dollar is to help improve sectors of the economy that compete against foreign goods and services, and thus boost exports. This is supported by the strand of literature that documents the effects of exchange rate shocks on open economies. Manalo, Perera, and Rees (2015) show that a temporary appreciation of the real exchange rate by 10% in Australia will bring down real GDP by 0.3% over one-to-two years, and that the mining and manufacturing industries are the most responsive ones to the exchange rate movements. Kohler, Manalo, and Perera (2014) provide a comparison of results obtained from various economic models regarding the impact of exchange rate fluctuations on output and price, all of which lead to conclusions that a lower exchange rate will increase aggregate output and trade-exposed industries will benefit the most. Karagedikli et al (2016) have similar findings in the New Zealand economy, in which exchange rate shocks have significant effects on the tradable sectors. Finally, Hahn (2007) demonstrates that in the main euro area, positive exchange rate shocks have a negative impact on GDP; and that among all sectors, the industry (excluding construction) and the trade and transportation services are influenced more than others.

There are three main channels through which the RBA can materially reduce the ex-
change rate. The first one is to lower the interest rate, which would decrease the demand for the Australian dollar, resulting in a weakened home currency. In fact, the RBA has cut the cash rate target from 3% to 2% from January 2013 to June 2015. Furthermore, it is capable of providing further easing of monetary policy should that be necessary in the future. Nevertheless, because the RBA has to keep the inflation rate consistent with the target of 2-3%, it can only afford cautious and slow interest rate cuts as a lower interest rate would cause upward inflation pressure. Therefore, the decrease in the interest rate during the time when the exchange rate has depreciated greatly was gradual and not significant. In addition, the room for more monetary easing is limited due to the zero lower bound of the interest rate. In light of this, easy monetary policy is a useful and important tool to promote a lower level of exchange rate but it cannot be relied on heavily by the RBA.

The second channel is that the RBA can directly intervene in the foreign exchange market by buying or selling Australian dollars with the sole purpose of moving the currency in the desired direction. However, Newman, Potter and Wright (2011) have reported that the RBA’s market interventions in the foreign exchange market have become much less frequent since the Australian dollar was floated in December 1983, partly because the Australian dollar’s liquidity has improved and its volatility has reduced as Australia’s foreign exchange market has developed over time. They also point out that the objective of RBA’s market interventions has evolved from smoothing out daily market volatility to stabilizing market conditions when unusual market dysfunction occurs, such as the 2007 financial crisis. Thus, although the RBA’s governor Stevens has indicated in one speech that intervention remains possible, it is not likely the RBA would intervene in the currency market to achieve a weaker Australian dollar given the relatively stable and improving economy.

The last but not least channel is jawboning on the exchange rate, also called “open mouth operations” by Guthrie and Wright (2000), which is the focus of this paper. Since
early 2013, the RBA has not only presented speeches or statements indicating a strong bias towards a lower-valued home currency, but also hinted its willingness to further lower the interest rate or even proceed with foreign exchange intervention to devalue the currency. There are two types of effects coming from jawboning that can impact the exchange rate. One is the anticipatory effect generated from the RBA’s indication of a possible interest rate cut or market intervention, which can cause the exchange rate to decline before the actual realization of the rate cut or intervention. As long as the RBA can credibly fulfill its claims to lower the interest rate, when necessary, in the long run, the anticipatory effect should be realized immediately after the central bank’s jawboning and reflected in the fast-changing exchange rate market. The other is the pure verbal effect which is achieved through the RBA’s talks or monetary statements intending to convince the market the exchange rate will be lower in the medium to long term without mentioning the ease of monetary policies and let the market deliver the exchange rate that the RBA prefers. Since there is no credible action from the RBA that can back up the claim that the exchange rate should go lower, the pure verbal effect solely depends on a successful change in the market belief that the future path of the exchange rate will follow the central bank’s guidance and have a lower value than what is currently expected. In this paper, I am particularly interested in evaluating the pure verbal effect of jawboning on the exchange rate. Therefore, in the rest of the paper, the jawboning strategy refers to pure jawboning by the central bank without hinting at any potential interest rate moves or market interventions.

Jawboning as a policy tool is not first invented by the RBA. In fact, it has been widely employed by central banks as a supplemental tool to implement monetary policy. For example, the US Federal Reserve has primarily used open market operations to let the federal funds effective rate follow the federal funds target rate; and it has also used open mouth operations to push the interest rate to the level that it aims at. Moreover, Guthrie and
Wright (2000) argue that open mouth operations can even be used alone without any open market operations to implement monetary policy. They show that New Zealand’s central bank which follows such policy implementation has successfully keep the interest rate in line with its desired level.

In this paper, however, jawboning is applied to the exchange rate policy rather than the monetary policy. In fact, there are major differences between the two. For the monetary policy, when central banks give talks to the public to reveal their preferred interest rate level, they are essentially using open market operations as a threat to force the market to deliver their target rate. Thus, the credibility of central banks’ commitment to using open market operations to achieve the target interest rate is what ensures the effectiveness of jawboning operations. This is the fundamental reason behind the success of New Zealand’s jawboning on the monetary policy. When it comes to the exchange rate policy, first of all, the RBA does not set a target exchange rate, unlike how they set a target interest rate; instead, it provides a preferred direction of exchange rate movement. Therefore, at times the market may not be clear whether the exchange rate has reached the level that matches the RBA’s expectation and the exchange rate may move in the undesired direction. Second, the RBA simply issues signals to the market that the exchange rate should go lower, but it does not have any persuasive operations to back itself up. And as a result, the jawboning strategy’s effect on the exchange rate is uncertain.

The jawboning strategy, if proved to be effective in moving the exchange rate to the desired direction, will become a beneficial tool for the RBA to manage the exchange rate policy. From Figure 8, the Australia’s real trade-weighted exchange rate index had been declining rapidly since early 2013, down almost 20% by the end of the second quarter of 2015.  

9 The Australian dollar has an even more pronounced drop of 30% against the US dollar from its peak in 2011 to June 2015.
rate. At a first glance, jawboning may be effective in pulling the exchange rate down. But a more careful look at Figure 9 shows that both the commodity prices and the interest rate had declined in the same period, which could be the dominant factors that led to the exchange rate depreciation.

In order to investigate whether the jawboning strategy has a significant impact on the exchange rate and whether it has lent support to output growth, I estimate a structural vector autoregression (SVAR) model for the Australian economy with two different datasets. The first dataset has nine quarterly variables from 1982:Q3 to 2015:Q2. The second dataset has eight monthly variables from July 1982 to June 2015. Included in both datasets is the constructed exchange rate stance index (ERSI) variable based on the RBA’s minutes of the monetary policy meetings which became available since October 2006. The ERSI is compiled using the narrative approach initiated by Romer and Romer (1989) who built on the study of Friedman and Schwartz (1963). It is a reasonably accurate measure of the strength
From the first dataset, the results suggest that a positive exchange rate shock would lower output and inflation, which is consistent with findings from Manalo, Perera, and Rees (2015); and more importantly, the ERSI shock leads to a drop in Australian’s output, cash rate and the exchange rate, and the decline in these variables are statistically significant at the 95% confidence level in the medium term. In the meanwhile, the ERSI shock’s effect on the inflation is uncertain due to wide confidence intervals.

