Commodity Trade and the Carry Trade: a Tale of Two Countries

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Wharton

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Carry Trades and Heterogeneity

- High interest rate currencies don’t depreciate on average
  ⇒ failure of UIP in the cross-section ⇒ carry-trade

- Common factor loadings explain carry trade risk premia
  ⇒ heterogeneity in countries’ SDF exposures to global shocks
  - Lustig, Roussanov and Verdelhan (2011)

- Much of this heterogeneity is permanent/persistent
  ⇒ unconditional currency risk premia ≠ 0 - LRV (2011, 2012)
  - Bakshi et. al. (2008), Campbell et. al. (2010), Koijen et. al. (2012)

- Most models feature transitory heterogeneity only
  - e.g. Verdelhan (2010), Stathopoulos (2011), Colacito-Croce (2012)

- What is the source of persistent heterogeneity?
G10 Currency Forward Discounts and FX Returns

- forward discounts $\approx$ interest rate differentials ($r^i - r^{US}$)
- currency excess returns $rx^i = r^i - r^{US} - \Delta s^i$

<table>
<thead>
<tr>
<th>Country</th>
<th>$E(r^i - r^{US})$</th>
<th>$E(rx^i)$</th>
<th>Import Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Japan</td>
<td>-1.97</td>
<td>-2.70</td>
<td>-0.54</td>
</tr>
<tr>
<td>Switzerland</td>
<td>-0.32</td>
<td>-1.53</td>
<td>-0.21</td>
</tr>
<tr>
<td>Germany - Euro</td>
<td>0.11</td>
<td>-0.15</td>
<td>-0.18</td>
</tr>
<tr>
<td>Sweden</td>
<td>0.80</td>
<td>1.37</td>
<td>-0.11</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>0.92</td>
<td>1.81</td>
<td>0.05</td>
</tr>
<tr>
<td>Canada</td>
<td>1.66</td>
<td>0.65</td>
<td>0.21</td>
</tr>
<tr>
<td>Norway</td>
<td>1.99</td>
<td>1.81</td>
<td>0.51</td>
</tr>
<tr>
<td>Australia</td>
<td>4.02</td>
<td>2.71</td>
<td>0.65</td>
</tr>
<tr>
<td>New Zealand</td>
<td>4.06</td>
<td>3.08</td>
<td>0.53</td>
</tr>
</tbody>
</table>
This Paper

- Model of unconditional currency risk premia
  - key features: goods markets frictions and heterogeneity in trade

- Economically-motivated sort based on Import/Export data
  - explains the unconditional carry trade in the data

- Model implies procyclical behavior of unconditional carry returns
  - consistent with the empirical evidence

- Calibrated model matches quantitative features of the data
  - rare disaster/crash risk premium
Key building blocks

- Countries fundamentally different: *ex ante asymmetry*
  - country size: Martin (2011), Hassan (2013)

- Traditional approach to exchange rates: *trade costs*
  - classic: Dumas (1992), Hollifield and Uppal (1997)
Simple Two-country Model with Heterogeneity

- Two countries: producer and commodity

- Commodity country’s commodity endowment $y$ and exports $x$

- Both countries use commodity to produce final good:
  - Commodity country: $z_c(y - x)$
  - Producer country: $z_p x$

- Producer country has a comparative advantage: $z_p > z_c$.

- Producer country exports $X$ of final good subject to trade cost:
  \[ \tau(X_t, \kappa z_{k_t}) = \frac{\kappa}{2} \frac{X_t}{z_{k_t}}. \]
Uncertainty

- Exogenous productivity dynamics \((z_p, z_c, z_k)\)

- Two stationary state variables:
  \[
  q \doteq \log z_p - \log z_k
  \]

- Shipping capacity slow to adjust \(\Rightarrow\) trade costs volatile
  \[
  z \doteq z_c/z_p \in (0, 1)
  \]

- Relative productivity persistent around long-term mean
Complete markets

\[ U(z_{ps}, z_{cs}, z_{ks}) = \max_{\{x_s, X_s\}} \mathbb{E}_t \left[ \int_t^\infty e^{-\rho(s-t)} \left( \frac{c^{1-\gamma}_{cs}}{1-\gamma} + \lambda \frac{c^{1-\gamma}_{ps}}{1-\gamma} \right) ds \right] \]

where:

- \( x \) is exports of commodity
- \( X \) is exports of final good
- \( c_c = z_c(y - x) + X \left(1 - \frac{\kappa}{2} \frac{X}{z_k}\right) \)
- \( c_p = z_p x - X \)
Endogenous risk-sharing, exchange rates, and productivity

• Planner’s FOC w.r.t. $X$ implies:

$$\lambda \left( \frac{c_c}{c_p} \right)^{-\gamma} = \frac{1}{\left(1 - \kappa \frac{X}{z_k}\right)} \Rightarrow S \text{ (real exchange rate)}$$

• Planner’s FOC w.r.t. $x$ implies:

$$S = \frac{z_p}{z_c} = \frac{1}{Z} \text{ (relative productivity)}$$
Consumption wedge $\omega(z)$

Define $\omega(z) \equiv \left( \frac{z}{\lambda} \right)^{-\frac{1}{\gamma}}$, so $c_p = \omega(z)c_c$.

- If $z_c/z_p \downarrow \iff$ Lower $z \iff$ Higher $\tau_X$

- Producer-country’s consumption moves more than commodity-country’s
  - Shipping costs reduce smoothing
  - Producer country absorbs fluctuations
Result 1: Interest-rate differential

Proposition 1

Interest-rate Differential: $r_p^f < r_c^f$ on average

- Consumption wedge $\Rightarrow c_p$ more volatile than $c_c$
- Drifts equal (unconditionally)
- Precautionary motive
- Carry trade?

$$(r_c^f - r_p^f)dt = -\mathbb{E}_t \left[ \frac{dS}{S} \right] + \gamma \mathbb{E}_t \left[ \frac{dS}{S} \frac{dc_p}{c_p} \right]$$

\[\text{Risk premium}\]
Result II: Carry-trade Risk premium

Proposition 2 - Currency Risk Premium

1. *Positive* over all $z$
2. *Monotone decreasing* in $z$

- Commodity currency risky since $S \downarrow$ when $cp \downarrow$ and $cc \downarrow$
- Covariance $\mathbb{E}_t \left[ \frac{dS}{S} \frac{dc_p}{c_p} \right] > 0$
Import ratio

- **Import ratio:**
  \[
  \frac{\text{Net Imports of Finished Goods} + \text{Net Exports of Basic Goods}}{\text{Total Consumption}}
  \]

- **Final Good Importers Minus Exporters (IMX)**
  \[\Rightarrow\text{Long commodity currency/short producer currency: a carry trade!}\]
Trade Data

- World trade data from U.N. Comtrade
- Classify goods into Basic/Input and Finished/Complex based on SITC

- Compute ratios of Net Exports/Imports to Total Trade (or GDP)
  - Basic Good Exports to Total Trade
  - Finished Good Exports to Total Trade
  - Combined Measure:
    \[
    \frac{\text{Net Imports of Finished Goods} + \text{Net Exports of Basic Goods}}{\text{Total Consumption (or Total Trade)}}
    \]

- Use ratios to sort countries into portfolios
Data Sources

FX Data - follow LRV (2011)

- Data from Barclays and Reuters.
- Start from daily spot and forward exchange rates in US dollars.
- Build end-of-month series from November 1988 to December 2012.
- Sample of 35 developed and emerging countries: Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Euro area, Finland, France, Germany, Greece, Hungary, India, Indonesia, Ireland, Italy, Japan, Kuwait, Malaysia, Mexico, Netherlands, New Zealand, Norway, Philippines, Poland, Portugal, Singapore, South Africa, South Korea, Spain, Sweden, Switzerland, Taiwan, Thailand, United Kingdom.

- Sub-sample of 21 developed-country currencies: Australia, Austria, Belgium, Canada, Denmark, Euro, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.
Model Predictions

1. Commodity country has higher interest rates on average
   - increasing in the Import Ratio
Interest Rates vs. Combined Trade Measure
## Yearly Forward Discounts

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Import Ratio</strong></td>
<td>0.974***</td>
<td></td>
<td>0.822***</td>
</tr>
<tr>
<td></td>
<td>(0.0689)</td>
<td></td>
<td>(0.0715)</td>
</tr>
<tr>
<td><strong>Log GDP Ratio</strong></td>
<td>-0.571***</td>
<td>-0.349***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(0.0967)</td>
<td>(0.110)</td>
<td></td>
</tr>
<tr>
<td><strong>$R^2$</strong></td>
<td>0.108</td>
<td>0.060</td>
<td>0.128</td>
</tr>
<tr>
<td><strong>N</strong></td>
<td>494</td>
<td>494</td>
<td>494</td>
</tr>
</tbody>
</table>
Model Predictions

