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Hedging in derivatives markets: the experience of Chile[1]

Prior to the onset of the 2008 financial crisis, domestic FX derivatives markets in Chile had gained depth and liquidity, boosted by the growing hedging needs of private pension funds. During the crisis, Chile suffered significantly less stress than other EMEs, within Latin America and outside. We present evidence suggesting that this was related to the liquidity and resilience of its FX derivatives markets.

JEL Classification: E44, F31, G23.

The collapse of Lehman Brothers in September 2008 disrupted financing to emerging market economies (EMEs), leading to a sharp drop in cross-border funding, increases in sovereign spreads and pressures in foreign exchange markets.[2] A key response of policymakers in these economies was to draw on large stocks of international reserves in order to supply foreign currency liquidity to foreign exchange markets that had ceased functioning. However, accumulating and holding official foreign reserves is costly. An important question is whether hedging in private financial markets can reduce the need for such reserves by mitigating financial stress, and intermediating foreign currency exposure within the private sector, from those agents with structurally long foreign currency positions towards those structurally short. More precisely, can large and liquid domestic derivatives markets reduce the risks associated with financial stress in sudden stop or capital flow reversal episodes?

Chile is an interesting case study. The depth and liquidity of the domestic derivatives market increased significantly in the years before the Lehman bankruptcy, driven by the growing hedging needs of the private pension funds (Administradoras de Fondos de Pensiones (AFPs) in Spanish). AFPs had relatively large investments in foreign markets but were limited in the amount of foreign currency risk they were allowed to carry. Hedging the exchange rate exposure

[1] The views expressed in this paper are those of the authors and do not necessarily represent the views of the BIS. The authors would like to thank, without implicating, Luis Ahumada, Claudio Borio, Stephen Cecchetti, Kevin Cowan, Dietrich Domanski and Christian Upper for helpful comments, which significantly improved earlier versions of the paper. We also thank Alan Villegas and Diego Urbina for skilful research assistance. All remaining errors are ours.

[2] See Jara et al (2009), Baba and Shim (2010), Moreno and Villar (2010) and Takáts (2010).

required entering into commitments to sell foreign currency in the future (ie taking a short forward position in foreign currency), to protect the Chilean peso (CLP) value of their foreign assets. In fact, AFPs typically hedged a larger share of their portfolio than was required by regulation. By the beginning of the third quarter of 2008, AFPs' net short forward position in the Chilean foreign exchange market was large enough to be the main counterpart to the net purchasing (long) forward positions taken by the two resident sectors with short FX exposures: banks and the non-financial sector.[3] We argue that, as a result of these matching needs, the size and resilience of the derivatives market was a relevant factor in explaining the fact that Chile suffered less severe stress during the global financial crisis than other EMEs with comparable or larger international reserve buffers. Resilience is explained by the continuous need of AFPs to hedge their foreign asset portfolios.[4]

The remainder of this paper is organised as follows. The next section discusses the evolution of the Chilean pension fund system and the accumulation of foreign assets by the private sector, notably pension funds. This is followed by a section reviewing the structure of Chile's derivatives markets, and then by a discussion of the empirical relationship between the size of FX derivatives markets in EMEs before the Lehman bankruptcy and the extent of financial stress in its aftermath. The last section concludes.

Pension funds and foreign asset holdings

In the early 1980s Chile substantially reformed its pension system. It moved from a defined-benefit to a privately managed defined-contribution system. Contribution to the new scheme was mandatory for all people entering the job market from May 1981 and optional for older workers. The new system had a number of important effects, including a rapid accumulation and diversification of investable resources, and the emergence of a new financial sector that by the mid-2000s had built up a large and positive net foreign asset position.[5]

Pension fund assets grew rapidly. By 1995 they were equivalent to almost 40% of GDP, and surpassed 60% by 2010. Regulations on the types of asset eligible for pension funds were liberalised over time. Initially, AFPs were only allowed to invest