From the second dataset, the outcomes demonstrate that a positive shock to the ERSI, which is an increase of 10 words in the RBA’s monetary statement minutes that conveys the central bank’s exchange rate bias, the real exchange rate will fall by 1.1% in two years and 1.2% in five years; and the business confidence index will rise by 0.04 in two years and stay 0.04 above the trend in five years. In addition, the ERSI explains 21.8% of the
variation in the exchange rate at five years.

This paper is organized as follows. Section 2 presents the SVAR model. Section 3 shows how the Exchange Rate Stance Index is constructed. Section 4 describes the quarterly data series and its results. Section 5 describes the monthly data series and its results and Section 6 concludes.

The Model

The SVAR is a credible and cogent approach for data description, forecasting and measuring effects of different shocks for policy analysis. Dungey and Pagan (2000) has an early application of the SVAR model on the Australian economy focusing on the impact of the monetary policy. Recently, Manalo, Perera, and Rees (2015) employ the SVAR model to investigate the effects of exchange rate shocks on output and inflation.

The SVAR framework is presented as follows.

Assume the Australian economy is described by the following structural form equation:

\[ A(L)Y_t = \varepsilon_t \]  \hspace{1cm} (19)

where \( Y_t \) is an \( n \) vector containing domestic and foreign economic variables and \( \varepsilon_t \) is an \( n \) vector of independently and identically distributed structural shocks with a variance-covariance matrix \( \Omega \). \( L \) is the lag operator and \( A(L) \) is defined to be:

\[ A(L) = A_0 - A_1L - A_2L^2 - \ldots - A_pL^p \]
where $A_0$ summarizes the contemporaneous relationships between the variables in the vector $Y_t$ and $p$ is the lag order.

The reduced form equation associated with the structural equation 2.1 is given by:

$$B(L)Y_t = u_t$$

(20)

where $B(L)$ is a matrix polynomial in the lag operator $L$ and $u_t$ is an $n$ vector of potentially correlated reduced form shocks with a variance-covariance matrix $\Sigma$.

The following results are obtained from the equations 2.1 and 2.2.

$$B(L) = A_0^{-1}A(L) = I - B_1L - B_2L^2 - \ldots - B_pL^p$$

and

$$u_t = A_0^{-1}\varepsilon_t$$

And from the above the relationship between the variance-covariance matrices $\Sigma$ and $\Omega$ can be uncovered:

$$\Sigma = A_0^{-1}\Omega A_0^{-1}$$

(21)

$A_0$ and $\Omega$ can be obtained from $\Sigma$ which is estimated from data. For $A_0$ and $\Omega$, there are a total of $n(n+1)$ parameters to be estimated. Since $\Sigma$ contains only $n(n+1)/2$ variables,
at least $n(n+1)/2$ restrictions are required. If the $n$ diagonal elements of $A_0$ are normalized to ones, the number of restrictions are reduced to $n(n-1)/2$. To achieve identification, the recursive ordering approach first applied by Sims (1980) is used such that $A_0$ is assumed to be lower triangular.

There are two major types of restrictions that are placed on the SVAR system. The first one is that foreign variables do not respond to domestic variables, as Australia is considered a small open economy. Specifically, all the coefficients for contemporaneous and lagged domestic variables appearing in the foreign-variable equations are set to be zeros. The second is the recursive ordering that was mentioned above. For example, in a bivariate SVAR system with output and interest rate, if output is ordered before interest rate, it indicates that output affects interest rate contemporaneously while interest rate affects output only with a lag. The actual ordering of variables will be discussed in the next section.

In addition to these two types of restrictions, there are a few additional restrictions on selected variables, which will also be discussed in the next section.

**The Exchange Rate Stance Index (ERSI)**

The simplest way to measure the RBA’s jawboning on the exchange rate is to use an indicator variable. A value of 1 indicates the jawboning policy is in effect and a value of 0 indicates otherwise. However, this is a relatively rough measure of the jawboning as the RBA may adjust the magnitude of talking down the currency over time in response to changes in economic and monetary conditions. Therefore, I try to look for a more precise variable that can quantify the jawboning effect.

A good choice of data is the RBA’s minutes of the monetary policy meetings. There are a couple advantages of using the minutes data. Firstly, the meeting minutes is reliable and meaningful, as it shows a clear indication of the RBA’s preference on the direction of
the exchange rate. Secondly, the minutes is published on the RBA’s official website every month except January starting from October 2006, which is more consistent than random speeches from members of the RBA.

In order to quantify the jawboning effect, I build an exchange rate stance index (ERSI) with the RBA’s minutes using the narrative approach developed by Romer and Romer (1989), who extended the narrative tradition that first appeared in Friedman and Schwartz (1963). The narrative approach has been extensively used in characterizing and assessing monetary policies. In this paper, nonetheless, it is used to evaluate the exchange rate policy. The ERSI is compiled in two steps. First, words, phrases or sentences signaling a bias for the exchange rate direction are searched for in the section of “Considerations for Monetary Policy” in the RBA’s minutes. “(The exchange rate) remained uncomfortably high” and “A further depreciation (of the exchange rate) therefore seemed both likely and necessary” are such examples. It is important to note that statements that are associated with interest rate or monetary policy guidance are not included in the search criteria, although such statements would affect exchange rate, because I try to capture the jawboning’s pure verbal effect only, but not the anticipatory effect of interest rate changes. Second, if a downward (upward) bias on the exchange rate is detected, the number of words that are pertinent to the stance on exchange rate is counted and denoted as a positive (negative) ERSI value. For example, in the monetary minutes in April 2013, the message related to exchange rate is found as “At the same time, the factors weighing on the economy D including the high exchange rate, the waning growth of mining investment, and fiscal consolidation D were likely to persist.”. In this case, “the waning growth of mining investment, and fiscal consolidation” should not be counted as they are not relevant to exchange rate and the ERSI value should be set to be 19.

There is no data available for the RBA’s minutes before October 2006 unfortunately.
All the missing ERSI values are assumed to be zeros, indicating the RBA has a neutral stance on the exchange rate. As for the missing data in every January since 2007. It will be imputed by the average of the ERSI values of the two months before and after January. Figure 10 illustrates the ERSI data series along with Australia’s real exchange rate data since 2006.

The Quarterly Data Series

Data

Nine variables at quarterly frequencies from 1982:Q3-2015:Q2 are included in the SVAR model. There are four foreign variables and five Australian variables.

