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

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Robert Ready, Nikolai Roussanov and Colin Ward

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Abstract

Persistent differences in interest rates across countries account for much of the profitability of currency carry trade strategies. We relate these differences to the differences of economic fundamentals across countries. We show that countries that primarily export basic commodities exhibit systematically high (real) interest rates while countries that specialize in exporting finished consumption goods typically have lower rates. The resulting interest rate differentials do not fully translate into the depreciation of the commodity currencies, on average. Instead, they translate into expected returns that capture the bulk of the unconditional risk premia that can be obtained in the currency markets. We provide a general equilibrium model of commodity trade and currency pricing that can rationalize these facts by relying on adjustment costs in the shipping sector.
1 Introduction

A currency carry trade is long high interest rate currencies and short low interest rate currencies. A typical carry trade involves buying Australian dollar, which for much of the last three decades earned a high interest rate, and funding the position with borrowing in Japanese yen, and thus paying extremely low rate on the short leg. Such a strategy earns positive expected returns on average, and despite substantial volatility and risk of large losses, such as ones incurred during the global financial crisis, exhibits high Sharpe ratios. In the absence of arbitrage this implies that the marginal utility of an investor whose consumption basket is denominated in yen is more volatile than that of an Australian consumer. Are there fundamental economic differences between countries that could give rise to such a heterogeneity in risk? One source of differences across countries is the composition of their trade. Countries that specialize in exporting basic commodities, such as Australia, tend to have high interest rates. Conversely, countries that import most of the basic input goods and export finished consumption goods, such as Japan, have low interest rates on average. These differences in interest rates do not translate into the depreciation of “commodity currencies” on average; rather, they constitute positive average returns, giving rise to a carry trade-type strategy. We document new evidence that this pattern is systematic and robust over the recent time period and is by no means limited to the Australia-Japan pair.

The fact that carry trade strategies typically earn positive average returns is a manifestation of the failure of the Uncovered Interest Parity (UIP) hypothesis, which is one of the major longstanding puzzles in international finance. It is commonly recognized that time-varying risk premia are a major driver of carry trade profits. In fact, a long-standing consensus in the international finance literature attributed all of the carry trade average returns to conditional risk premia, with no evidence of non-zero unconditional risk premia on individual currencies throughout most of the twentieth century (e.g. see Lewis (1995)). However, Lustig, Roussanov, and Verdelhan (2011a) show that unconditional currency risk premia are in fact substantial; indeed, they account for between a third and a half of the profitability of carry trade strategies.¹ Lustig, Roussanov, and Verdelhan (2011a) argue that these returns are compensation for global risk, and the presence of unconditional risk premia implies that there is persistent heterogeneity across countries’ exposures to common shocks. In this paper we uncover a potential source of such heterogeneity.

We show that the differences in average interest rates and risk exposures between countries that are net importers of basic commodities and commodity-exporting countries can be

¹See also Campbell, Medeiros, and Viceira (2010) and Lustig, Roussanov, and Verdelhan (2011b) for additional empirical evidence. Theoretical models of Hassan (2010) and Martin (2011) relate currency risk premia to country size.
explained by appealing to a natural economic mechanism: trade costs. We model trade costs by considering a simple model of the shipping industry. At any time the cost of transporting a unit of good from one country to the other depends on the aggregate shipping capacity available. Marginal costs of shipping an extra unit of good is increasing - i.e., trade costs in our model are convex. But investment in shipping capacity reduces the marginal cost of shipping in the future. Convex shipping costs imply that the sensitivity of the commodity country to world productivity shocks is lower than that of the country that specializes in producing the final consumption good, simply because it is costlier to deliver an extra unit of the consumption good to the commodity country in good times, but cheaper in bad times. Therefore, under complete financial markets, the commodity country’s consumption is smoother than it would be in the absence of trade frictions, and, conversely, the commodity importer’s consumption is riskier.