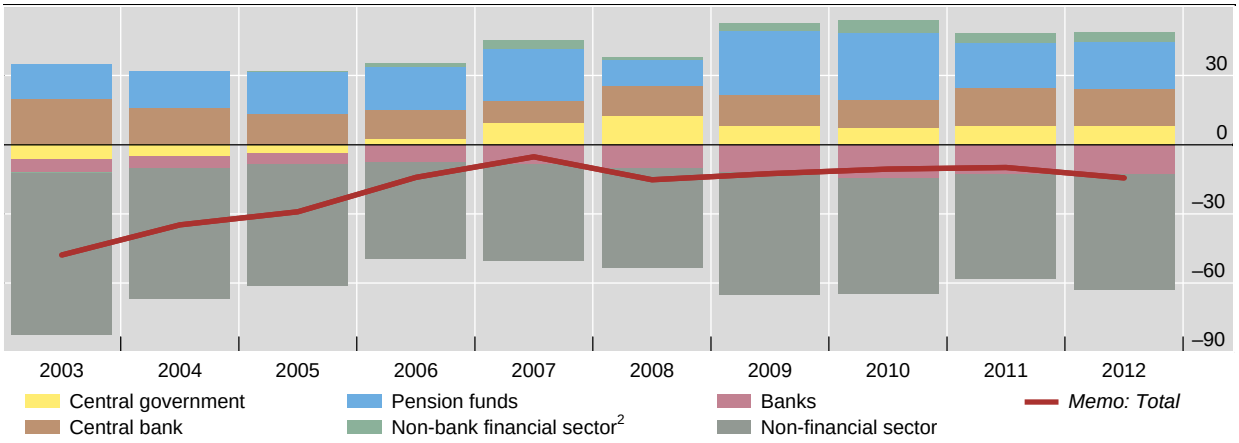
[3] While the non-financial sector hedges its position in the foreign exchange market (Acharán and Villena (2011)), banks function in part as intermediaries: they act as counterparties to pension funds and find resident or non-resident investors willing to hold the positions they have assumed. However, as discussed below, banks do not fully offset positions taken vis-à-vis pension funds.

[4] The literature provides mixed results on the effectiveness of hedging markets in EMEs. Allayannis et al (2001) present evidence that the firm value of East Asian companies that hedged their foreign currency positions before the 1997 financial crisis did not outperform non-hedgers during the crisis. In the case of Brazil, Rossi (2012) shows that the use of derivatives by Brazilian companies reduced the impact on firm value of currency depreciation, except for large fluctuations of the exchange rate. However, Coutinho et al (2012) observe that the use of derivatives reduced the cost of capital for Brazilian firms after 2008, although it tended to raise this cost before the crisis. Gómez-González et al (2012) find that hedging exchange rate risk by using derivatives had a significant positive impact on the market value of Colombian firms, after controlling for other variables like profitability, size and leverage. Taking a more macroeconomic view, Moreno (2007) argues that the low and/or ineffective hedging of foreign currency borrowing in Southeast Asia partly explains the severity of the 1997–98 crisis.

[5] For a detailed description of how the pension system evolved over time, see Hormazábal (2010).

Net international investment position by sector

End-of-period data,[1] as a percentage of GDP — Graph 1



[1] For 2012, second quarter. [2] Mutual funds and insurance companies.

Source: Central Bank of Chile.

in Chilean fixed income instruments, but new types of assets were authorised later on, including investment in the domestic stock market (starting in 1985) and in foreign assets (since 1990, with meaningful investments starting in 1993). In January 1992, only 1.5% of the (then) single fund could be invested in foreign assets, whereas by the end of 2011 that had risen to 75% for the intermediate-risk type of fund, and 100% for the most aggressive type.[6] The most conservative type could carry up to 35% of foreign assets in its total portfolio. The maximum allowed exposure to foreign currency ranged from 15 to 50% of total assets from the least to the most risky type of fund.

AFPs' foreign asset holdings began to increase steadily after the financial crises of the late 1990s. Graph 1 shows that pension funds developed a large positive net foreign asset position (mainly reflecting sizeable gross foreign assets and minuscule foreign liabilities),[7] rivalling that of the central government (which includes the sovereign wealth and the pension reserve funds) and the central bank. On the other hand, resident banks and the non-financial sector over time accumulated a significant net debtor position with the rest of the world, the latter because of substantial flows of foreign direct investment. In fact, Chile enjoys a rather exceptional situation among EMEs: it is one of the two countries among major emerging markets that have a financial (non-bank) private sector with a very large net long foreign asset position as a fraction of GDP (26% in 2007, see Table 1).[8] Having such natural resident counterparties in FX derivatives markets

[6] In 2002, a major restructuring of the system split the original single fund into five different funds, with different risk profiles. The regulators set the authorised asset pool and investment limits separately for each type of fund. Implementation of investment and exposure limits changed substantially during 2012. For the current rules, see www.spensiones.cl/portal/regulacion/582/w3-propertyvalue-5942.html.

