Funding Flows and Credit in Carry Trade Economies

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1. Introduction

A carry trade is a transaction where an investor borrows at a low interest rate in one country and invests in assets that have a higher (risk-adjusted) yield in another. For countries that are carry trade targets due to their relatively high risk-adjusted rates of return, life oscillates between 'paddling in an ocean of global money' (Sighvatsson 2007) and being stranded by the receding tide on bumpy shores. Despite the importance of carry trade flows for the macroeconomic outcomes of these countries, most of the literature on the carry trade focuses on the price dimension.

Galati, Heath and McGuire (2007) provide a detailed discussion of multiple carry trade strategies and of the likely extent of carry flows for a number of countries, while Burnside *et al* (2011) and Jorda and Taylor (2012), among others, have analysed the profitability of different carry trade strategies.

Carry trade profits and risk-adjusted returns (Sharpe ratios) are living proof that uncovered interest parity (UIP), at least in the short to medium run, is a convenient textbook shortcut that is grossly falsified by reality. Deviations from UIP and the forward premium puzzle have led to a massive literature in international finance (see, for example, Frankel (1983) and Fama (1984)). Brunnermeier, Nagel and Pedersen (2008) reconcile UIP and the carry trade phenomenon by showing that carry traders are exposed to liquidity risk and that occasional sharp reversals may wipe out the carry element of the excess return. Similarly, Farhi and Gabaix (2011) argue that currency investors are subject to country-specific, time-varying rare disasters.

Gagnon and Chaboud (2007) emphasise the massive exchange rate effects of a carry trade unwinding. Lustig and Verdelhan (2007) and Lustig, Roussanov and Verdelhan (2010) suggest that foreign currencies must pay high excess returns as they tend to depreciate against the US dollar precisely when US consumption growth is low. Abhyankar, Gonzalez and Klinkowska (2012) show that a conditional consumption capital asset pricing model (CAPM) is able to price a large variation in the cross-section of carry trade portfolios. Bacchetta and van Wincoop (2010) invoke infrequent portfolio decisions to explain the slow exchange rate appreciation and rapid reversal pattern associated with carry trade episodes.

Instead of focusing on the failure of UIP and the profitability of the carry trade, in this paper we present an empirical study of the effects that capital flows (the funding flows) have on asset prices, the provision of credit and the stance of monetary policy in the target countries. In this we relate

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to two recent theoretical papers: Plantin and Shin (2011) who emphasise funding externalities and strategic complementarities among speculators as well as the role of monetary policy rules in sustaining the carry trade flows and Truempler (2013) who studies the interactions between carry trade flows, monetary policy and the real economy in a quantitative model of a small open economy. In Section 2 of the paper we describe the pattern of cross-border credit flows; we analyse their determinants in Section 3. Section 4 discusses the existence of co-movement in asset prices and in particular house prices. We study interactions between credit flows, the VIX and monetary policy in Section 5, before concluding in Section 6.

2. 'An Ocean of Global Money': The Pattern of International Flows

Our sample of carry trade target countries includes: Australia, Brazil, Canada, Hungary, Iceland, Israel, Mexico, New Zealand, Norway, Poland, South Africa, South Korea, Sweden and Turkey. All these economies have been the recipients of massive capital flows in the past decade and their financial sectors have experienced large increases in the availability of liquidity; moreover, most of these countries have been included in previous studies on the carry trade. These countries are all small to medium-sized open economies with floating exchange rates, according to the International Monetary Fund (IMF) *Annual Report on Exchange Arrangements and Exchange Restrictions* (IMF 2012). Some of them are 'free floaters' (Australia, Canada, Mexico, New Zealand, Norway, Poland and Sweden), while the remainder manage their exchange rates to some degree, but are still classified as 'floaters'. They are mostly financially open, though some of them have erected barriers to capital flows, especially in recent years. For example, the tax imposed by Brazil on some capital inflows in 2009 and the crisis restrictions of Iceland on capital outflows since 2008.

It has been noted in the literature that cross-border capital inflows exhibit strong co-movements across countries and are volatile. For example, Calvo, Leiderman and Reinhart (1996) note that 'global factors affecting foreign investment tend to have an important cyclical component, which has given rise to repeated booms and busts in capital inflows'. Among these factors, Reinhart and Reinhart (2009) have identified world real rates, world growth rates and commodity prices as important drivers of capital flow 'bonanzas'. In this paper, we will focus on cross-border credit flows, a subcategory of capital flows, as their importance has grown with the development of global banking after the 1990s and they tend to be particularly procyclical with rapid build-ups in good times and sharp reversals in crisis times (see CIEPR (2012)).

Figure 1 shows the outstanding end-of-quarter amount of direct cross-border credit available to the countries in our panel from 1990 to the end of 2012. We define direct credit as the funding available through direct borrowing from non-resident banks (loans and securities) to both banks and non-banks of the recipient country (see Appendix A for more details on the data). Avdjiev, McCauley and McGuire (2012) emphasise the importance of cross-border credit flows in igniting credit booms in emerging markets.