2 Data

Following Lustig, Roussanov, and Verdelhan (2011a) we use forward and spot exchange rates to construct forward discounts and excess returns on currencies. We use the same set of currencies. Data is provided by Barclays and Reuters and is available via Datastream. We use monthly series from November 1983 to June 2010.

We use two samples in our analysis. The sample of all 35 developed and emerging countries includes: 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. The sub-sample of 21 developed-country currencies includes: Australia, Austria, Belgium, Canada, Denmark, Euro, Finland, France, Germany, Greece, Ireland, Italy, Japan, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom.

In order to classify countries based on their exports we utilize the U.N. COMTRADE database of international trade flows. We use the NBER extract version of this data, available for years 1980-2000 (we extrapolate the data for the years 2001-2010 using the 2000 values). We classify the goods into basic/intermediate and final based on their SITC descriptions.

At the end of each month \( t \), sort all currencies in 6 (or 5 for developed countries) portfolios based on the average ratio of net exports of final or basic input goods to the total trade of that good over the pre-ranking period. Portfolios are ranked from low to high based on input good exports and from high to low based on final good exports, in order to produce
consistent rankings. The sorting is done based on the average value of the export variable over the first half of our sample (roughly), 1980-1995. Average forward discounts and average returns are computed over the second half of our sample, 1995-2010. Thus, these returns capture the notion of unconditional risk premia while at the same time representing an implementable trading strategy. Lustig, Roussanov, and Verdelhan (2011a) use a similar approach for uncovering unconditional currency risk premia by sorting currencies based on past average forward discounts.

Using the individual currency forward discounts \( f_t - s_t \) and log excess returns approximated as

\[
r_x^{t+1} = f_{t+1} - s_{t+1},
\]

we compute the log currency excess return \( r_x^j_{t+1} \) for each portfolio \( j = 1, 2, \ldots, 6 \) by averaging:

\[
r_x^j_{t+1} = \frac{1}{N_j} \sum_{i \in P_j} r_x^i_{t+1}.
\]

We do not take into account bid/ask spreads in the construction of these portfolios. Since our portfolios do need to be rebalanced, transaction costs are likely to be small (returns based on long-horizon, e.g. one-year, forward contracts are typically similar to those obtained by rolling over shorter-horizon contracts).

We sort currencies into portfolios using two variables constructed based on the U.N. international trade data. The first variable is the ratio of the net exports of goods that are classified as “final” to the total trade in such goods. The second variable is the ratio of net exports of goods that are classified as “input” goods (mostly consisting of basic commodities) to total trade in such goods. The first variable captures the extent to which a country specializes in the production of finished goods, and the second variable captures the extent to which a country specializes in exporting basic commodities. Intuitively, for a given country either the first ratio is high and the second low, or, conversely, the second variable is high and the first low. Therefore, we sort currencies in the descending order based on the first variable, and in ascending order on the second variable. We compute the average forward discounts and average log excess returns for each of the portfolios. The results are reported in tables 1 and 2. The results using both sorts are very similar: portfolios representing high final good export ratios and those with low input good export ratios have low average forward discounts, suggesting that they capture countries whose interest rates are typically low relative to the U.S. Conversely, portfolios with high values of the commodity exports ratio and low values of final good exports exhibit high average forward discount, indicating high average interest rates. The pattern is virtually monotonic across portfolios for both
This table reports average forward discounts and average log excess returns on currency portfolios sorted on the ratio of the countries’ net exports of finished goods relative to total trade in such goods, in descending order. Data are monthly, from Barclays and Reuters (available via Datastream). The returns do not take into account bid-ask spreads. The pre-ranking period is 1980–1995, post-ranking period is 1/1996–6/2010.

 sorts, especially for developed countries subsample, with differences between the highest and the lowest portfolios’ average forward discounts of around 4.5% per annum.