[7] As discussed later, pension funds' hedging of their foreign asset holdings provided derivatives market hedges to domestic residents with foreign liabilities such as banks and corporations. However, such hedges are not shown in Graph 1, which reflects transactions with non-residents.

[8] The other is South Africa, which did not suffer much FX stress either, as shown below. Israel also had a financial (non-bank) private sector with a sizeable net long investment position abroad.

Net international investment position in EMEs by sector[1]

End of 2007, as a percentage of GDP — Table 1

	Monetary authorities	Government	Banks	Non-bank financial sector	Non-financial sector	Total
Argentina	17	–6	0	2	10	24
Chile	10	9	–8	26	–42	–5
Colombia	10	–7	–1	3	–30	–25
Israel	17	–7	2	10	–30	–9
Mexico	8	0	–10	1	–38	–40
South Africa	11	–1	3	24	–61	–24
Other emerging markets[2]	19	–3	–4	3	–63	–39

[1] Data for Korea, Malaysia, Peru and the Philippines are not available with same level of disaggregation. [2] Simple median of the Czech Republic, Hungary, India, Indonesia, Poland, Russia and Thailand.

Sources: Central Bank of Chile; IMF.

helped in sustaining market liquidity and resilience during periods of financial stress.

Derivatives markets and FX risk in Chile

The main market participants in the Chilean derivatives market are pension funds, non-financial firms and domestic banks (insurance companies, mutual funds and other financial firms have a very limited participation). Almost all domestic FX derivative transactions are performed in the Formal Foreign Exchange Market (Mercado Cambiario Formal in Spanish), which is an OTC market largely composed of resident Chilean commercial banks, including subsidiaries of international banks. According to Orellana and Rodriguez (2009), the main underlying assets traded in derivatives markets include foreign exchange (slightly more than 90% of notional value in 2007), commodities (around 7% of turnover in 2007) and interest rates.

FX derivative instruments consist mostly of forward contracts (over 90% of the notional amount in 2010), followed by FX swaps (7.2% in 2010). The vast majority of exchange rate forward transactions are short-term (less than 42 days). Transactions over 42 days are about 28% of the total turnover.[9] Most forward contracts are non-deliverable, which means that the obligation to purchase (long position) or sell (short position) a foreign currency (typically the US dollar) is not settled in that currency, but in Chilean pesos (CLP). Therefore, on the settlement date, if the prevailing spot exchange rate is higher than the forward exchange rate agreed to (in CLP per US dollar), the party holding the short position must pay the long position holder the difference between the spot and forward exchange rate, in CLP.

[9] These features broadly coincide with findings by Mihaljek and Packer (2010). OTC markets dominate FX hedging in EMEs, representing about 90% of their turnover. However, FX swaps have a much larger relative size in other EMEs than in Chile (about 73% of turnover in 2010). See Acharán and Villena (2011) for a detailed description of Chilean derivatives markets.