1. Commodity country has higher interest rates on average

2. Commodity currency earns positive expected return
   - increasing in the Import Ratio
Portfolios Sorted on Import Ratio

All countries:

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Forward Discount: $f^j - s^j$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>-0.39</td>
<td>0.84</td>
<td>1.70</td>
<td>2.01</td>
<td>2.91</td>
<td>2.78</td>
</tr>
<tr>
<td>Std</td>
<td>0.64</td>
<td>0.68</td>
<td>0.63</td>
<td>0.69</td>
<td>0.61</td>
<td>0.49</td>
</tr>
<tr>
<td>Excess Return: $r\chi^j$</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>-0.54</td>
<td>1.61</td>
<td>2.78</td>
<td>1.73</td>
<td>1.78</td>
<td>4.34</td>
</tr>
<tr>
<td>Std</td>
<td>7.93</td>
<td>9.08</td>
<td>9.69</td>
<td>7.14</td>
<td>8.79</td>
<td>9.66</td>
</tr>
<tr>
<td>SR</td>
<td>-0.07</td>
<td>0.18</td>
<td>0.29</td>
<td>0.24</td>
<td>0.20</td>
<td>0.45</td>
</tr>
</tbody>
</table>

Final Good Importers Minus eXporters (IMX) strategy: 6 minus 1.
Portfolios Sorted on Combined Measure

Developed Countries:

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>Forward Discount: $f^j - s^j$</th>
<th>Excess Return: $r_{x^j}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>-0.68 -0.08 0.91 1.48 2.44</td>
<td>-0.12 1.01 0.99 3.48 3.86</td>
</tr>
<tr>
<td>Std</td>
<td>0.68 0.73 0.58 0.65 0.54</td>
<td>8.98 10.66 9.26 8.89 9.63</td>
</tr>
<tr>
<td>SR</td>
<td>-0.01 0.09 0.11 0.39 0.40</td>
<td>-0.01 0.09 0.11 0.39 0.40</td>
</tr>
</tbody>
</table>
Model Predictions

1. Commodity country has higher interest rates on average

2. Commodity currency earns positive expected return

3. Commodity currency is contemporaneously correlated with trade costs and commodity prices
FX, Commodities and Shipping Costs during the Crisis
Carry Strategies

- Commodity-currency strategy: Final Good Importers Minus Exporters (IMX)

- Compare to the “traditional” carry trade strategy $HML_{FX}$
  - LRV (2011)

- Decomposition into conditional and unconditional components
  - LRV (2012)
    - conditional - $HML_{FX}$ orthogonal to IMX ($CHML$)
    - unconditional - Sort on pre-formation average interest rate (1984-1995) and examine post-formation returns (1995-2012)

- IMX explains the unconditional carry trade
### IMX, Trade Costs, and Commodity Prices

#### Carry Trades and Trade Costs

<table>
<thead>
<tr>
<th></th>
<th>IMX</th>
<th>HML(_{FX})</th>
<th>CHML(_{FX})</th>
</tr>
</thead>
<tbody>
<tr>
<td>(\Delta bdi_t)</td>
<td>0.030**</td>
<td>0.022*</td>
<td>0.003</td>
</tr>
<tr>
<td></td>
<td>(0.014)</td>
<td>(0.012)</td>
<td>(0.008)</td>
</tr>
<tr>
<td>R-sq</td>
<td>0.034</td>
<td>0.017</td>
<td>0.000</td>
</tr>
</tbody>
</table>

#### Carry Trades and Commodity Prices

<table>
<thead>
<tr>
<th></th>
<th>IMX</th>
<th>HML(_{FX})</th>
<th>CHML(_{FX})</th>
</tr>
</thead>
<tbody>
<tr>
<td>(R^\text{Com}_t)</td>
<td>0.345**</td>
<td>0.172*</td>
<td>-0.010</td>
</tr>
<tr>
<td></td>
<td>(0.070)</td>
<td>(0.090)</td>
<td>(0.057)</td>
</tr>
<tr>
<td>R-sq</td>
<td>0.133</td>
<td>0.031</td>
<td>0.000</td>
</tr>
</tbody>
</table>
Model Predictions