Importantly, portfolio average excess returns follow the pattern of the average forward discounts, being negative for the low portfolios and positive for the high portfolios, with the spreads in average returns between extreme portfolios close to or exceeding 4% per year. Thus, the differences in the average forward discounts translate almost fully into average excess returns, contrary to the UIP hypothesis. Since the sorting variables are very persistent, these differences are likely to capture unconditional rather than conditional risk premia. As an illustration of this, Figure 1 plots the average forward discounts on individual currencies over (roughly) the second half of our sample (post-1995) against the average ratio of the final good imports to total trade over the first half of our sample (pre-1995). The two variables appear to line up well, with higher levels of the impot ratio typically corresponding to high average forward discounts (e.g., this includes the so-called “commodity countries” - Australia, New Zealand, Norway - as well as Greece), where as low values of final good import ratio correspond to low average forward discounts (Japan is the most salient extreme case, with most of the European countries in the middle).
This table reports average forward discounts and average log excess returns on currency portfolios sorted on the ratio of the countries’ net exports of basic input goods relative to total trade in such goods, in ascending order. Data are monthly, from Barclays and Reuters (available via Datastream). The returns do not take into account bid-ask spreads. The pre-ranking period is 1980–1995, post-ranking period is 1/1996–6/2010.

3 Model

3.1 Setup

The are two countries, each populated by a representative consumer endowed with CRRA preferences over the same consumption good, with the same risk aversion coefficient $\gamma$. The countries differ in their production technologies. The “commodity” country produces a basic input good using linear production technology

$$Y_c = Z_c L_c;$$

assuming one unit of labor is supplied inelastically this is equivalent to an exogenous endowment of basic commodity equal to the productivity shock $Z_c$.

The “producer” only produces final consumption good using commodity input $x$ and labor,

$$Y_p = (Z_p L_p)^\alpha B^{1-\alpha},$$

where $B$ is the input of the basic commodity, one unit of labor is supplied inelastically.

The countries are spatially separated so that transporting goods from one country to the other incurs shipping costs. Our model of shipping costs extends variable iceberg cost of
Figure 1: Average Forward Discounts and Final Goods Export Ratio: Developed Countries

Backus, Kehoe, and Kydland (1992), where each unit of good shipped in either direction loses a fraction

\[ \tau(x) = \frac{Kx}{2S_t} \]

to shipping costs, which depends on the total amount of goods shipped in this direction, \( x \), and the shipping capacity available at time \( t, S_t \).

In the producer country, representative competitive firm solves

\[
\max \left\{ (Z_p L_p) \alpha (Z_c (1 - \tau (Z_c)))^{1-\alpha} - w_p L_p - P_c Z_c (1 - \tau (Z_c)) \right\}
\]

From the first-order conditions and zero profits, the price of the basic commodity is given by

\[
P_c = (1 - \alpha) \left[ \frac{z_p}{z_c (1 - \tau (Z_c))} \right]^{\alpha}.
\]
Consumption allocations for the commodity and the producer country, $C_{c,t}^{1-\gamma}$ and $C_{p,t}^{1-\gamma}$, are determined by the output of the producer country $Y_p$ and the amount of consumption good exported to the commodity country $X$.

### 3.2 Solution

Under complete markets, the equilibrium allocation is identical to that chosen by a central planner for a suitable choice of Pareto weight $\mu$.

The planner’s problem is therefore

$$\max_{X_t} E_t \left[ \sum_{t=0}^{\infty} \beta^t \left( \frac{C_{c,t}^{1-\gamma}}{1-\gamma} + \mu \frac{C_{p,t}^{1-\gamma}}{1-\gamma} \right) \right]$$

subject to

$$C_{p,t} = Y_{p,t} - X_t - I_t$$

and

$$C_{c,t} = X_t \left( 1 - \frac{\kappa X_t}{2S_t} \right)$$

where $I$ is investment in the shipping capacity $S_t$, which evolves as

$$S_{t+1} = (1-\delta) S_t + S_t \phi \left( \frac{I_t}{S_t} \right),$$

where $\phi(I_t, S_t)$ is the adjustment cost function.