Figure 1: Total Direct Cross-border Credit

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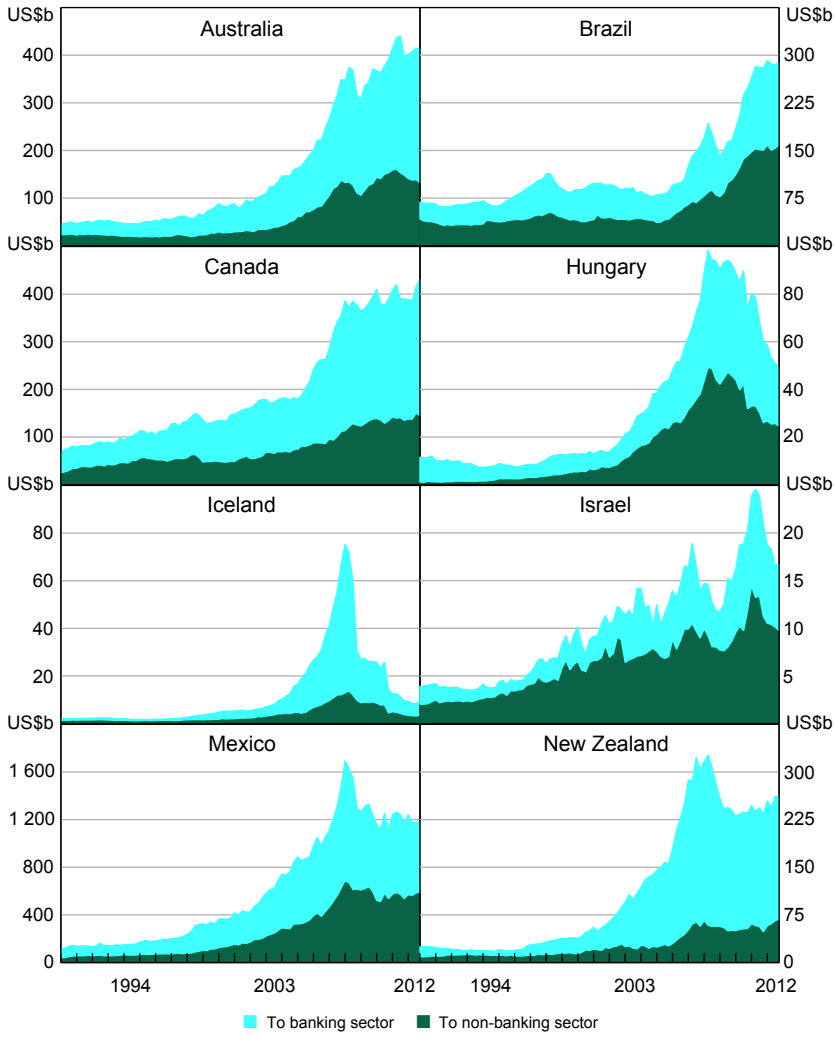

Figure 1: Total Direct Cross-border Credit
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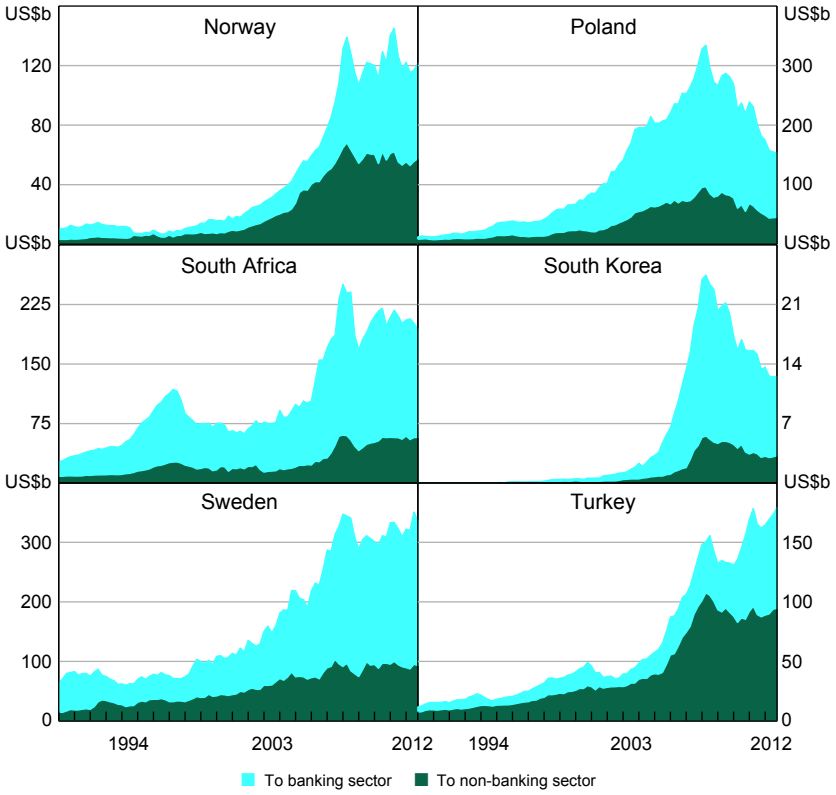


Notes: Claims on all sectors of non-residential banks; all instruments, all currencies
Source: BIS locational banking statistics

We see a strikingly common pattern for credit inflows across most of these economies: inflows were relatively stable between 1990 and 2000 (with noticeable differences in scales depending on the size of the countries) while there was a sharp increase in the size of inflows around 2000 for most of the economies; this is especially true for Australia, Canada, Hungary, Iceland, Israel, Mexico, Poland and Sweden. Flows into Norway, South Korea and Turkey picked up (spectacularly) a little later. For some of the countries (Australia, Canada, Iceland, New Zealand, Poland, South Korea and Sweden) the share of credit inflows intermediated by the banking sector increases massively in the years preceding the financial crisis and remains a significant portion of outstanding credit from non-resident banks.