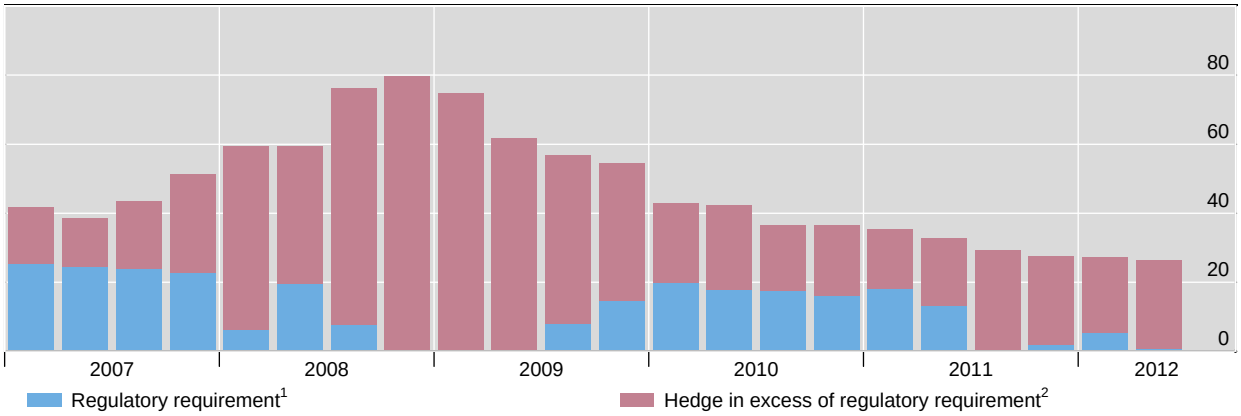
Non-deliverable forwards (NDFs) compensate long position holders when the CLP depreciates, thus shifting *exchange rate risk* to short position holders. NDFs can also help reduce FX funding risks, albeit indirectly. In particular, hedging mitigates the adverse impact of exchange rate depreciation on the financial health (and thus the borrowing capacity) of banks (and others) that have borrowed in foreign currency.

Graph 2 shows that AFPs have typically hedged a large portion of their total foreign assets. In the fourth quarter of 2008, the time of the Lehman failure, they had hedged almost 80% of their FX exposure, coverage much higher than required by regulation. Graph 3 (left-hand panel) reveals that AFPs accounted for almost the whole short side of the domestic FX derivatives markets, standing on the opposite side of most net long forward positions taken by both the banks and the non-financial sector. The net short forward position of AFPs generally exceeded the short-term foreign currency debt of banks and the non-financial sector, so AFPs could easily offer all the needed exchange rate risk coverage for those exposures (Graph 3, right-hand panel). This might partly explain why Chilean corporates seeking USD funding consistently paid a lower spread over sovereign debt than companies in most EMEs before, during and after the global crisis. For instance, since 2004 they paid on average 130 basis points less than Mexican companies, 320 basis points less than firms from emerging Asia and 80 basis points less than those from emerging Europe.

It may be noted that transactions of Chilean banks in the domestic derivatives markets were partly offset in the external market. During this period Chilean banks typically offset against non-residents about 40% of the USD net long forward position accumulated with Chile's residents, mainly AFPs.

Pension funds' FX derivatives position

End-of-period data, as a percentage of total foreign assets — Graph 2



[1] Calculated as the weighted average of the regulatory requirement for each type of fund, where funds' total assets are used as weights. The regulatory requirement was defined as an upper bound on the fraction of the total portfolio that could be exposed to FX risk. [2] Difference between the actual ratio of the net short forward position to total foreign assets and the regulatory requirement ratio (re-expressed as a fraction of total foreign assets).

Sources: Central Bank of Chile; Superintendencia de Pensiones (Chile).

Did derivatives markets reduce financial stress?

Chile's derivatives markets showed remarkable resilience during the period of stress that followed the Lehman bankruptcy in mid-September 2008.

One indicator is that the AFPs did not stop hedging, or did not extensively unwind existing positions. As discussed above, the hedging of their foreign asset portfolios increased to ratios much higher than required by regulation especially during the third and fourth quarters of 2008, and the first quarter of 2009. By continuously rolling over FX hedges they preserved the CLP value of their portfolios, and incidentally provided uninterrupted insurance to Chilean residents with short structural positions in USD. In fact, Graph 3 (right-hand panel) shows that, despite a fall in the USD value of their net short forward position (driven by the plummeting value of their foreign investments), they continued to offer ample FX coverage to insure all the short-term external debt of banks and the non-financial sector.[10]

Three explanations may be offered for the willingness of AFPs to continue providing US dollar hedging throughout the period of financial stress. First, having paid their counterparties part of the FX gains on their foreign currency assets when the CLP depreciated after the Lehman bankruptcy, AFPs had a strong financial incentive to keep hedging so as to benefit from a future recovery of the CLP. Second, the fact that they provided hedges largely via NDFs reduced FX liquidity pressures that might have arisen with standard forward or swap contracts, and that might have deterred AFPs from rolling over their positions. Third, perceptions of counterparty risk were limited in part because the authorities were in a position to deliver foreign currency if needed (see empirical analysis below). Cowan and Valdivia (2011) report that Chilean banks were not completely deprived of external financing, but the cost of borrowing increased and maturities shortened. The Central Bank of Chile provided USD swaps that helped to ease USD funding stress.