1. Commodity currency is high interest rate / high-return currency

2. Commodity currency is contemporaneously correlated with trade costs and commodity prices

3. Risk premium is time varying and procyclical
Time variation in IMX/Carry risk-premium

- Model prediction:
  high $\tau \Rightarrow$ greater segmentation in consumption risk

- $\tau$ is high in “good” times (Low $z \Leftrightarrow$ High $\tau$)
  - $z_p$ rises relative to $z_c \Rightarrow z \downarrow$

- IMX/Carry expected returns procyclical?
Predicting IMX/Carry Returns

### Predicting Carry Trade with Baltic Dry Index (BDI)

<table>
<thead>
<tr>
<th>Horizon:</th>
<th>IMX 3-month</th>
<th>$HML_{FX}$ 3-month</th>
<th>$CHML_{FX}$ 3-month</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta bdi_{t-4,t-1}$</td>
<td>0.093** (0.034)</td>
<td>0.077* (0.031)</td>
<td>0.022 (0.025)</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.041</td>
<td>0.027</td>
<td>0.003</td>
</tr>
</tbody>
</table>

### Predicting G10 Carry Trades with Commodity Prices

<table>
<thead>
<tr>
<th>$\Delta CRB_{t-4,t-1}$</th>
<th>$IMX$</th>
<th>$HML_{FX}$</th>
<th>$CHML_{FX}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0.396* (0.228)</td>
<td>0.421** (0.186)</td>
<td>0.083 (0.122)</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.015</td>
<td>0.003</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Model Predictions

1. Commodity country has higher interest rates on average

2. Commodity currency earns positive expected return

3. Commodity currency is contemporaneously correlated with trade costs and commodity prices

4. Risk premium is time varying and procyclical

5. Producer country is more exposed to global shocks
Consumption Expenditure during the Crisis
Model Predictions

1. Commodity country has higher interest rates on average

2. Commodity currency earns positive expected return

3. Commodity currency is contemporaneously correlated with trade costs and commodity prices

4. Risk premium is time varying and procyclical

5. Producer country is more exposed to global shocks

6. Relative productivity and real exchange rates closely related
Model with labor and segmented markets

- Labor allocated to commodity production pinned down by $x$
- Fraction $1 - \psi$ of households are “inactive” in financial markets

\[
\max_{x, \mathcal{X}} u(c_c^A) + \lambda u(c_p^A) \quad \text{s.t.}
\]

\[
c_p^I = (1 - \psi_p) \beta y_p \quad \text{Labor share}
\]

\[
c_p^A = y_p - X - c_p^I
\]

\[
c_c^I = (1 - \psi_c)(y_{cp} + px(1 - \tau(X, z_k)))
\]

\[
c_c^A = \psi_c y_{cp} + X(1 - \tau(X, z_k)) - (1 - \psi_c)px(1 - \tau(X, z_k)) \quad \text{Terms-of-trade}
\]

Risk sharing
\[ \Rightarrow \lambda \frac{u'(c^A_p)}{u'(c^A_c)} = \frac{1}{S} \neq \lambda \frac{u'(c_p)}{u'(c_c)} \]

- Idea: \( z_p \uparrow \Rightarrow p \uparrow \Rightarrow c^A_p/c^A_c \) rises more than \( c_p/c_c \)

- Terms-of-trade effect benefits \( c^l_c \) and squeezes \( c^A_c \)
Dynamics

- Productivity (of final goods producer):
  \[ d \log z_{pt} = (\mu - \mu Z \eta) \, dt + \sigma_p dB_{pt} + dQ_t \]

- Cointegrated with supply of commodity:
  \[ q_t = \log z_{pt} - \beta \log z_{ct} \]
  \[ dq_t = [(1 - \beta)(\mu - \mu Z \eta) - \beta \psi q_t] \, dt + \sigma_p dB_{pt} - \beta \sigma_c dB_{ct} + dQ_t, \]
  \[ \Rightarrow d \log z_{ct} = (\mu + \psi q_t) \, dt + \sigma_c dB_{ct} \]