There is a high degree of synchronisation of cross-border credit flows in our sample of small open economies, irrespective of the continent, the income level and the details of the exchange rate regime.

3. Determinants of Credit Inflows

The role of global banks in the world economy and their financing patterns has been the subject of much interest recently (see, for example, Borio and Disyatat (2011); Cetorelli and Goldberg (2012)). Bruno and Shin (2013a) build a model of international banking flows in which global banks finance themselves in the US dollar markets and channel liquidity to all other regions of the world via the local banking systems. They use a variant of the Vasicek (2002) model with a two-tier banking system. In their framework, the level and the growth rate of bank leverage are important determinants of capital flows on the supply side. They show empirically that the leverage of banks is strongly negatively related to the VIX,[1] which is widely seen as a market proxy for risk aversion and uncertainty. One possible rationale for this correlation is that, in a system where value at risk is both a regulatory tool and a metric used internally by banks to measure risk, there is a lot of credit creation when measured risks are low. This credit creation in turn pushes up asset prices, compresses spreads and renders measured risks even lower, eventually leading to more leverage. Hence, when the VIX is low, global banks leverage a lot by financing themselves in the US dollar markets, and channel vast amounts of liquidity to other regions of the world, where they lend to local banks. This process ultimately leads to an increase in the leverage of local banks which tend to borrow more in tranquil times.

On the demand side, the Bruno and Shin (2013a) model suggests that increases in equity capital of local banks and lower local stock market volatility are important determinants of larger cross-border inflows. Cross-border lending should also be increasing in the interest rate spread between the local lending rate and the interest rate of the funding currency. The authors find support for their predictions in a panel of 46 countries and show that supply-side factors tend to dominate demand-side factors as drivers of credit flows. In their study, a lower VIX (in level and growth rate) is associated with increases in cross-border credit flows. This confirms earlier results of the literature, for example studies by Brunnermeier *et al* (2008) and Forbes and Warnock (2012) that emphasise the strong co-movements of capital flows with the VIX.

In Tables 1 to 3 we study the determinants of cross-border credit inflows. We build on the specification of Bruno and Shin (2013a) and run a set of panel regressions involving data for the 14 countries in our sample. The panel is not balanced due to different, and sometimes limited, availability of data.

We use a fixed set of regressors in all our estimations which consists of the lagged log of the VIX; the current quarterly VIX growth rate; lagged local equity market volatility (Vol); and current local bank equity capital growth (Eqy). These variables are meant to capture global and local determinants. We control for other local variables such as the real exchange rate (RER), GDP growth, the growth in the debt-to-GDP ratio, M2 growth, inflation (ΠΠ) and the change in the spread between the local policy rate and the US federal funds rate. The majority of data series are available from 1990:Q1 to 2012:Q4. All data are at quarterly frequency except local stock market volatility and local bank equity capital growth (proxied by return on assets) which are annual. Flows are expressed in log differences. All controls are lagged. Standard errors are adjusted for clustering at the country level.

1 The VIX is the Chicago Board Options Exchange Market Volatility Index. It is a measure of the implied volatility of S&P 500 index options.

Table 1 investigates the ability of these variables to predict direct cross-border credit inflows to all sectors, while Tables 2 and 3 repeat the same analysis focusing on credit to banks and non-banks respectively. We explain up to 42 per cent of the variation in direct credit inflows. Coefficients enter with the expected signs. Direct credit inflows are strongly negatively related to the VIX, falling when the financial markets uncertainty goes up. They also tend to fall when the growth rate of the VIX goes up but this is not always significant. Similarly, inflows tend to fall when the volatility of the local equity market goes up (though this effect is not significant). Flows increase strongly when local equity goes up. They also increase when the growth rate of M2 goes up in the target country. Flows increase with the interest rate differential though this effect is not significant. Changing the controls does not alter the results.

Table 1: Direct Credit Flows to All Sectors
Fixed effect estimator over full sample

	(1)	(2)	(3)	(4)	(5)	(6)
VIX_{t-1}	−0.0366***		−0.0802***	−0.0427***		−0.0824***
	(−3.05)		(−7.13)	(−3.18)		(−4.53)
ΔVIX_t	−0.0014		−0.0094	−0.0337***		−0.0467
	(−0.21)		(−0.40)	(−2.75)		(−1.28)
Vol_{t-1}		−0.0545	−0.0247		−0.0373	−0.0108
		(−1.38)	(−0.58)		(−0.80)	(−0.21)
ΔEqy_t		0.0059***	0.0054***		0.0044***	0.0048***
		(16.08)	(20.92)		(7.58)	(5.53)
ΔRER_{t-1}				−0.1412***	−0.3272	−0.2167
				(−3.36)	(−1.52)	(−1.12)
ΔGDP_{t-1}				−0.0427**	−0.0788	−0.0858*
				(−2.28)	(−1.47)	(−1.84)
$\Delta(Debt/GDP)_{t-1}$				−0.0059	−0.0052	−0.0001
				(−1.06)	(−0.75)	(−0.01)
$\Delta M2_{t-1}$				0.0749*	0.1583***	0.1583***
				(2.47)	(4.49)	(4.88)
Π_{t-1}				−0.3099*	−0.5973**	−0.0969
				(−1.69)	(−2.05)	(−0.32)
$\Delta(i - i_{US})_{t-1}$				0.0063	0.0064	0.0123
				(1.30)	(0.35)	(0.72)
Linear trend	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.015	0.310	0.391	0.089	0.385	0.428
Within group R^2	0.017	0.320	0.407	0.102	0.425	0.473
N	1 259	194	194	640	139	139
n	14	14	14	14	14	14