Another indicator of resilience is deviations from three-month covered interest parity (CIP), which imply that stress in Chilean FX markets was less severe than in other EMEs. In fact, the stress in FX markets in Chile at the time of Lehman bankruptcy was comparable to that observed in the euro zone, and much lower than that observed in Brazil, Korea or Mexico (Graph 4, left-hand panel).[11] CIP deviations indicate whether the implied cost of USD financing in the domestic FX forward market differs from that in international (Libor) markets.[12] Admittedly, this measure blends FX and funding risks, but the two risks are intertwined.

[10] In the very short run, the drop in the USD value of the net short forward position of AFPs may have contributed to stress in the foreign exchange market. On balance, however, the fact that they still maintained large hedges played a stabilising role.

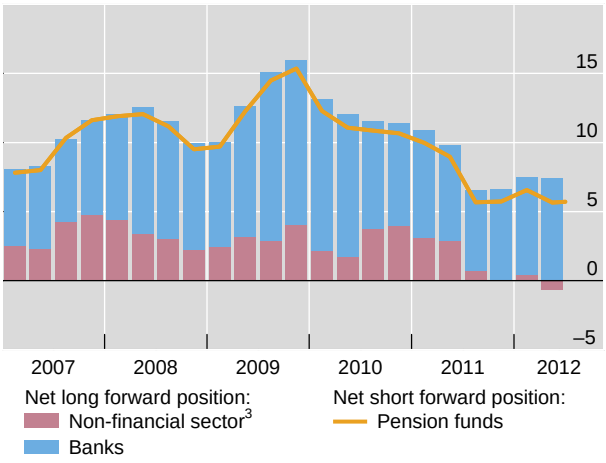
[11] In Chile, significant deviations of CIP started in the second half of 2007, coinciding with the beginning of the subprime crisis and also a rapid tightening of monetary conditions by the Central Bank. Between July 2007 and January 2008 the monetary policy rate (MPR) was increased by 125 basis points. The MPR was further tightened by 200 basis points between June and October 2008.

[12] In normal conditions, CIP is a non-arbitrage condition that requires the spread between domestic and foreign interest rates to be equal to the forward spread, ie the spread between the forward and spot exchange rates. If we denote S_t as the spot CLP/USD exchange rate in t, and $F_{t,t+s}$ as the t forward exchange rate to be settled in time t+s, then CIP means that $\frac{(1+r_{t+s}^{CLP})}{(1+r_{t+s}^{USD})} - \frac{F_{t,t+s}}{S_t} = 0$. In stress situations, this does not necessarily hold, because the difference between spreads becomes too large to trade away, usually in the face of heightened counterparty risk.

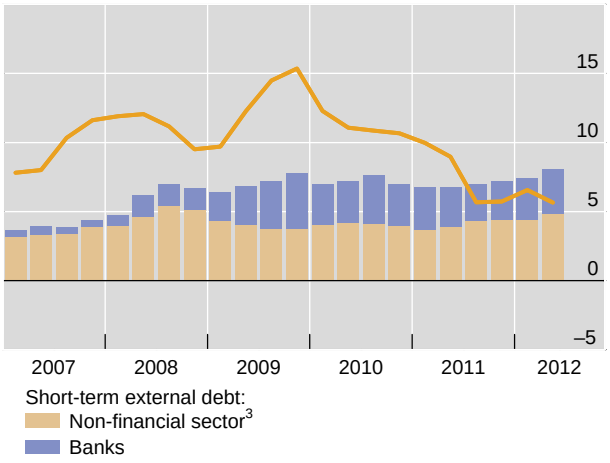
Derivatives position and short-term external debt, by institutional sector[1]

End-of-period data, as a percentage of GDP[2] Graph 3

Derivatives position



Pension funds' derivatives position and short-term external debt



[1] Derivatives positions in the Chilean FX market. [2] Four-quarter moving sum. [3] Companies and individuals.

Source: Central Bank of Chile.