Included in the foreign variables are the US real GDP, the US inflation, the US federal funds rate and the commodity price index. And the domestic variables for Australia’s
economy are the real GDP, the trimmed mean inflation, the cash rate, the ERSI and the real trade-weighted exchange rate index.

In the model, the seasonally adjusted US real GDP is logged and detrended with a quadratic time trend. It represents the economic conditions in developed countries faced by Australia. The US inflation is measured by the seasonally adjusted trimmed mean personal consumption expenditure price index. The federal funds rate enters the model in levels. The US real GDP, the inflation rate and the federal funds rate are all closely related to the monetary policy implemented by the Federal Reserve, which will affect Australia’s real exchange rate through uncovered interest rate parity. The commodity price index denominated in Special Drawing Right (SDR) is logged in the model. It is treated as a foreign variable instead of a domestic variable because the commodity prices are determined by demand and supply in the international market and Australia is viewed as a price-taker. Since Australia is a large exporter of raw materials, its economic activities will be influenced by movements in the commodity price index. For example, China’s recent economic slowdown has led to a weaker demand for raw materials, which has caused commodity prices to plummet.

For the list of domestic variables, output, inflation and the cash rate are similar to the counterparts in the block of international variables. The real exchange rate is measure by the trade-weighted index adjusted for relative consumer price levels and is logged. The last variable is the ERSI variable to measure the RBA’s jawboning on the exchange rate. This variable is assumed to be endogenous, considering the strength of jawboning could vary over time when the RBA react to international and domestic economic conditions.

The recursive order of the nine variables is similar to that of Manalo, Perera, and Rees (2015), which is \{US GDP, US inflation, US federal funds rate, commodity price index, Australia’s GDP, Australia’s inflation, Australia’s cash rate, the ERSI, Australia’s real ex-

49
change rate). The basic rationale for this structure is that slow-moving variables such as output are ordered before the fast-moving variables such as exchange rate. For instance, when there are changes to the output, the inflate rate, the monetary policy or the exchange rate policy, the nominal exchange rate will immediately respond in the liquid foreign exchange market, which mostly determines the movements of the real exchange rate in the short run. And when the exchange rate or the interest rate changes, operating firms will be affected with a delay, as they need time to adjust their production, investments and prices.

I follow Manalo, Perera and Rees (2015) and include two dummy variables in the model. One is to represent the monetary policy regime change of inflation targeting starting from 1993:Q1 to 2015:Q2. The other is to account for the highly volatile market conditions during the financial crisis from 2008:Q4 to 2009:Q3.

Lastly, lag order tests suggest that one lag is optimal based on the Hannan and Quinn Information Criterion (HQIC) and Schwarz’s Bayesian information criterion (SBIC).

**Results**

The results for the quarterly data series are presented in this section. The effects of exchange rate shocks on output and inflation are examined first. From Figure 11, it is shown that a temporary positive exchange rate shock will cause GDP to contract over a prolonged period of time, hitting the trough in the third quarter after the shock; in the meantime, the trimmed mean inflation will drop first and then return to the initial level slowly, following a similar path as GDP. These results are consistent with the those from Manalo, Perera, and Rees (2015).

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10 Manalo, Perera, and Rees (2015) use Australian terms of trade instead of the commodity price index and they do not have the ERSI variable.

11 A robustness check has been performed to show that results such as the impulse response functions from the model with two lags, as was specified in Manalo, Perera, and Rees (2015), are very similar to those in this paper’s model with one lag.
Next the results for the ERSI are discussed. To begin with, as shown in Figure 12, the positive shock to the ERSI variable is persistent and it decays slowly over an extended period of time. The impulse response of the real exchange rate displays a sharp decline at the impact date of the ERSI shock, followed by further declines, hitting the trough in seven quarters, which indicates jawboning has a considerable impact on the real exchange rate, achieving the RBA’s goal of lowering the exchange rate. However, the exchange rate policy of jawboning down the currency causes a drop in the output as well in the short and medium term. This invalidates the ultimate goal of the RBA to improve economic activities. According to Manalo, Perera, and Rees (2015), a temporary depreciation of the exchange rate increases output in the subsequent periods. This is possibly the motivation of the RBA to bring down the Australian dollar. But interestingly, the implementation of
Figure 12. Impulse Response Functions to a One Standard Deviation Shock in the ERSI (Australia: 1982:Q3-2015:Q2)

*Note:* The blue line represents the orthogonal impulse response function and the shaded area is the 95% confidence interval.

talking down the Australian dollar does cause a decrease in the exchange rate, but fail to boost economic output. One possible explanation is that when firms and consumers see the unusual exchange rate policy carried out by the RBA, they feel that the RBA is pessimistic about the economy and thus adopt such strong policy actions. This will result in cautious behavior from firms and consumers, implying less investment and less consumption. Following the ERSI shock, the cash rate follows a path similar to output, as declining output will trigger easing monetary policy. Based on Figure 12, the ERSI shock has uncertain effect on inflation as the confidence interval is fairly wide.

To further examine how much jawboning can affect Australian macroeconomic volatility, the variance decomposition of Australia’s output, inflation, cash rate and real exchange rate is performed. In Table 12, it can be seen that the ERSI contributes little to fluctuations
Table 12. Variance Decomposition - Domestic Variables (per cent of variance explained by ERSI, quarterly data)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Horizon (quarters)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Output</td>
<td>0</td>
</tr>
<tr>
<td>Inflation</td>
<td>1.4</td>
</tr>
<tr>
<td>Cash rate</td>
<td>0.1</td>
</tr>
<tr>
<td>Exchange rate</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Table 13. Variance Decomposition - Exchange Rate (per cent of variance explaining exchange rate, quarterly data)

<table>
<thead>
<tr>
<th>Shock</th>
<th>Horizon (quarters)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>US output</td>
<td>7.5</td>
</tr>
<tr>
<td>US inflation</td>
<td>0.4</td>
</tr>
<tr>
<td>US interest rate</td>
<td>1.3</td>
</tr>
<tr>
<td>Commodity prices</td>
<td>14.5</td>
</tr>
<tr>
<td>AU output</td>
<td>1.3</td>
</tr>
<tr>
<td>AU inflation</td>
<td>0.7</td>
</tr>
<tr>
<td>AU cash rate</td>
<td>2.8</td>
</tr>
<tr>
<td>AU exchange rate</td>
<td>71.3</td>
</tr>
<tr>
<td>AU ERSI</td>
<td>0.2</td>
</tr>
</tbody>
</table>

in domestic aggregate variables across different time horizons. The most affected variable is domestic output, whose variation is increasingly attributed to jawboning on the exchange rate, up to 6.5% at five years. In other words, the RBA’s jawboning exchange rate policy plays a small role in affecting domestic output over the medium term.