Notes: Standard errors adjusted for clustering at country level; *, ** and *** denote significance at the 10, 5 and 1 per cent levels, respectively; *t*-statistics are in parentheses

Table 2: Direct Credit Flows to Bank Sector

Fixed effect estimator over full sample

	(1)	(2)	(3)	(4)	(5)	(6)
VIX_{t-1}	–0.0271**		–0.0800***	–0.0420***		–0.0690**
	(–2.32)		(–6.55)	(–2.80)		(–2.48)
ΔVIX_t	0.0124		–0.0005	–0.0335**		–0.0484
	(1.03)		(–0.02)	(–2.07)		(–1.10)
Vol_{t-1}		–0.0403	–0.0093		–0.008	0.0124
		(–0.90)	(–0.20)		(–0.16)	(0.24)
ΔEqy_t		0.0074***	0.0069***		0.0046***	0.0048***
		(15.02)	(17.91)		(4.30)	(3.04)
ΔRER_{t-1}				–0.1608**	–0.3191	–0.2376
				(–2.69)	(–1.21)	(–0.97)
ΔGDP_{t-1}				–0.0246	–0.0929	–0.0973
				(–1.02)	(–1.27)	(–1.54)
$\Delta(Debt/GDP)_{t-1}$				–0.0056	–0.0218	–0.0181
				(–0.81)	(–1.40)	(–0.89)
$\Delta M2_{t-1}$				0.0873**	0.1943***	0.1959***
				(2.21)	(3.66)	(3.46)
Π_{t-1}				–0.2138	–0.2804	0.1503
				(–0.75)	(–0.58)	(0.33)
$\Delta(i - i_{US})_{t-1}$				0.0045	–0.0023	0.0026
				(0.72)	(–0.09)	(0.10)
Linear trend	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.002	0.241	0.287	0.049	0.321	0.331
Within group R^2	0.004	0.253	0.306	0.062	0.365	0.384
N	1 258	194	194	640	139	139
n	14	14	14	14	14	14

Notes: Standard errors adjusted for clustering at country level; *, ** and *** denote significance at the 10, 5 and 1 per cent levels, respectively; *t*-statistics are in parentheses

Table 3: Direct Credit Flows to Non-bank Sector
Fixed effect estimator over full sample

	(1)	(2)	(3)	(4)	(5)	(6)
VIX_{t-1}	−0.0371***		−0.0765***	−0.0404***		−0.0880***
	(−3.26)		(−4.54)	(−3.14)		(−3.60)
ΔVIX_t	−0.0122		−0.0208	−0.0335***		−0.0523
	(−1.54)		(−0.65)	(−3.59)		(−1.14)
Vol_{t-1}		−0.0791**	−0.0525		−0.0792*	−0.0513
		(−2.21)	(−1.35)		(−1.68)	(−0.96)
ΔEqy_t		0.0017***	0.0012***		0.0009**	0.0012**
		(5.40)	(5.06)		(2.07)	(2.12)
ΔRER_{t-1}				−0.0991*	−0.3289	−0.2138
				(−2.62)	(−1.69)	(−1.24)
ΔGDP_{t-1}				−0.0449*	−0.0327	−0.0399
				(−1.86)	(−0.64)	(−0.79)
$\Delta(Debt/GDP)_{t-1}$				−0.0041	0.005	0.0103
				(−1.60)	(0.95)	(1.37)
$\Delta M2_{t-1}$				0.0185	0.0659	0.0662
				(0.64)	(1.17)	(1.26)
Π_{t-1}				−0.4973**	−0.9375**	−0.3999
				(−2.44)	(−2.13)	(−1.04)
$\Delta(i - i_{US})_{t-1}$				0.0099*	0.018	0.0244*
				(2.23)	(1.15)	(1.65)
Linear trend	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.018	0.151	0.229	0.047	0.152	0.212
Within group R^2	0.020	0.165	0.249	0.060	0.207	0.275
N	1 259	194	194	640	139	139
n	14	14	14	14	14	14

Notes: Standard errors adjusted for clustering at country level; *, ** and *** denote significance at the 10, 5 and 1 per cent levels, respectively; *t*-statistics are in parentheses

The results of Table 2 (credit flows to the banks) and Table 3 (credit flows to the non-banks) are largely similar to the results of Table 1. There are some minor differences – the interest rate spread variables tend to be more significant, and the role of M2 is less significant, while past inflation tends to dampen flows to non-banks. To sum up, we confirm in our panel of carry trade economies that credit flows are procyclical and highly negatively correlated with the VIX. Small open economies, whether floaters or free floaters, like other economies receive capital inflows in a way which is closely related to a 'global financial cycle' reflecting the leverage of financial intermediaries and proxied by the VIX (see Miranda Agrippino and Rey (2012) and Rey (2013)).

