Sources of Real Exchange Rate Fluctuations:
A Cointegration Approach for Commodity Currencies

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Overview

- Examines the roles of economic fundamentals in explaining the commodity currencies: Australia, Canada and New Zealand

- A SVECM approach to analyse the effect of shocks to economic fundamentals on the real exchange rate

- Decomposition of permanent and transitory shocks

- Identification frameworks
  - Pagan and Pesaran (2008)
Preview of the Results

- Long-run equilibrium relationship between the real exchange rate, commodity prices, output and government spending

- Supply shocks are the most important source of the real exchange rate fluctuations

- Commodity price shocks are less important than other permanent shocks

- Transitory shocks play a negligible role

- Findings help distinguish competing theoretical models and some policy implications are drawn
Outline

- Theoretical considerations: real exchange rate dynamics derivation
- Econometric model
- Pagan and Pesaran’s (2008) framework to identify structural parameters
- Results
- Conclusion
Theoretical Considerations
Derivation of real exchange rate dynamics

- Real exchange rate identity:

\[ q_t = s_t - p_t + p_t^*. \]  \hspace{1cm} (1)

- Fisher parity condition:

\[ i_t = r_t + E_t \Delta p_{t+1}. \] \hspace{1cm} (2)

- Uncovered Interest rate parity (UIP):

\[ E_t \Delta s_{t+1} = i_t - i_t^*. \] \hspace{1cm} (3)

- Expected change in the real exchange rate:

\[ E_t \Delta q_{t+1} = \theta (\bar{q}_t - q_t). \] \hspace{1cm} (4)

- Real exchange rate dynamics:

\[ q_t = \bar{q}_t + \frac{1}{\theta} (r_t^* - r_t). \] \hspace{1cm} (5)
Theoretical Considerations

Economic fundamentals driving equilibrium real exchange rate

- Real exchange rate dynamics for each country $j$, where $j = au, cn, nz$: 

$$ q^j_t = q^j_t(rpcom_t, y^{US}_t, y^j_t, g^j_t) + \frac{1}{\theta} r^j_t + \rho^j_t, \quad (6) $$

$rpc\text{om}_t$: real commodity price index

$y^{US}_t$: The U.S. real output per capita

$y^j_t$: country $j$'s real output per capita

$g^j_t$: U.S.-country $j$ government spending (to GDP) differential

$r^j_t$: U.S.-country $j$ real interest rate differential

$q^j_t$: real exchange rate against the U.S. dollar

$\rho^j_t$: exchange rate shock
A system of six endogenous variables for each country $j$,

$$X_t^j = [y_{US}^j, rpcom_t^j, y_t^j, g_t^j, r_t^j, q_t^j],$$

- $y_{US}^j, rpcom_t^j, y_t^j, g_t^j, q_t^j$ are I(1) and $r_t^j$ is I(0)

- One cointegration vector among the five I(1) variables

- Four common trends generated by permanent shocks, and two transitory shocks
Econometric Model (2)
Permanent and transitory shocks

- Four permanent shocks
  - the U.S. supply shock
  - real commodity price shock
  - domestic supply shock
  - relative demand shock

- Two transitory shocks
  - interest rate shock
  - exchange rate shock
Econometric Model (3)

Structural model

- SVAR (3) for each country \( j \) relative to the U.S.:

\[
\Gamma_0 X^j_t = \Gamma_1 X^j_{t-1} + \Gamma_2 X^j_{t-2} + \Gamma_3 X^j_{t-3} + \varepsilon_t
\]  

(7)

- Transformed into:

\[
B_0 \Delta X^j_t = -B(1) X^j_{t-1} + B_1 \Delta X^j_{t-1} + B_2 \Delta X^j_{t-2} + \varepsilon_t,
\]  

(8)

where

\[
B_0 = \Gamma_0,
B_1 = -(\Gamma_2 + \Gamma_3),
B_2 = -\Gamma_3,
B(1) = \Gamma_0 - \Gamma_1 - \Gamma_2 - \Gamma_3.
\]
Econometric Model (4)

- Reduced-form VECM:

\[
\Delta X_t^j = -B_0^{-1} B(1) X_{t-1}^j + B_0^{-1} B_1 \Delta X_{t-1}^j + B_0^{-1} B_2 \Delta X_{t-2}^j + B_0^{-1} \varepsilon_t
\]

\[
= \Pi X_{t-1}^j + B_0^{-1} B_1 \Delta X_{t-1}^j + B_0^{-1} B_2 \Delta X_{t-2}^j + B_0^{-1} \varepsilon_t. \quad (9)
\]

Since there are \( r < n \) cointegration relations in the system, \( \Pi = \alpha \beta' \) and

\[
\Delta X_t^j = \alpha \beta' X_{t-1}^j + B_0^{-1} B_1 \Delta X_{t-1}^j + B_0^{-1} B_2 \Delta X_{t-2}^j + B_0^{-1} \varepsilon_t,
\]

\[
B_0 \Delta X_t^j = \alpha^* \beta' X_{t-1}^j + B_1 \Delta X_{t-1}^j + B_2 \Delta X_{t-2}^j + \varepsilon_t, \quad (10)
\]

where \( \alpha^* = B_0 \alpha \).
Structural VECM:

$$B_0 \Delta X^j_t = \alpha^i \beta' X^i_{t-1} + B_1 \Delta X^j_{t-1} + B_2 \Delta X^j_{t-2} + \varepsilon_t,$$

Pagan and Pesaran (2008) show that $\alpha^*_i = 0$ for structural equation $i$ where $\varepsilon_{it}$ is permanent.