Previously it has been shown that jawboning can cause significant downward exchange rate movements. To examine how much jawboning and other shocks contribute to the variance of the exchange rate, a variance decomposition on the real exchange rate is used. Table 13 shows that in the short-term, the exchange rate movement is mostly explained by its own shock and modestly explained by commodity price shocks and US GDP shocks. As
the horizon goes beyond ten quarters, the commodity price shocks become the most dominant force in determining the real exchange rate fluctuations while the effects of exchange rate shocks on itself fade over time. This is in agreement with Gruen and Wilkinson (1994), who demonstrate that the Australia’s real exchange rate is largely explained by the terms of trade and real interest differentials in the long run.  

In summary, the RBA’s jawboning strategy appears to be effective in pushing down the exchange rate; but it fails to improve GDP. One concern of the results from the quarterly data is that the number of available data points for the ERSI may not be sufficient, as non-zero ERSI values only show up after 2011. An improvement of the analysis can be obtained by using monthly data instead, which will be discussed in the next section.

The Australia’s terms of trade and the commodity price index are highly correlated with a correlation coefficient of 0.98 between 1982 and 2015. Figure 13 shows the comovements of the two. Therefore, it is suitable to use the terms of trade and the commodity price index interchangeably in data analysis.
The Monthly Data Series

Data

Identical to the quarterly data series, the time frame for the monthly data will be from July 1982 to June 2015.

Variables in the quarterly data series, such as US inflation, US federal funds rate, commodity price index, Australia’s cash rate and Australia’s real exchange rate index, are also available at monthly frequency. As a result, they will be kept in the monthly dataset. As for the US GDP and the Australia’s GDP, the US business confidence index and the Australia’s business confidence index will be used as a substitute, respectively. Lastly, there is no monthly consumer price index data available for Australia. Since the effect of jawboning on price level changes is not the emphasis of this paper, it is acceptable to omit the domestic inflation variable.

The recursive order of the eight variables follows the same reasoning behind the quarterly data series: \{US business confidence index, US inflation, US federal funds rate, commodity price index, Australia’s business confidence index, Australia’s cash rate, ERSI, Australia’s real exchange rate\}.

Both dummy variables defined in the quarterly data series are also included in the monthly dataset.

Finally, the lag length is set equal to seven, according to the Akaike Information Criterion (AIC) and Akaike’s Final Prediction Error (FPE).

\(^{13}\)The business confidence index measures enterprises’ assessment of current and immediate future expected business conditions, which is a leading indicator of economic activities.
Results

In the previous section, it has been shown that an appreciation of the exchange rate will lead to a decrease in GDP. Figure 14 suggests that an exchange rate shock will also cause a decline in the business confidence index. The impulse response functions from Figure 11 and Figure 14 display a similar pattern. As a result, it is reasonable to view the business confidence index as a good proxy for aggregate economic activities.

From Figure 15, it can be seen that the ERSI has a strong and persistent reaction to its own shock and that the ERSI will have a statistically significant and permanent increase after the shock. This indicates that if the central bank unexpectedly increase the strength of its jawboning on the exchange rate, its stance on the currency will have a permanent shift to the up side in the long run. This is consistent with the common belief that the central bank maintains a persistent exchange rate policy and will not easily deviate from its policy goals. Hence, the public should raise the expectation about the magnitude of the jawboning
Figure 15. Impulse Response Functions to a One Standard Deviation Shock in the ERSI (Australia: July 1982-June 2015)

Note: The blue line represents the orthogonal impulse response function and the shaded area is the 95% confidence interval.

over the long term if a positive change in the ERSI is spotted. Figure 15 also shows that the real exchange rate reacts to the ERSI shock with a steep drop, which becomes statistically significant after one year. As for the business confidence index, in response to the ERSI shock, it drops for 8 months initially and then steadily increases over the medium term. The improvement in the business confidence index is statistically significant after 44 months. In the mean time, the cash rate drops continuously for about two years and then moves up slightly and slowly.

A possible explanation for the impulse response paths of the business confidence index, the cash rate and the real exchange rate is as follows. When there is an unanticipated shock to the ERSI, indicating that the RBA has enhanced its stance on talking down the currency,
the market will be given an impression that the RBA has a negative outlook about the economy in the near term and thus it is eager to bring down the exchange rate to strengthen the competitiveness of the export industry and promote economic growth. Consequently, the business confidence will drop for the first several months. Meanwhile, the exchange rate experiences a drastic drop immediately due to the RBA’s jawboning, which changes the market’s expectation of the exchange rate level. The interest rate, however, responds little until 3 months after the shock, which implies that the exchange rate policy does not affect monetary policy directly. Several months after the shock, the interest rate starts to move lower in response to the weak business confidence. With the falling interest rate and exchange rate, which tend to encourage investments and exports, it is natural to see stable gains in the business confidence index eight months after the shock.

The main goals of the RBA’s jawboning are to lower the exchange rate and revitalize the economy. According to the impulse responses of the exchange rate and the business confidence index to the ERSI shock, jawboning has a positive effect in reducing the exchange rate and boosting firms’ willingness to expand and invest. When there is an unanticipated increase of 10 words relating to talking down the exchange rate in the RBA’s monetary meeting minutes, which is equivalent to a shock of 10 to the ERSI, the real exchange rate will drop by 1.1% in two years and 1.2% in five years; and the business confidence index will have an increase of 0.04 in two years and the increase will remain at 0.04 in five years. The improvement of the business confidence index over the medium term after the ESRI shock is opposite to the deterioration of output based on the quarterly data. But such results are not necessarily contradictory. Since the business confidence index is a leading indicator of economic activities, its movements will lead the GDP changes by a few quarters. If the first three quarters of the impulse response of GDP from Figure 12 are removed and then

14 The Australia’s business confidence index fluctuates around 100 and has a standard deviation 0.99 of between July 1982 and June 2015.
Table 14. Variance Decomposition - Domestic Variables (per cent of variance explained by the ERSI, monthly data)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Horizon (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Business confidence index</td>
<td>0.02</td>
</tr>
<tr>
<td>Cash rate</td>
<td>0.04</td>
</tr>
<tr>
<td>Exchange rate</td>
<td>1.1</td>
</tr>
</tbody>
</table>

Table 15. Variance Decomposition - Exchange Rate (per cent of variance explaining exchange rate, monthly data)

<table>
<thead>
<tr>
<th>Shock</th>
<th>Horizon (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>US business confidence index</td>
<td>3.2</td>
</tr>
<tr>
<td>US inflation</td>
<td>0.01</td>
</tr>
<tr>
<td>US interest rate</td>
<td>0.2</td>
</tr>
<tr>
<td>Commodity prices</td>
<td>5.3</td>
</tr>
<tr>
<td>AU business confidence index</td>
<td>1.8</td>
</tr>
<tr>
<td>AU cash rate</td>
<td>0.02</td>
</tr>
<tr>
<td>AU exchange rate</td>
<td>88.7</td>
</tr>
<tr>
<td>AU ERSI</td>
<td>0.8</td>
</tr>
</tbody>
</table>

compared to impulse response of business confidence index from Figure 15, it can be seen that the shape of both impulse responses are almost identical, which indicates the moving directions of output and business confidence index in response to the ERSI shock are consistent. Anyhow, the results show that although business confidence has improved due to the jawboning exchange rate policy, the output actually has underperformed. Therefore, more evidence is needed to demonstrate the effectiveness of the jawboning strategy to raise GDP.