4. Asset Prices and the VIX

Miranda Agrippino and Rey (2012) use a large cross-section of 858 risky asset prices distributed across five continents and show that an important part of the variance of risky returns (25 per cent) is explained by a single global factor. This result is striking as the set of assets used in the estimation is heterogeneous. It contains stocks, corporate bonds and commodities. Risky returns on all continents and across asset classes give weight to the contribution of this global factor. Miranda Agrippino and Rey (2012) show that this global factor is closely related to the VIX. These results, combined with those in the previous section, indicate both cross-border credit flows and risky asset prices are closely related to global fluctuations in uncertainty and risk aversion.

Since real estate prices have proved to be a very important component of financial crises both in emerging markets and in advanced economies, we now investigate whether they also follow a global cycle. To do this, we look at a panel of house prices for our set of countries. All regressions include the lagged log of the VIX; current VIX growth; and credit flows to all sectors (FlwAll), flows to the banking sector (FlwBS) and flows to non-banks (FlwNBS) all expressed as a ratio to GDP and lagged by one quarter. Controls include lagged GDP and M2 growth, the lagged nominal effective exchange rate (NEER), and the lagged change in the spread between the local policy rate and the US federal funds rate. We also test in the cross-section whether the sensitivity of real estate markets to the global factor can be related to different intensities of credit flows into those markets. In order to do so, we augment our regressions with a term that interacts the VIX with measures of credit flows. Results are reported in Table 4.

Table 4: Property Price Indices
Fixed effect estimator over full sample

	(1)	(2)	(3)	(4)	(5)	(6)
VIX_{t-1}	–0.0114**	–0.0114**	–0.0115**	–0.0115**	–0.0115**	–0.0115**
	(–2.12)	(–2.14)	(–2.15)	(–2.15)	(–2.16)	(–2.17)
ΔVIX_t	–0.0067**	–0.0067**	–0.0068**	–0.0067**	–0.0067**	–0.0068**
	(–2.46)	(–2.48)	(–2.52)	(–2.47)	(–2.49)	(–2.52)
$FlwALL_{t-1}$	0.0042*					
	(1.67)					
$FlwBS_{t-1}$		0.0043*				
		(1.75)				
$FlwNBS_{t-1}$			0.0154			
			(0.86)			
$FlwALL_{t-1}$ x VIX_{t-1}				0.0011*		
				(1.66)		
$FlwBS_{t-1}$ x VIX_{t-1}					0.0011*	
					(1.67)	
$FlwNBS_{t-1}$ x VIX_{t-1}						0.006
						(1.07)
ΔGDP_{t-1}	0.0566**	0.0570**	0.0636***	0.0564**	0.0570**	0.0624***
	(2.53)	(2.55)	(3.01)	(2.50)	(2.53)	(2.92)
$\Delta M2_{t-1}$	0.0099	0.0097	0.0092	0.0102	0.0099	0.0096
	(0.71)	(0.69)	(0.64)	(0.71)	(0.69)	(0.66)
$\Delta(i - i_{US})_{t-1}$	–0.0016	–0.0016	–0.0016	–0.0016	–0.0016	–0.0016
	(–1.18)	(–1.18)	(–1.24)	(–1.17)	(–1.18)	(–1.22)
$NEER_{t-1}$	0.0237*	0.0242*	0.0245*	0.0241*	0.0246*	0.024*
	(1.66)	(1.73)	(1.66)	(1.70)	(1.76)	(1.64)
Linear trend	Yes	Yes	Yes	Yes	Yes	Yes
Adj R^2	0.127	0.127	0.124	0.127	0.127	0.125
Within group R^2	0.138	0.138	0.135	0.138	0.138	0.136
N	642	642	643	642	642	643
n	14	14	14	14	14	14

Notes: Standard errors adjusted for clustering at country level; *, ** and *** denote significance at the 10, 5 and 1 per cent levels, respectively; *t*-statistics are in parentheses

We find that property prices are negatively related to the VIX and are also significantly negatively related to its growth rate. We also find that more credit flows tend to be associated with higher property prices (this is true for the aggregate flows to all sectors but particularly for flows to banks). We do not find, however, that the sensitivity of real estate markets to the VIX increases with capital flows. It is worth emphasising that none of the above regressions indicate causality. They merely indicate (striking) correlations between the VIX, property prices and credit flows.

5. Credit Creation, Financing Costs and the Ocean of Money

What creates the ocean of money engulfing the shores of carry trade targets? More prosaically, what are the determinants of the fluctuations in the VIX? Given the strong procyclicality of credit flows and the way global banks operate (see, for example, Shin (2012)) it is natural to investigate the effect on the 'global financial cycle' of refinancing costs in dollars, that is Federal Reserve monetary policy and its effect on credit creation and on credit flows (see also Rajan (2005) for the link between monetary policy and risk taking). As an alternative, it would also be very interesting (but out of the scope of this paper) to study the effect of refinancing costs on the yen market.

Bekaert, Hoerova and Lo Duca (2012), Miranda Agrippino and Rey (2012), and Bruno and Shin (2013b) perform VAR analyses and, under some identification assumptions, suggest that monetary policy in the centre country is one of the determinants of the VIX. When the federal funds rate goes down, the VIX falls, banks' leverage rises, as do gross credit flows. Their estimates suggest that between 10 and 30 per cent of the variance of the VIX is explained by shocks to the federal funds rate in the 1990–2007 period.