Graph 4 (right-hand panel) shows that a measure of financial stress based on CIP (vertical axis) is negatively related to the ratio of international reserves to short-term external debt (horizontal axis).[13] The negative relationship is quite strong: a regression analysis reveals that almost 50% of the financial stress is explained only by the size of the foreign reserve cover to short-term external debt. Chile (which is excluded from the regression to obtain an out-of-sample prediction) is indeed an outlier: when only international reserves are considered (point labelled "CL" in the right-hand panel of Graph 4), its financial stress was much lower than that of countries with comparable foreign reserve cover. In fact, it was similar to that suffered by Malaysia and Peru, which had about three times the foreign reserve cover. The out-of-sample forecast error of CL comfortably exceeds the two standard error band of the regression.

Next, we recalculate the size of the effective hedge of the economy, adding the net short forward position of AFPs to official international reserves (point labelled "CL*" in the right-hand panel of Graph 4).[14] Both help limit foreign currency risk. International reserves do so by reducing the likelihood of a currency crisis ex ante, and by smoothing out currency depreciation ex post. FX derivatives markets allow

[13] The measure of financial stress is the percentage change of the 20-day standard deviation of CIP deviations in the domestic market between 31 August 2008 and 31 October 2008. We use this window because the 15 September 2008 Lehman bankruptcy did not immediately impact EME financial systems, but rather, the effects built up over the following month. Short-term debt is defined as the USD amount of international bank claims and debt securities that would mature within one year, as of the second quarter of 2008. The points correspond to the major EMEs that at the time were not global financial hubs and did not have an explicit currency peg in place. That is, they exclude China, Hong Kong SAR, Russia, Saudi Arabia, Singapore and Venezuela. We also exclude Thailand, which during 2008 experienced a severe political crisis, unrelated to the economic situation.

[14] Foreign reserves and hedges are not perfect substitutes, so the addition is an approximation, to make the point that both factors matter.

agents to hedge FX risk in advance, and so they might contribute to reducing stress after a financial shock, for instance by reducing the incentive to hoard foreign currency in the spot market. In addition, both can help reduce FX funding strains. They do so by reducing the vulnerability to exchange rate risk and, in the case of international reserves, by providing ammunition to tackle any FX funding strains if and when they emerge. Point CL* is no longer an outlier, and its out-of-sample forecast error almost falls inside the two standard error band.[15]

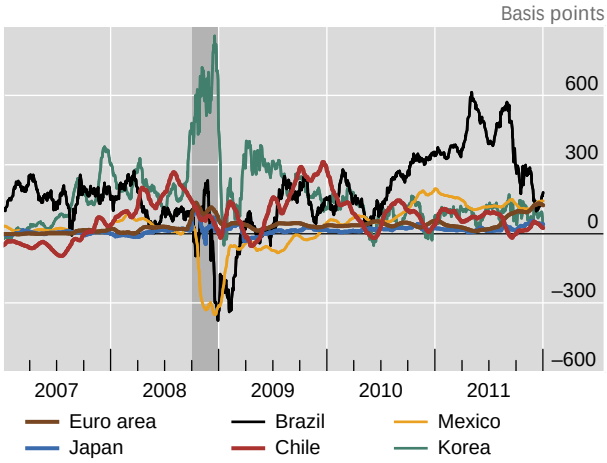
To assess robustness, using the same sample of countries (this time including Chile), we ran a regression of the same dependent variable, the change in the standard deviation of CIP deviations, on a number of controls. These included the ratio of international reserves to short-term debt (as previously defined), the ratio of FX derivatives turnover to GDP (as a measure of derivatives market size) and the ratio of FX transactions with non-residents to total FX transactions (both spot and forward), as a measure of each country's FX market integration with global markets, as suggested by Acharán and Villena (2011). The last two variables are computed using the BIS 2007 Triennial Central Bank Survey of Foreign Exchange and Derivatives Market Activity.