The quarterly data has shown that the RBA’s jawboning is not a major cause of volatility for Australian macroeconomic variables, as well as the real exchange rate. The monthly data produces different results for the exchange rate. Table 14 shows that the ERSI plays an
Table 16. Variance Decomposition - ERSI (per cent of variance explaining ERSI, monthly data)

<table>
<thead>
<tr>
<th>Shock</th>
<th>Horizon (months)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>US business confidence index</td>
<td>0.8</td>
</tr>
<tr>
<td>US inflation</td>
<td>0.1</td>
</tr>
<tr>
<td>US interest rate</td>
<td>0.1</td>
</tr>
<tr>
<td>Commodity prices</td>
<td>0.1</td>
</tr>
<tr>
<td>AU business confidence index</td>
<td>0.1</td>
</tr>
<tr>
<td>AU cash rate</td>
<td>0.1</td>
</tr>
<tr>
<td>AU exchange rate</td>
<td>0.7</td>
</tr>
<tr>
<td>AU ERSI</td>
<td>98.0</td>
</tr>
</tbody>
</table>

important part in explaining the exchange rate in the long term, up to 21.8% at five years. In addition, the quarterly data suggests that the commodity prices are the only determinant factor in affecting the exchange rate in the long run. However, Table 15 shows that although the commodity prices are still the most significant source of variation for the exchange rate, the US business confidence index, the Australia’s exchange rate and the ERSI all play an almost equally important role in influencing the exchange rate. It is worth noting that the contribution of commodity prices and the ERSI to the variance of the exchange rate increases over time while that from the US business confidence index and the exchange rate diminishes in the longer horizon.

Lastly, a variance decomposition is performed on the ERSI. Table 16 shows that the variation of ERSI is mostly explained by its own shock in all horizons, which provides evidence that the ERSI responds little to other variables and it is appropriate to assume it is an exogenous variable if necessary. This is a rather interesting result as it implies the RBA does not adjust the jawboning strength based on international and domestic economic conditions.
Robustness Analysis

Previously, it has been shown that the business confidence index is a good proxy for output. However, it differs from output in that output is a slow-moving variable while business confidence could change rather quickly in response to economic and financial conditions. Therefore, I estimate the SVAR model for the monthly data with a different recursive order - the US and the Australia’s business confidence indexes are ordered after the US federal funds rate and the Australia’s cash rate, respectively. The variance decomposition results are almost identical to those with the original recursive order, which suggests the model is robust.

Conclusion

Between 2013 and 2015, the RBA has been trying to lower the exchange rate to foster the rebalance of the domestic economy. To accomplish this goal, it has implemented an innovative exchange rate policy tool, which is to jawbone down the exchange rate by delivering messages to the public that the exchange rate is overvalued and should depreciate over time. To explore the jawboning strategy’s effect on the exchange rate and domestic economic conditions, I use a structural vector autoregressive (SVAR) model to examine the Australian economy.

The results from both the quarterly data and the monthly data show that a shock to the ERSI which measures the magnitude of jawboning will cause a significant decline in the real exchange rate at all horizons. However, the quarterly dataset suggests the ERSI shock has a negative impact over GDP while the monthly dataset shows the ERSI has a positive effect on Australia’s business confidence index in the medium term. Thus, it appears the jawboning policy fails to stimulate GDP growth despite its positive effect on
business confidence.

Moreover, according to the variance decomposition analysis of the real exchange rate, the ERSI explains more than 20% of the variance of the exchange rate at 5 years. In summary, the jawboning strategy implemented by the RBA has a strong and negative impact on the exchange rate, but its effect on economic activities is still debatable. Nonetheless, jawboning on the currency has the potential to become part of the arsenal of exchange rate policy tools for developed small open economies.

A few improvements can be done to increase the robustness of the paper. For example, additional foreign variables such as asset prices can be added to the SVAR system; the ordering of the variables can be rearranged; the ERSI can be created using a different set of criteria, such as the five-value index used by Shu and Ng (2010) to measure China’s monetary stance.
Chapter 3: Unemployment Dynamics in Emerging Countries: Local vs. Global Financial Risk

Introduction

It is well known that business cycles are highly volatile in emerging countries and that interest rate shocks, which comprise the international rate component and the country spread component, play an important role in explaining the business cycle movements (Neumeyer and Perri, 2005; Uribe and Yue, 2006). A recent paper by Akıncı (2013), however, argues that the important role of the U.S. interest rate shocks in affecting the business cycles in emerging markets should be replaced by the global financial risk shocks. Specifically, she points out that the U.S. real risk-free interest rate shocks have negligible effects on the aggregate economic activities in emerging economies, while the shocks to the global financial risk, as proxied by the U.S. Baa corporate spread, account for about 20% of the variations in the macroeconomic aggregates. Moreover, she suggests that the innovations in the global financial risk have a greater contribution to changes in the macroeconomic aggregates than those in the country spread, which is a local financial risk.

Our paper compares how the global financial risks and local financial risks affect the macroeconomic variables in emerging countries, which is similar to Akıncı’s (2013). However, this paper is distinct from Akıncı’s (2013) work in two regards. First of all, Akıncı (2013) uses quarterly data for analysis, which is common in the literature that studies the business cycles in emerging markets. Nevertheless, global and local financial risk factors
are high-frequency variables that respond to market conditions quickly, and thus analyzing financial data at the monthly frequency rather than the usual quarterly frequency would yield more insightful results. We are able to gather monthly data for a number of emerging countries from 1999 to 2015 to conduct the analysis. Second, Akıncı (2013) looks at macroeconomic variables such as GDP, investment and trade balance-to-GDP ratio while we focus on unemployment and inflation, partly because monthly data is available for unemployment and inflation but not for GDP and others. As is documented in recent literature (Boz, Durdu, and Li, 2015; Shapiro, 2016), the unemployment rates in emerging countries, on average, have a higher standard deviation than that in developed ones, and there is a negative correlation of $-0.41$ between unemployment and output. On one hand, this suggests that the business cycle properties of unemployment share some similarities to those of output. On the other hand, the correlation of $-0.41$ indicates that output and unemployment are not strongly correlated and there could be differences between the dynamics of output and unemployment in response to different shocks.