What are the dynamic interactions of the VIX with credit and spreads in the specific case of Australia?

We build on the study of Bekaert *et al* (2012). They show that movements in the federal funds rate have an effect on uncertainty (expected stock market volatility) and risk aversion, two components they extract from the VIX. Like them, we focus on the links between monetary policy (defined in our case as the spread of the local policy rate over the federal funds rate) and the VIX but, unlike them, we also study their dynamic interrelations with currency fluctuations, credit flows and growth. We also build on Miranda Agrippino and Rey (2012) in which a detailed analysis of the determinants of the fluctuations of the VIX, jointly with leverage and credit and US monetary policy, is performed. Bruno and Shin (2013b) also perform a related analysis and focus on the delayed overshooting puzzle and movements in the US dollar.

5.1 Monetary policy and credit in a target economy (Australia) and the VIX

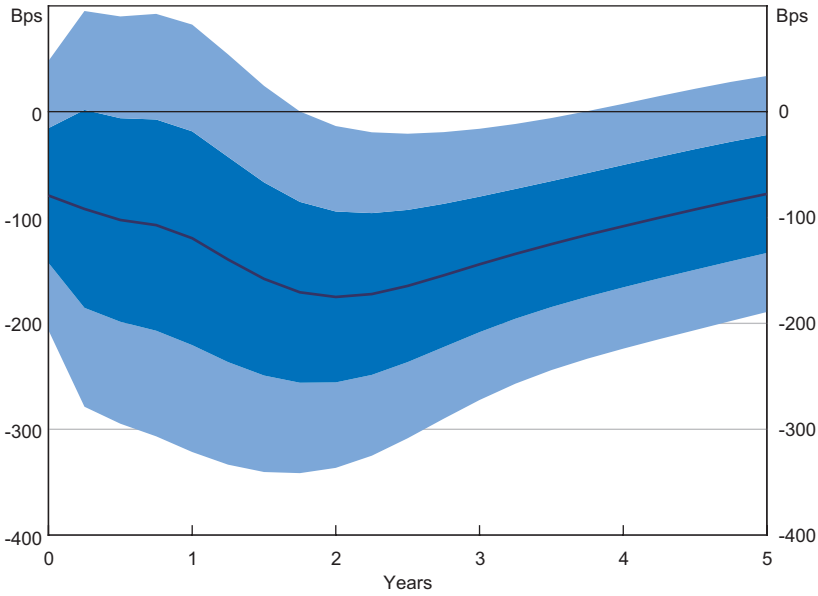
To study the interaction between monetary policy, credit flows and the VIX we run a 7 variable recursive VAR on Australian quarterly data from 1990:Q1 to 2012:Q4. The period is constrained by data availability with the VIX starting only in 1990. The variables included in the VAR are, in the following order: real GDP, prices (measured as the log of the implicit GDP price deflator), credit measures (domestic credit and total direct cross-border credit), the interest rate spread between the Australian official cash rate and the US effective federal funds rate (proxy for funding cost), the nominal exchange rate between Australian and US dollars (domestic price of foreign currency so an increase means a depreciation of the Australian dollar) and the VIX. The ordering of the variables in the VAR reflects the assumption that financial variables (the VIX and exchange rate) react quickly (i.e. within the quarter) to shocks to interest rates while it would take at least one quarter for GDP, prices and credit variables to respond. This type of identifying assumption is often used in the monetary policy literature. All variables except the interest rate differential and the

exchange rate are logged. The VAR includes two lags of each variable, which was selected using a combination of criteria.[2]

Results in the form of orthogonalised impulse response functions are shown in Figures 2 to 5 below. Shaded areas are 1 (dark) and 2 (light) standard deviation bootstrapped confidence bands obtained with 1 000 replications.

In Figure 2, we show the response of the AUD/USD exchange rate to a 50 basis point increase in the spread of the Australian policy rate over the US federal funds rate. These results are consistent with the dynamics of carry activity: the Australian dollar appreciates against the US dollar following an increase in the spread between the two currencies; the appreciation is both significant and persistent.

Figure 2: Exchange Rate Response to a Change in the Interest Rate Differential



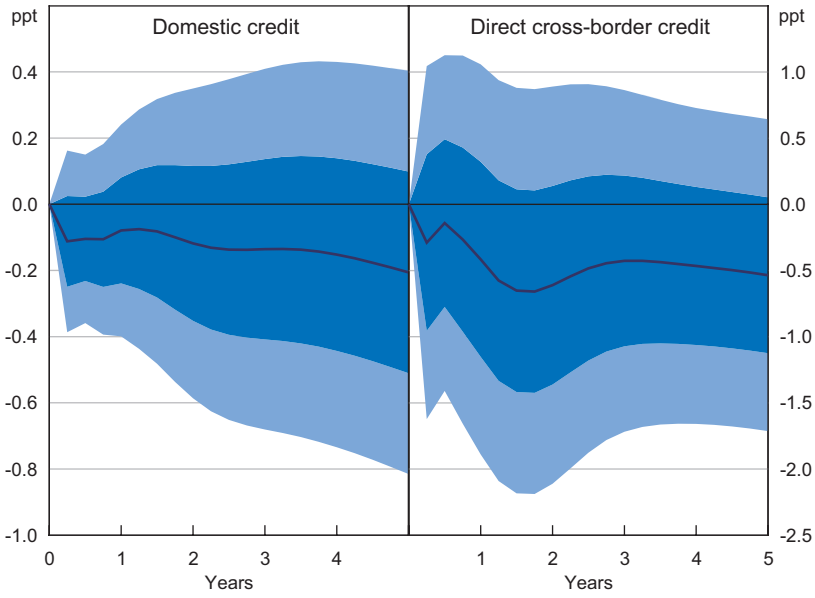
Notes: Response of AUD/USD exchange rate (domestic price of foreign currency) to a 50 basis point increase in the interest rate differential measured as the difference between the Australian official cash rate and the US effective federal funds rate; bootstrapped one and two standard deviation confidence bands are obtained using 1 000 replications