Structural equations for which there are known permanent shocks must have no error correction terms present in them, thereby $\beta' X^i_{t-1}$ are available to be used as instruments for estimating their structural parameters.

Cointegration vector ($\beta'$) is estimated super-consistently by OLS.
\[ \Delta X^j_t = \begin{bmatrix} \Delta y^j_t^{US} \\ \Delta r_p^{com} \\ \Delta y^j_t \\ \Delta g^j_t \\ \Delta r^j_t \\ \Delta q^j_t \end{bmatrix} \]

\[ \alpha^* = \begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ \alpha_5 \alpha^* & \alpha_5^* \\ \alpha_6 \alpha^* & \alpha_6^* \end{bmatrix} \]

\[ \beta^\prime = \begin{bmatrix} \beta_1 & \beta_2 & \beta_3 & \beta_4 & 0 & 1 \\ 0 & 0 & 0 & 0 & 1 & 0 \end{bmatrix} \]
Identifying Permanent Shocks

- The U.S. supply shock is identified by contemporaneous restrictions

\[
B_0 = \begin{bmatrix}
\times & 0 & 0 & 0 & 0 & 0 \\
\times & \times & \times & \times & \times & \times \\
\times & \times & \times & \times & \times & \times \\
\times & \times & \times & \times & \times & 0 \\
\times & \times & \times & \times & \times & \times \\
\end{bmatrix}
\]

- Commodity price, domestic supply and relative demand shocks are identified by long-run restrictions:

\[
B_0 - B_1 - B_2 = \begin{bmatrix}
\times & \times & \times & \times & \times & \times \\
\times & \times & 0 & 0 & \times & \times \\
\times & \times & \times & 0 & \times & \times \\
\times & \times & \times & \times & \times & \times \\
\times & \times & \times & \times & \times & \times \\
\end{bmatrix}
\]


Interest rate and exchange rate shocks are identified by a contemporaneous restriction:

\[ B_0 = \begin{bmatrix} x & 0 & 0 & 0 & 0 & 0 \\ x & x & x & x & x & x \\ x & x & x & x & x & x \\ x & x & x & x & x & x \\ x & x & x & x & x & x \\ x & x & x & x & x & x \\ x & x & x & x & x & x \end{bmatrix} . \]
Impulse Responses to the U.S. Supply Shock

Sources of Real Exchange Rate Fluctuations

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Impulse Responses to the Real Commodity Price Shock

Sources of Real Exchange Rate Fluctuations
Impulse Responses to the Domestic Supply Shock

Chanthapun (CAM)

Sources of Real Exchange Rate Fluctuations
Impulse Responses to the Relative Demand Shock

- Demand shock on yus
- Demand shock on rpsom
- Demand shock on yd
- Demand shock on g
- Demand shock on r
- Demand shock on q
Impulse Responses to the Interest Rate Shock

- Interest rate shock on yus
- Interest rate shock on rpcm
- Interest rate shock on yd
- Interest rate shock on q
- Interest rate shock on r
- Interest rate shock on q
Impulse Responses to the Exchange Rate Shock
Impulse Responses of the Australian Real Exchange Rate

[a] US supply shocks on q

[b] commodity price shocks on q

[c] domestic supply shocks on q

[d] demand shocks on q

[e] interest rate shocks on q

[f] exchange rate shocks on q
### Variance Decomposition of Australian Real Exchange Rate

#### Sources of Real Exchange Rate Fluctuations

<table>
<thead>
<tr>
<th>Horizon</th>
<th>U.S. supply shock</th>
<th>commodity price shock</th>
<th>domestic supply shock</th>
<th>demand shock</th>
<th>interest rate shock</th>
<th>exchange rate shock</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 year</td>
<td>12.22</td>
<td>1.64</td>
<td>77.14</td>
<td>5.90</td>
<td>0.27</td>
<td>2.83</td>
</tr>
<tr>
<td>2 years</td>
<td>15.64</td>
<td>2.17</td>
<td>74.69</td>
<td>4.75</td>
<td>0.30</td>
<td>2.46</td>
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<tr>
<td>3 years</td>
<td>24.51</td>
<td>2.42</td>
<td>66.60</td>
<td>3.91</td>
<td>0.34</td>
<td>2.23</td>
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<tr>
<td>5 years</td>
<td>33.78</td>
<td>3.03</td>
<td>56.89</td>
<td>4.04</td>
<td>0.34</td>
<td>1.93</td>
</tr>
<tr>
<td>15 years</td>
<td>26.34</td>
<td>3.42</td>
<td>61.72</td>
<td>7.01</td>
<td>0.23</td>
<td>1.29</td>
</tr>
</tbody>
</table>
Supply shocks are the most important source of the real exchange rate fluctuations for Australia and New Zealand.

Relative demand shocks are the most important for Canada.

Commodity price shocks play a smaller role.

Transitory shocks account for very little of the real exchange rate fluctuations.
The importance of supply shocks found contradicts previous findings in the SVAR literature.

Cointegrating relationship is crucial in empirical exchange rate modeling.

Support to theoretical models emphasising the role of productivity differential as a key driver of the real exchange rate, e.g. Balassa (1964) and Samuelson (1964).

The unimportance of transitory interest rate shock.

Monetary policy is less likely to influence the real exchange rate successfully.
Questions and comments