- Cointegrated with shipping costs:
  \[ q_{kt} = \log z_{ct} - \log z_{kt} \]
  \[ dq_{kt} = (\psi q_t - \psi_k q_{kt}) \, dt + \sigma_c dB_{ct} - \sigma_k dB_{kt} \]
  \[ \Rightarrow d \log z_{kt} = (\mu + \psi_k q_{kt}) \, dt + \sigma_k dB_{kt} \]
### Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\lambda$</td>
<td>1</td>
<td>Relative Pareto weight</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.9</td>
<td>Cobb-Douglas producer-country labor share</td>
</tr>
<tr>
<td>$\gamma$</td>
<td>5</td>
<td>Relative risk aversion</td>
</tr>
<tr>
<td>$\rho$</td>
<td>0.001</td>
<td>Rate of time preference (annualized)</td>
</tr>
<tr>
<td>$\kappa_c^0$</td>
<td>0.01</td>
<td>Fixed commodity trade cost</td>
</tr>
<tr>
<td>$\kappa_c^1$</td>
<td>0.55</td>
<td>Variable commodity trade cost</td>
</tr>
<tr>
<td>$\kappa_f^0$</td>
<td>0.001</td>
<td>Fixed final trade cost</td>
</tr>
<tr>
<td>$\kappa_f^1$</td>
<td>0.75</td>
<td>Variable final trade cost</td>
</tr>
<tr>
<td>$\sigma_p$</td>
<td>0.0025</td>
<td>Productivity shock volatility (annualized)</td>
</tr>
<tr>
<td>$\sigma_k$</td>
<td>0.0001</td>
<td>Shipping shock volatility (annualized)</td>
</tr>
<tr>
<td>$\sigma_c$</td>
<td>0.0015</td>
<td>Commodity shock volatility (annualized)</td>
</tr>
<tr>
<td>$\mu$</td>
<td>0.018</td>
<td>Uncompensated TFP growth rate (annualized)</td>
</tr>
<tr>
<td>$\psi$</td>
<td>0.01</td>
<td>Mean reversion of commodity supply ($z_c$ to $z_p$)</td>
</tr>
<tr>
<td>$\psi_k$</td>
<td>0.00001</td>
<td>Mean reversion of shipping capacity ($z_k$ to $z_c$)</td>
</tr>
<tr>
<td>$\eta$</td>
<td>1 per 25 years</td>
<td>jump frequency</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>1.1</td>
<td>Power tail of jump</td>
</tr>
<tr>
<td>$Z_{\min}$</td>
<td>2%</td>
<td>Minimum jump size</td>
</tr>
<tr>
<td>$Z_{\max}$</td>
<td>120%</td>
<td>Maximum jump size</td>
</tr>
</tbody>
</table>

Distribution of Simulated Equilibrium Moments

Match the two countries to GDP-weighted baskets:

“commodity country” = (Australia, Canada, New Zealand, Norway)
“producer country” = (Germany, Japan, Sweden, Switzerland)

<table>
<thead>
<tr>
<th></th>
<th>Medians</th>
<th>Means</th>
<th>Means, no disasters</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean   Std   AC</td>
<td>Mean   Std   AC</td>
<td>Mean   Std   AC</td>
<td>Mean   Std   AC</td>
</tr>
<tr>
<td>(\Delta y_{pt})</td>
<td>1.58  0.93  0.24</td>
<td>1.38  2.34  0.25</td>
<td>1.53  1.32  0.25</td>
<td>1.23  1.83  0.31</td>
</tr>
<tr>
<td>(\Delta y_{ct})</td>
<td>1.56  0.70  0.60</td>
<td>1.34  1.72  0.58</td>
<td>1.50  0.98  0.56</td>
<td>2.84  0.97  0.43</td>
</tr>
<tr>
<td>(\Delta c_{pt})</td>
<td>1.58  0.91  0.24</td>
<td>1.40  2.23  0.25</td>
<td>1.53  1.28  0.25</td>
<td>1.40  1.41  -0.20</td>
</tr>
<tr>
<td>(\Delta c_{ct})</td>
<td>1.70  0.39  0.25</td>
<td>1.57  1.27  0.25</td>
<td>1.67  0.62  0.25</td>
<td>2.92  0.92  0.31</td>
</tr>
<tr>
<td>(\Delta X_t)</td>
<td>1.58  0.94  0.24</td>
<td>1.37  2.43  0.25</td>
<td>1.52  1.35  0.25</td>
<td>3.21  10.21  0.02</td>
</tr>
<tr>
<td>(r_{pt}^f)</td>
<td>3.24  0.78  0.73</td>
<td>3.27  1.20  0.73</td>
<td>3.23  0.89  0.74</td>
<td>2.44  0.71  0.92</td>
</tr>
<tr>
<td>(r_{ct}^f)</td>
<td>6.64  0.28  0.82</td>
<td>6.49  0.58  0.82</td>
<td>6.60  0.36  0.83</td>
<td>4.65  0.58  0.94</td>
</tr>
<tr>
<td>(dRet_t)</td>
<td>2.74  6.95  0.09</td>
<td>2.37  10.56  0.09</td>
<td>2.70  7.49  0.09</td>
<td>2.86  7.62  0.04</td>
</tr>
</tbody>
</table>