Figures 3, 4 and 5 explore how credit flows and credit creation are influenced by changes in the interest rate spread, the exchange rate and the VIX. Shocks are normalised to a 50 basis point increase in spread and a 1 per cent increase in both the exchange rate and the VIX; responses are in percentage points.

2 It is customary, when using data sampled at quarterly frequency, to include up to four lag in the VAR estimation; here, however, due to limited data availability we choose to rely on likelihood ratio and Bayesian Information Criterion for lag selection to avoid over fitting. We also run a number of smaller VARs where we drop a subset of our seven variables each time to check for the robustness of our results.

Figure 3 shows that an increase in the interest rate differential (the spread of the Australian rate over the US rate) has very little impact on domestic credit or on direct cross-border credit; while both tend to react negatively, the effect is not significant.

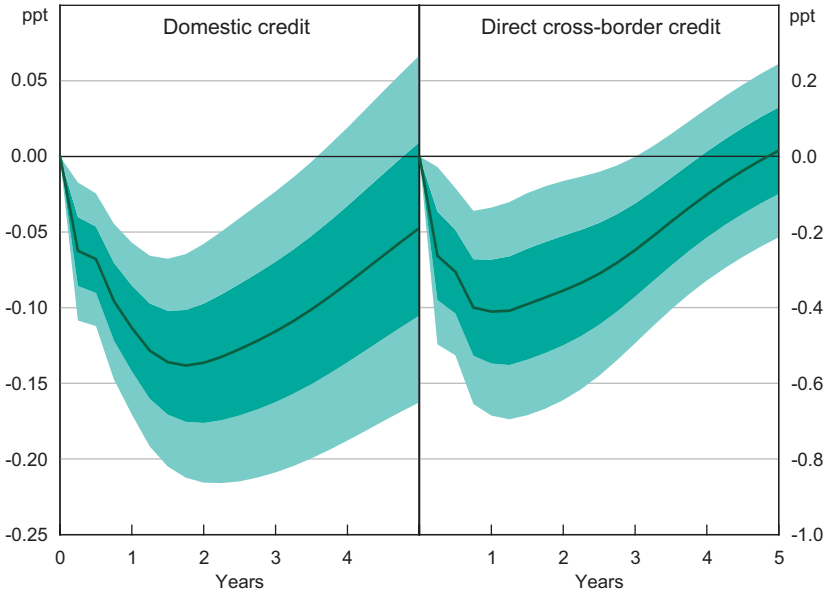
Figure 3: Responses to a Change in the Interest Rate Differential



Notes: Responses to a 50 basis point increase in the interest rate differential; bootstrapped one and two standard deviation confidence bands are obtained using 1 000 replications

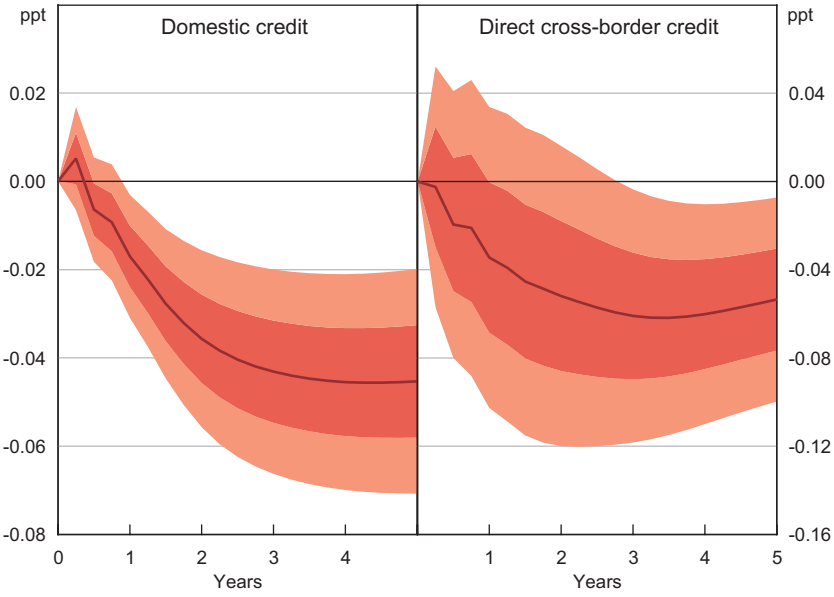
Figures 4 and 5 show that the effect of a depreciation of the Australian dollar and increased market 'fear', as captured by an increase in the VIX, have a very similar impact on credit flows and credit creation. They significantly reduce domestic credit creation and cross-border flows. The effects are all significant and long lasting.