The main contribution of this paper to the literature is that we take a more thorough look at the local financial risk factors, as opposed to the existing literature that places an emphasis on the effects of global financial risk shocks. Akıncı (2013) uses the country spread to represent the country specific financial risk in her baseline model. Nonetheless, the country spread does not affect domestic firms that do not borrow from the international market. As a result, it does not fully capture the local financial risk in emerging countries and the model suffers the omitted variable bias. In light of this, we examine a number of local financial risk factors and have added to the model the dividend yield as a proxy for the local financial risk. Alternative local financial risk variable such as the price-earnings ratio is also tested for the robustness of the results.

In this paper, we estimate a panel vector autoregressive (VAR) model with monthly data
between 1999 and 2015 from six emerging countries, including Brazil, Chile, Colombia, Mexico, Peru and Venezuela. There are two major findings. First, the local financial risks such as the country spread and the dividend yield contribute more to the variance of unemployment than the global financial risk and the U.S. interest rate, which is opposite to the conclusion in Akınç’s (2013) paper. Second, the global financial risks explain a decent amount of variations in the local financial risks in emerging markets.

This rest of the paper is organized as follows. Section 2 presents the empirical model, the identification strategy and the estimation method. Section 3 examines the unemployment dynamics using the results of the impulse response functions and variance decompositions. Section 4 discusses the robustness of the results under several alternative specifications. Section 5 concludes.

The Model

Model Specification

The model specification follows that in the work of Uribe and Yue (2006) and Akınç (2013).

The panel vector autoregressive (VAR) model framework is presented as follows.

\[ A(L)Y_{i,t} = \eta_i + \varepsilon_{i,t} \]

where \( i \) and \( t \) denote countries and time period, respectively. \( Y_t \) is an \( n \) vector containing domestic and foreign macroeconomic and financial variables, \( \eta \) represents the fixed effect and \( \varepsilon_t \) is an \( n \) vector of independently and identically distributed structural shocks with a
variance-covariance matrix $\Omega$. $L$ is the lag operator and $A(L)$ is defined to be:

$$A(L) = A_0 - A_1 L - A_2 L^2 - \ldots - A_p L^p$$

where $A_0$ summarizes the contemporaneous relationships between the variables in the vector $Y_{i,t}$ and $p$ is the lag order.

**Variable Selection**

Included in the panel VAR model are six variables at monthly frequencies from 1999:M1-2015:M12 from a total of six emerging countries: Brazil, Chile, Colombia, Mexico, Peru and Venezuela. In the literature, most studies use quarterly data for analysis. In this paper, however, the data we used is at a higher monthly frequency; and therefore, we expect to gain deeper insights into how macroeconomic variables in emerging markets react to global and local financial risk factors. The choice of countries is mainly based on data availability. The choice of the starting year of 1999 is also due to data availability in these emerging countries.

There are two foreign variables and four domestic variables. The foreign variables are common in all the six countries.

*Global risk-free interest rate* : We use the U.S. real risk-free interest rate to represent the global risk-free interest rate. The U.S. real interest rate is computed using the nominal monthly Treasury bill rate deflated by the average of inflation rates in the current and past 11 months. This variable is included in the model because the global risk-free interest rate would affect the borrowing costs of emerging countries. A higher risk-free rate would increase the lending rates in the emerging markets even if the country risk premiums in these countries remain unchanged.
Global financial risk: The U.S. Baa corporate spread is used as the proxy for the global financial risk. The U.S. Baa corporate spread is calculated as the difference between Moody’s U.S. Baa corporate bond yield and the U.S. 20-year Treasury bond rate. Other options for the global financial risk proxy include the U.S. stock market volatility index (VIX) and the U.S. high yield corporate spread, which is the difference between the yield of the Merrill Lynch high yield master II index and the U.S. 20-year Treasury bond yield. The global financial risk is an important risk factor to be included in the model as under the background of today’s financial globalization, global financial risks can be transmitted to emerging economies rapidly and cause a sudden decline in their output and raise unemployment.

Domestic unemployment rate/inflation rate: The unemployment rate and inflation rate are seasonally adjusted and they represent the economic conditions in the emerging economies. We can also observe whether the inverse relationship between the unemployment rate and the inflation rate exist in the countries in the sample, based on the Phillips curve (Phillips 1958).

Local financial risk: A number of local financial risk variables are examined. Included in the baseline model is the dividend yield, which measures the dividend payouts as a percentage of the share price of the domestic firms. Firms would adjust their dividend yield when its profitability or growth strategy changes, or when faced with changes in external economic and financial conditions. There are a number of reasons why firms would change their dividend payments. First, an increase in net earnings of a firm could lead to higher dividends. Second, if a firm has decided to expand its operations, it would raise investments in capital and reduce dividends. Third, if a firm experiences larger financial constraints, other candidates that are not as representative include the U.S. economic policy uncertainty index constructed by Baker, Bloom and Davis (2016), the U.S. dividend yield and Robert Shiller’s 5-year/10-year cyclically adjusted price-to-earnings (CAPE) ratio applied to the U.S. S&P 500 equity market. They will be presented in the robustness analysis section.
such as higher borrowing costs, it could lower its dividends. Fourth, if the risk premium for a firm to issue debt has increased, this firm may want to offer a higher dividend yield to attract additional equity investment from investors. Moreover, according to the influential work by Campbell (1991) and a more recent paper by Cochrane (2011), dividends have strong predictive power of excess stock returns over the long horizon. Therefore, we include the dividend yield variable in our model as a local financial variable. Other possible proxies for the local financial risk are the dividend yield averaged over previous 3 (or 6,12) months, the price-earning ratio, and the average of the price-earning ratios in the previous 3 (or 6, 12) months.

*Country spread*: The country spread is measured by the J.P. Morgan’s EMBI + government bond spread. It directly affects the financial costs of firms which borrow from the international market and thus is a major local financial risk factor.

**Identification**

To achieve identification, the recursive ordering approach first applied by Sims (1980) is used such that the matrix $A_0$ is assumed to be lower triangular with diagonal elements normalized to ones.

There are two major types of restrictions that are imposed on the empirical model system. The first restriction is that country-specific local variables do not affect the global financial variables, as the emerging countries are considered small open economies. Specifically, in the two equations with the foreign variables as the dependent variable, all the coefficients for contemporaneous and lagged domestic variables appearing on the right-hand side of the equations are set to be zeros. The second one is the recursive ordering restrictions. A simple example is used to illustrate the basics of the ordering. For example, in a bivariate system with the unemployment rate and the country spread, if the unemploy-
ment rate is ordered before the country spread, it indicates that the unemployment would affect the country spread contemporaneously while the country spread would affect the unemployment with a one-period lag. Therefore, the rationale for the recursive structure is that slow-moving variables such as unemployment or inflation should be ordered before the fast-moving variables such as the dividend yield or the country spread. In this paper, the variable ordering is \{country-specific unemployment rate, country-specific inflation rate, U.S. real interest rate, U.S. Baa corporate spread, country-specific dividend yield, country spread\}.