The log of the producer country shock evolves according to:

$$z_{p,t+1} = \mu_z + z_{p,t} + \sigma_p \epsilon_{p,t+1}$$

The rate of commodity production is exogenous (normalized labor input) and the log of commodity production evolves as

$$z_{c,t+1} = \mu_z + z_{p,t} + \rho(z_{c,t} - z_{p,t}) + \sigma_c \epsilon_{c,t+1},$$

where we imposed cointegration between the two productivity shocks to ensure that the relative price process is stationary.

Final good output is a function of the commodity good output net of shipping costs, and since labor is normalized to one in each country we have

$$Y_{p,t} = (Z_{p,t})^\alpha \left( Z_{c,t} \left( 1 - \frac{\kappa Z_{c,t}}{2S_t} \right) \right)^{1-\alpha}$$
Combining the planner’s problem with the constraints arising from the firms’ intratemporal optimization we can form a Lagrangian:

\[ \max_{C_p,C_c,Y,I,S,X,\lambda_y,\lambda_c,\lambda_{cp}} \sum_{t=0}^{\infty} \beta^t \left( \frac{1}{1-\gamma} C_{p,t}^{1-\gamma} + \mu \frac{1}{1-\gamma} C_{c,t}^{1-\gamma} \right) \]

\[ + \lambda_{cp,t} (C_{p,t} - Y_{p,t} + X_t + I_t) \]

\[ + \lambda_{cc,t} \left( C_{c,t} - X_t \left( 1 - \kappa X_t \frac{1}{2S_t} \right) \right) \]

\[ + \lambda_{y,t} \left( Y_{p,t} - \left( Z_{p,t} \right)^\alpha \left( Z_{c,t} \left( 1 - \kappa Z_{c,t} \frac{1}{2S_t} \right) \right)^{1-\alpha} \right) \]

\[ + \lambda_{s,t} \left( S_{t+1} - (1 - \delta) S_t - S_t \phi \left( \frac{I_t}{S_t} \right) \right) \]

F.O.Cs yield the intratemporal relation for consumption between the two countries as well as the intertemporal Euler equation.

\[ \frac{C_{p,t}^{\gamma}}{\mu C_{c,t}^{\gamma}} = \left( 1 - \kappa X_t \frac{1}{S_t} \right) \]

\[ \frac{1}{\phi'} \left( \frac{I_t}{S_t} \right) = \beta E_t \left( \frac{C_{p,t+1}}{C_{p,t}} \right)^{-\gamma} \]

\[ \left[ \frac{1}{1 - \kappa X_{t+1} \frac{1}{S_{t+1}}} \right]^{\kappa X_{t+1}^2} \frac{Z_{p,t+1}}{Z_{c,t+1}}^{\alpha} \left( 1 - \kappa Z_{c,t+1} \frac{1}{2S_{t+1}} \right)^{-\alpha} \frac{\kappa Z_{c,t+1}^2}{2S_{t+1}} + \frac{(1 - \delta) \phi \left( \frac{I_{t+1} + 1}{S_{t+1}} \right) - \frac{I_{t+1}}{S_{t+1}} \phi \left( \frac{I_{t+1}}{S_{t+1}} \right)}{\phi' \left( \frac{I_{t+1}}{S_{t+1}} \right)} \]

The model is solved using standard perturbation methods.