- “Disaster” = \(\Delta c_p < -5\%\)
- annualized, time-aggregated (macro: annual frequency; returns: monthly frequency)
## Carry Return Predictability in the Model

<table>
<thead>
<tr>
<th>Carry Trades and Trade Costs</th>
<th>$dRet_t$</th>
<th>$dRet_t$</th>
<th>$dRet_t$</th>
<th>$dRet_t$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Return Horizon:</td>
<td>1-month</td>
<td>3-month</td>
<td>6-month</td>
<td>12-month</td>
</tr>
<tr>
<td>$\Delta \tau_f$</td>
<td>1.95**</td>
<td>1.49*</td>
<td>1.04</td>
<td>0.58</td>
</tr>
<tr>
<td></td>
<td>( 0.95)</td>
<td>( 0.83)</td>
<td>( 0.68)</td>
<td>( 0.57)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>0.01</td>
<td>0.02</td>
<td>0.02</td>
<td>0.01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Carry Trades and Commodity Prices</th>
<th>$\Delta \log P_t$</th>
<th>$\Delta \log P_t$</th>
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<td>6-month</td>
<td>12-month</td>
</tr>
<tr>
<td>$\Delta \log P_t$</td>
<td>1.88**</td>
<td>1.43*</td>
<td>0.99</td>
<td>0.55</td>
</tr>
<tr>
<td></td>
<td>( 0.87)</td>
<td>( 0.78)</td>
<td>( 0.66)</td>
<td>( 0.56)</td>
</tr>
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<td>$R^2$</td>
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</tr>
</tbody>
</table>
Summary

- Propose an economic mechanism for heterogeneity in risk exposure across countries.

- Theory-motivated strategy based on import/export of basic/finished goods (IMX) delivers high expected returns and Sharpe ratios.

- Explains the *unconditional* carry trade returns.

- Captures pro-cyclical dynamics of carry risk premia using trade costs and commodity prices, consistent with model predictions.
Stochastic processes

Productivity growth

\[ \frac{dz_p}{z_p} = \mu dt + \sigma dB \]

Shipping capacity

\[ q = \log z_p - \log z_k \]
\[ dq = \phi \left( \bar{q} - \frac{\sigma^2_k - \sigma^2}{2\phi} - q \right) dt + \sigma_q dB_q \]
\[ \Rightarrow \quad \frac{dz_k}{z_k} = (\mu + \phi(\bar{q} - q))dt + \sigma_k dB_k \]

Relative productivity

\[ z \equiv z_c/z_p \in (0, 1) \]
\[ dz = \theta(\bar{z} - z)dt + \sigma_z \sqrt{z(1 - z)} dB_z. \]
Appendix

Risk-free rates

\[ \pi = e^{-\rho t} c^{-\gamma} \]

Producer:

\[ \frac{d\pi_p}{\pi_p} = -\rho dt - \gamma \frac{dc_p}{c_p} + \frac{1}{2} \gamma (1 + \gamma) \frac{dc_p^2}{c_p^2} \]

\[ \pi_c = e^{-\rho t} c^{-\gamma} = e^{-\rho t} \left( \frac{c_p}{\omega(z)} \right)^{-\gamma} = e^{-\rho t} c_p^{-\gamma} S \lambda \]

Commodity:

\[ \frac{d\pi_c}{\pi_c} = -\rho dt + \frac{dS}{S} - \gamma \frac{dc_p}{c_p} + \frac{1}{2} \gamma (1 + \gamma) \frac{dc_p^2}{c_p^2} - \gamma \frac{dS}{S} \frac{dc_p}{c_p} \]

\[ r^f dt \overset{\circ}{=} -\mathbb{E}_t \left[ \frac{d\pi}{\pi} \right] \]

Therefore,

\[ (r^f_c - r^f_p) dt + \mathbb{E}_t \left[ \frac{dS}{S} \right] = \gamma \mathbb{E}_t \left[ \frac{dS}{S} \frac{dc_p}{c_p} \right] \]