With the above ordering, innovations in domestic macroeconomic conditions such as the unemployment and the inflation will cause changes in the local financial variables such as the dividend yield and the country spread immediately while the local financial variables will have a delayed impact on the unemployment and the inflation. The dividend yield is ordered before the country spread. The reason is that Lintner (1956) suggests that firms smooth their dividends to maintain a target dividend payout ratio in the long term, and thus the dividends do not respond to country spread fluctuations promptly but the country spread would react instantly to reflect changes in the dividend yield. Furthermore, the real U.S. interest rate is ordered before the U.S. Baa corporate spread, as it is natural to make the assumption that changes in the short-term risk-free interest rate would contemporaneously affect the risk premium of long-term risky corporate bonds while the latter would only have an effect on the former with a delay.

A change in the ordering of specific variables will be discussed in the robust analysis section.
Estimation

The panel VAR is estimated using the least squares dummy variable estimator (LSDV), which has been extensively applied to macroeconomic studies with panel data (see Juessen and Linnemann 2010). The LSDV method pools data from the six countries and eliminates the country fixed effects, which is essentially $\eta_t$ in the model. It also imposes the restrictions that the matrices $A(L)$ are identical across all of the six countries. This assumption is reasonable as the coefficients for each of the countries are similar when the VAR is estimated individually for each country.

There is a potential disadvantage with the LSDV method. Nickell (1981) has derived an analytical expression for the bias introduced in the first-order autoregressive model with fixed effects, and he concludes that the bias is large if the time dimension is small, but it will decrease as time dimension increases. Since we have a large time series dataset (192 observations), the bias will likely have a minimal impact on our application.

The lag order test suggests that the optimal lag is 3 based on the Akaike information criterion (AIC).

Results

In this section, we would investigate the impact of global and local financial shocks on domestic macroeconomic variables such as unemployment and inflation in emerging countries, as well as how local financial variables such as the dividend yield and the country spread would respond to changes in global financial conditions and domestic economic conditions. We would also like to look into the relationship between unemployment and inflation and see if the inverse relationship as reflected in the Phillips Curve can be observed.
Impulse Responses

Shown in Figure 16 are the impulse responses functions to a one standard deviation shock in the U.S. real risk-free interest rate. It is not surprising to see that the global financial risk declines in response to an increase in the U.S. short-term interest rate and continues to drop for 7 months before moving back towards the equilibrium level. This is mainly due to the two financial crises in the selected sample time frame from 1999 to 2015, during which the U.S. interest rate moved inversely to the global financial risk. In the 2000-2002 stock market crash, there was a modest spike in the global risk and the Federal Reserve lowered the interest rate to stabilize the economy. Shortly after the stock market crash, the global financial risk started to diminish while the Federal Reserve entered the cycle of raising the interest rate to counter increasing inflation due to the credit expansion up until 2007. Then in the 2007-2008 global financial crisis, the global financial risk had a strong spike while the Federal Reserve aggressively lowered the interest rate. However, as suggested by Akıncı (2013), if the sample period is limited to the pre-2007 financial crisis, the global financial risk would increase with a delay when there is a shock to the short-term interest rate, which matches the common prediction by economic theory.

Furthermore, when there is a positive shock to the U.S. interest rate, the dividend yield in the emerging countries would drop by 0.13% to the lowest level in the 12th month. Similarly, the country spread would go up after a delay of 8 months. The intuition behind these movements is that an increase in the international risk-free interest rate would bring up the borrowing costs of firms in the emerging countries that have access to the international capital market. As a result, domestic firms would lower their dividend payments in order to maintain an appropriate cash level; in addition, the country spread goes up over the medium term due to higher default risks. As to domestic macroeconomic variables, the unemployment rate would go above the steady state in the medium term likely because of
Figure 16. Impulse Response Functions to a One Standard Deviation Shock to the U.S. Interest Rate

Note: The blue line represents the orthogonal impulse response function. The green and red lines represent the upper and lower 95% confidence interval bounds.

the higher country spread and the firms’ cautious operating and hiring activities reflected by the lower dividend yield. One interesting finding is that the direction of the inflation rate movement is inversely related to that of the unemployment, which fulfills the Phillips Curve. There is one last note about the impulse response functions of the U.S. interest rate shock - the 95% confidence interval for the impulse responses of the unemployment and the country spread are very wide and the point estimates are not statistically significant.

The second shock we examine is the global financial risk shock. Figure 17 displays the corresponding impulse responses. Compared with Figure 16, it is clear that the unexpected global financial risk shock has a larger impact than the global risk-free interest rate on the unemployment, the dividend yield and the country spread in the emerging countries.
Specifically, a one standard deviation increase in the U.S. Baa corporate spread would cause the country spread to increase by 30 basis points, the dividend yield to increase by 0.22%, and the unemployment rate to increase by 0.08%, reaching their peak effects, respectively. The negative responses of the country spread and the inflation to the innovations of the global financial risk are in agreement with what people would expect. But the increase in the dividend yield is counterintuitive as firms tend to be more vigilant about their cash level when faced with heightened global financial risk. A possible explanation is that higher corporate spread in the international market would transmit to the emerging countries and thus cause domestic firms to increase their dividend yield to attract further equity investment from investors. Regarding inflation, its inverse relationship with unemployment is again
Figure 18. Impulse Response Functions to a One Standard Deviation Shock to the Dividend Yield

Note: The blue line represents the orthogonal impulse response function. The green and red lines represent the upper and lower 95% confidence interval bounds.

observed, similar to that in Figure 16. Lastly, the U.S. interest rate goes up with a one-period delay after the shock. The major finding from the impulse responses in Figure 16 and Figure 17 is that the global financial risk is a more dominant factor than the U.S. real interest rate that influences the unemployment dynamics and the local financial variables in emerging economies.

From Figure 18 we can see that when there is an unanticipated shock to the dividend yield, the unemployment rate would start to decline after one period and continue to drop for 30 months to reach the trough, followed by a steady move back to the equilibrium level; and the inflation rate would have a short-term spike and then return to the equilibrium level. Higher dividend yield from a firm could indicate that the firm has earned better net
Figure 19. Impulse Response Functions to a One Standard Deviation Shock to the Country Spread

Note: The blue line represents the orthogonal impulse response function. The green and red lines represent the upper and lower 95% confidence interval bounds.

profits or expect a better outlook on profitability, which naturally could result in a drop in unemployment rate. The country spread, in response to a shock to the dividend yield, would fall by as much as 14 basis points after an initial rise of 25 basis points.

Figure 19 displays the impulse responses to a positive shock to the country spread. As expected, the unemployment rate first increases, reaching the peak of 0.15% at the 22nd month, then decreases slowly back to the steady state. The inflation advances for two periods after the shock impact date then drops gradually to the pre-shock level. The dividend yield moves high right after the impact date then reverses to a downtrend in the medium term.

Based on Figure 16 to Figure 19, it can be noted that the responses of unemployment
to local financial variables are stronger than those to the global financial factors.