### 3.3 Exchange Rates

With power utility the stochastic discount factor in each country \( i \in \{ p, c \} \) is given by

\[ M_{i,t+1} = \left( \frac{C_{i,t+1}}{C_{i,t}} \right)^{-\gamma} \]

Complete markets imply that the real exchange rate \( Q_{t+1} \), in the units of the producer country consumption per unit of commodity country consumption, satisfies
\[ M_{p,t+1} = M_{c,t+1} \frac{Q_{t+1}}{Q_t}. \]

Combining these equations and substituting the F.O.C. for intratemporal consumption yields

\[
\frac{1 - \frac{\kappa X_{t+1}}{S_{t+1}}}{1 - \frac{\kappa X_t}{S_t}} = \frac{Q_{t+1}}{Q_t}
\]

(8)

Equation 8 highlights the simplicity of the exchange rate dynamics in the model. High productivity in the home country implies high levels of exports, which in turn drives up shipping costs. Though consumption in both countries rises, these higher shipping costs result in a lower proportion of the final consumption good being shipped to the commodity producing country, and therefore its exchange rate rises vis-a-vis the producer country. Conversely, following bad productivity shocks consumption in both countries falls, but as it becomes cheaper to ship the consumption good to the commodity country, its consumption falls less than that of the producer country. Consequently, its currency depreciates. Since the exchange rate is positively correlated with consumption growth of the producer country, it is risky and therefore commands a positive risk premium.

### 3.4 Calibration

Since the model features power utility preferences, we cannot expect it to produce reasonable volatility of the stochastic discount factors, which is necessary for matching the volatility of exchange rates and the magnitudes of currency risk premia. The goal of our calibration is to exhibit the qualitative mechanism of the model, in particular, the differences in the SDF volatilities between the commodity and the producer country that are driven by the convex shipping costs. In our calibration we set the conditional volatility of the productivity shocks of both countries to be equal to each other, at 1.5% per annum. These and other model parameters are listed in table 3. The resulting moments of the endogenous variables are reported in table 4. While the differences in consumption volatilities are small, they are sufficient to generate differences in average interest rates (due to the precautionary motive), and therefore the average forward discount from the perspective of the producer country consumer is positive on average. Moreover, this average forward discount translates entirely into the average excess return on the carry trade (long high interest rate/commodity currency, short low interest rate/producer currency). The latter is small but nevertheless implies a sizable Sharpe ratio of 0.24 due to low volatility of the exchange rate.
4 Conclusion

We present new evidence on the relation of the currency carry trade profits to the patterns in international trade: countries that specialize in exporting basic goods such as raw commodities tend to exhibit high interest rates where as countries primarily exporting finished goods have lower interest rates on average. These interest rate differences translate almost entirely into average returns on currency carry trade strategies. We propose a novel mechanism that helps rationalize these findings: convex shipping costs combined with endogenous capacity of the shipping industry. Nonlinearity of the shipping costs implies that the consumption - and therefore the SDF - of the country producing the consumption good is more sensitive to productivity shocks, and is thus riskier.

While our model can qualitatively rationalize the differences the relation between the carry trade and the patterns of trade in commodity markets, the simple power utility setting that we use cannot match the quantitative asset pricing facts. Augmenting the model with recursive preferences, e.g. following Colacito and Croce (2010), appears to be a promising direction of further research.
### Table 4: Model Moments

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<thead>
<tr>
<th></th>
<th>Mean</th>
<th>STD</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Producer Consumption Growth</strong></td>
<td>1.00%</td>
<td>1.40%</td>
</tr>
<tr>
<td><strong>Commodity Country Consumption Growth</strong></td>
<td>1.00%</td>
<td>1.39%</td>
</tr>
<tr>
<td><strong>Producer Risk Free Rate</strong></td>
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<td>2.73%</td>
</tr>
<tr>
<td><strong>Commodity Country Risk Free Rate</strong></td>
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</tr>
<tr>
<td><strong>Spot Exchange Rate Change</strong></td>
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<td>0.77%</td>
</tr>
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<td><strong>Forward Discount</strong></td>
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<td>0.12%</td>
</tr>
<tr>
<td><strong>Carry Trade Return</strong></td>
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<td>0.23%</td>
</tr>
<tr>
<td>Sharpe Ratio</td>
<td>0.24</td>
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References