Figure 4: Responses to a Change in the Exchange Rate



Notes: Responses to a 1 per cent increase in the AUD/USD exchange rate (domestic price of foreign currency; bootstrapped one and two standard deviation confidence bands are obtained using 1 000 replications

Figure 5: Responses to a Change in the VIX



Notes: Responses to a 1 per cent increase in VIX; bootstrapped one and two standard deviation confidence bands are obtained using 1 000 replications

Some differences, however, are worth highlighting: while the reduction in the provision of domestic credit that follows a depreciation in the local currency reverses after the first two years, the effect is much more persistent when market 'fear' increases. In both cases, the availability of cross-border flows is immediately affected. It therefore seems that shocks to the VIX are more important determinants of cross-border credit inflows to Australia (and of domestic credit creation) than interest rate spreads. This VAR analysis dovetails nicely with our cross-country panel regression results of the previous sections.

The complete set of impulse responses is provided at <http://www.rba.gov.au/publications/confs/2013/index.html>. They show that, as expected, both GDP and its deflator fall significantly when the VIX increases. On the other hand, the GDP deflator increases significantly when direct cross-border credit flows go up.

6. Conclusions

We presented cross-country panel regressions on the determinants of cross-border credit flows and property prices for a panel of small open economies with floating exchange rates. We also presented evidence on the determinants of house prices. The VIX is highly correlated with credit inflows and with asset prices. We also provided a VAR analysis of the interaction between monetary policy, credit flows and the VIX for Australia. While our interpretation of the VAR is subject to accepting our identification restrictions implicit in the order of the variables, we read the data as consistent with the fact that tranquil periods in international financial markets (reflected in the low value of the VIX) are associated with more credit flows into Australia. This in turn boosts credit creation in the economy. Larger inflows are also associated with an appreciating exchange rate. The effect of fluctuations in the VIX seems to be a powerful determinant of domestic credit and cross-border credit flows; in particular, it is more potent than interest differentials between Australia and the United States. Decreases in the VIX are also associated with increased GDP and a higher GDP deflator. Furthermore, it has been found elsewhere that lowering the federal funds rate is associated with a fall in the VIX (with a lag). There is, therefore, some potential for a feedback loop between monetary policy (spread between the Australian policy rate and the US rate), capital flows and credit creation. This type of feedback loop may sustain a prolonged departure from uncovered interest parity.

An extreme example of this mechanism, as noted in Plantin and Shin (2011), is Iceland. The high interest rate differential in Iceland fuelled capital inflows via the issuance of 'glacier bonds' that were used to fund investment projects in Iceland. Such large inflows led to a sharp appreciation in the krona and an overheating economy leading to an increase in policy rates. But the higher interest rate differential attracted more capital inflows that fuelled the booming economy.

It is important to gain a better understanding of what determines the potency of the feedback loop that sustains credit flows and prolonged departure from uncovered interest parity. Clearly the expenditure switching role of the exchange rate has to be rather weak for the loop to operate and the expansionary effect of capital flows fuelled by low volatility and risk aversion rather strong. Which other factors also determine fluctuations in risk and in credit flows is an interesting open question.

Appendix A: Data

Cross-sectional analysis

Domestic credit: constructed as the sum of domestic claims of depository corporations excluding central banks. Domestic claims are defined as claims on private sector, public non-financial corporations, other financial corporations and net claims on central or general government (claims less deposits). *Source*: Other Depository Corporation Survey and Deposit Money Banks Survey; Monetary Statistics; International Financial Statistics (International Monetary Fund (IMF)). Underlying data in national currencies.

Direct cross-border credit: measured as claims of all BIS reporting countries on all sectors, and bank and non-bank sectors of a given country in all currencies. *Source*: Bank for International Settlements (BIS), locational banking statistics, Tables 7A and 7B. Data are in US$ million, end-of-period, converted with respective end-of-period exchange rate.

Cross-border credit flows: exchange rate adjusted change in claims of all BIS reporting countries on all sectors, and bank and non-bank sectors of a given country in all currencies. *Source*: BIS, locational banking statistics, Tables 7A and 7B. Data are in US$ million, amounts outstanding at the end of the current and the previous period are converted into their original currency components using the respective end-of-period exchange rates. The differences between these individual components are subsequently converted back into US dollars using average exchange rates during the period.

Local volatility: volatility of stock price index, measured as the 360-day standard deviation of the return on the national stock market index. *Source*: Bloomberg and Global Financial Development Database (World Bank); annual data.

Equity growth: measured as a percentage, return on assets of commercial banks using net income to yearly averaged total assets. *Source*: Bankscope (Bureau van Dijk) and Global Financial Development Database (World Bank); annual data.

Debt-to-GDP ratio: central government debt as a per cent of GDP. *Source*: Haver Analytics and national statistical offices.

Stock market indices: end-of-period close quotes of national stock market indices. *Source*: Global Financial Data and Haver Analytics.

Nominal effective exchange rate: broad effective exchange rate indices. *Source*: BIS.

Inflation: CPI All Items quarterly inflation. *Source*: International Financial Statistics (IMF).

House price indices: *Source*: BIS and OECD.

Nominal GDP data in USD: original data in national currencies from national statistical offices; converted by Haver Analytics with respective end-of-period exchange rate.

VAR analysis

Australian GDP deflator: Australian Bureau of Statistics.

Australian credit: Australian Bureau of Statistics.

All other Australian variables: Haver Analytics.

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