We also study how the unemployment rate and the inflation rate interact with each other. Figure 20 shows that an unanticipated shock to the unemployment would lead to a drop in inflation, which is consistent with what economic theory predicts: higher unemployment will cause lower consumption, which will in turn induce lower inflation. Figure 21 shows the impulse response of unemployment to a shock to the inflation. The unemployment drops after one period but then quickly goes up and stay above the steady state in the medium term. This suggests that high inflation is disadvantageous to the labor market conditions in emerging countries.

Next we will explore the variance decomposition of certain variables to gain more insights.

Figure 20. Impulse Response Functions to a One Standard Deviation Shock to the Unemployment

*Note:* The blue line represents the orthogonal impulse response function. The green and red lines represent the upper and lower 95% confidence interval bounds.
Variance Decomposition

Figure 22 - Figure 25 lay out the variance decompositions of several variables, including unemployment, inflation, dividend yield and country spread, at different horizons. First of all, we examine the variance decomposition of unemployment. At five years (60 months), the U.S. interest rate and the U.S. Baa corporate spread explain 0.2% and 2.6% of the variation in unemployment, respectively; while the inflation rate, the dividend yield and the country spread explain 3.4%, 7.8% and 16%, respectively. Second, for inflation, the two largest contributors to the movements in the inflation rate are the employment rate and the country spread, each of which explains a little more than 4% of the inflation variance at five years. The above results suggest that domestic macroeconomic and financial variables play a more important role in explaining macroeconomic fluctuations in emerging economies than the global financial risk, contrary to the findings in Akıncı (2013); and that the U.S.
real interest rate has a minimal effect on emerging countries’ business cycle movements. In addition, the changes in the unemployment is mostly explained by its own innovations in the short term (less than 1 year) but increasingly explained by the dividend yield and the country spread in the medium to long-term (5-10 years).

Third, the variance of the dividend yield are largely explained by its own innovations and the global financial risk (8%) in the short term (12 months). But in the medium term (60 months), the contribution of the global risk reduces to 7.2% and those of the U.S. interest rate and the unemployment increase to 6.9% and 4.8%, respectively.

Fourth, the global financial risk and the dividend yield together explain over 21% of the variation in the country spread in the first few months. But in the medium term (60 months), their explanation power decreases to 12.6%; while domestic macroeconomic variables, unemployment and inflation, exhibit their important effects on the country spread, explaining
Counterfactual Experiments

In this section, a counterfactual experiment, similar to what was performed in Akınçi (2013), is implemented to investigate by how much the global financial shocks explain the unemployment fluctuations in emerging economies through their effects on local financial risks including the dividend yield and the country spread.

In the experiment, we set the coefficients on the global financial variables to zeros in the two equations where the dividend yield or the country spread serves as the dependent variable. The variance decomposition in Figure 26 shows that the percentage of variance of unemployment explained by the U.S. interest rate is reduced by about 65% when compared to the baseline scenario; and Figure 27 shows that the percentage of variance of
unemployment explained by the global risk is reduced by about 60%. These results indicate that global financial factors affect macroeconomic aggregates in emerging markets mainly through their effects on local financial risks.

**Robustness Analysis**

In the last section, it was shown that local financial risks are the main drivers for unemployment fluctuations in emerging countries while the global financial risks play a minor role. In this section, the robustness checks will be conducted using alternative variable selection and model specifications to see whether such results still hold.
Alternative Global Financial Risk Proxies

There are several options for the global financial risk proxy, which are the U.S. stock market volatility index (VIX), the U.S. high yield corporate spread, which is the difference between the yield of the Merrill Lynch high yield master II index and the U.S. 20-year Treasury bond yield, the U.S. economic policy uncertainty index constructed by Baker, Bloom and Davis (2016), the U.S. dividend yield and Robert Shiller’s 5-year/10-year cyclically adjusted price-to-earnings (CAPE) ratio applied to the U.S. S&P 500 equity market.

We estimate the panel VAR model with the above six alternative proxies for the global financial risk. The findings are that the U.S. high yield corporate spread has more explanation power for the unemployment variations than the U.S. Baa corporate spread but still does not exceed that from the local financial risks; and that all other five proxies have even less contributions than the U.S. Baa corporate spread to the variance of the unemployment.
This suggests that the significance of global financial risks in affecting unemployment is at most as much as local financial risks.

**Alternative Local Financial Risk Proxies**

We estimate the baseline model with alternative local financial risk proxies, such as the dividend yield averaged over previous 3 (or 6, 12) months, the price-earning ratio, and the average of the price-earning ratios in the previous 3 (or 6, 12) months. The results all suggest that local financial risks are more important than global financial risks in explaining business cycle movements in emerging countries.

**Additional Emerging Countries**

The following four emerging economies are added to our sample: Bulgaria, Hungary, Poland and Russia. These countries are not included in the baseline sample because they
Figure 27. Percentage of Variance of Unemployment Explained by Global Risk - Counterfactual

experienced a transition from a centrally planned economy to a free market economy in the aftermath of the collapse of the Soviet Union in the early 1990s, which cause their economic data to be erratic.

The results from the new sample do not differ much from the baseline sample.

**Alternative Ordering in Identification**

Different ordering of the variables in the identification strategy could lead to different results. We estimate the baseline model with two alternative orderings. When the global financial risk is ordered before the U.S. real interest rate, or when the country spread in the emerging countries is ordered before the local dividend yield, the results are only slightly different and do not change the major conclusions.
Conclusion

Previous studies have stressed the importance of global financial shocks in shaping the business cycle movements in emerging countries. In this paper, however, we find that the local financial risk factors, including the country spread and the dividend yield, account for a larger portion of the variance of unemployment than the global financial risks. Specifically, the innovations in the country spread and the dividend yield explain 16% and 8% of the movements of the unemployment, respectively; while the innovations in the global financial risk and the U.S. real interest rate explain only 3% and 0.2%, respectively. The global financial factors, however, have an influence over the local financial factors. For instance, the U.S. interest rate shocks explain 7% of the variations of the dividend yield and the global financial risk shocks explain 7% and 6% of the variations of the dividend yield and the country spread, respectively. These results are robust to alternative global financial risk proxies, additional emerging countries and alternative identification strategies.
References


Appendix: TFP Process
I follow Stock and Watson (1999) and measure the total factor productivity as Solow residuals. The two Canadian data samples are of annual frequency from 1981 to 2000 and from 2001 to 2013, respectively. The calculation is based on the production function using data from Statistics Canada’s CANSIM database and is given by:

$$\log z_t = \log y_t - \alpha \log k_t - (1 - \alpha) \log h_t$$

The productivity measure is then detrended by the Hodrick-Prescott filter with smoothing parameter 50 to isolate the deterministic trend from the productivity shocks.

The same is done to extract the productivity data for the Australian and New Zealand’s economies.