We expect that larger international reserves will reduce financial stress, whereas more integrated markets would have suffered more from the global illiquidity that followed the Lehman event. Our hypothesis is that larger derivatives markets will

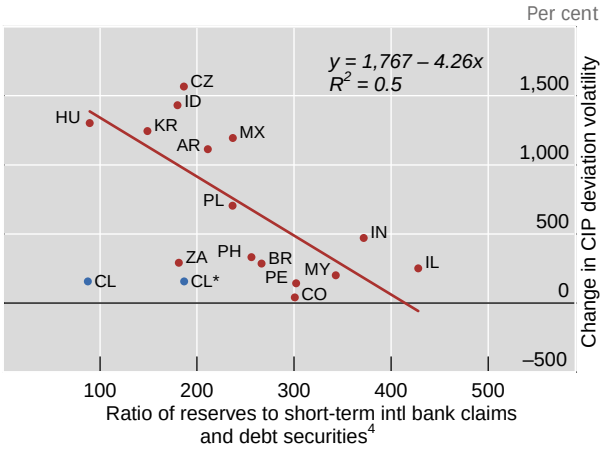
Change in CIP deviations[1] around the Lehman Brothers bankruptcy

Graph 4

CIP deviations in advanced economies and EMEs[2]



CIP deviation volatility[3] and FX risk coverage



The shaded area marks Q4 2008, when the impact of the Lehman Brothers bankruptcy was observed in emerging market economies.

AR = Argentina; BR = Brazil; CL = Chile; CO = Colombia; CZ = Czech Republic; HU = Hungary; ID = Indonesia; IL = Israel; IN = India; KR = Korea; MX = Mexico; MY = Malaysia; PE = Peru; PH = Philippines; PL = Poland; ZA = South Africa. CL* = reserves plus net short position of pension funds managers in foreign exchange domestic market.

[1] Calculated as the difference between the three-month FX swap-implied US dollar interest rate and three-month US dollar Libor. The former is derived from the CIP condition based on three-month interbank interest rates, except for: Brazil, retail certificate of deposit; Chile, DISCTB promissory note rate; Colombia, DTF rate; India and Indonesia, certificate of deposit; Japan, call money (uncollateralised). [2] 22-day moving average. [3] Change in 20-day rolling standard deviation between 31 August and 31 October 2008. [4] Q2 2008.

Sources: IMF; Bloomberg; Datastream; BIS; authors' calculations.

[15] We also tried including sovereign wealth funds (SWFs) in the analysis, but that did not qualitatively change the results, presumably because assets in SWFs are typically not very liquid, and cannot be relied upon to forestall episodes of exchange rate volatility.

Explaining CIP deviations volatility[1]

OLS regression results[2] (16 observations) Table 2

	Coefficient	t-statistic	p-value
Constant	1128.177**	2.342	0.037
Reserves / short-term intl bank claims and debt securities[3, 4]	–3.003**	–2.501	0.028
FX derivatives turnover / GDP[5]	–388.627*	–2.165	0.051
Cross border share of total FX turnover[4, 6]	15.949**	2.513	0.027
Adjusted R-squared	0.375		

** = significant at 5%; * = significant at 10%.

[1] Change in 20-day rolling standard deviation of CIP deviation between 31 August and 31 October 2008, in percentage points. See Graph 4 for CIP deviation calculation details. [2] White heteroskedasticity-consistent standard errors and covariance. [3] Q2 2008. [4] In per cent. [5] Daily average OTC foreign exchange derivatives turnover (local currency against all foreign currencies) in April 2007 as a percentage of Q2 2007 GDP (four-quarter moving sum). [6] Comprising spot and foreign exchange derivatives (outright forwards, swaps, currency swaps and options), based on daily average turnover in April 2007.

Sources: IMF; Bloomberg; Datastream; BIS; authors' calculations.

also reduce financial stress once we control for the other factors. Table 2 shows the results. The coefficients of all three variables have the expected signs, although international reserves and financial integration are more significant than the size of FX derivatives markets, whose coefficient only rejects the usual zero null hypothesis at the 10% significance level. This last result might be due to the lack of a variable to control for derivatives markets resilience, ie the ability to maintain liquidity and depth during the global crisis. Coming back to Chile, its low stress seems to be partly explained by a relatively large derivatives market and a relatively low integration with global financial markets. However, it also has the most negative residual in the sample, indicating that its low stress is poorly explained by the variables included in the regression.

Conclusions

The accumulation of foreign assets by pension funds in Chile resulted in the emergence of a financial (non-bank) private sector with a very large positive net foreign asset position as a fraction of GDP, which is unusual among EMEs. In hedging their own foreign currency exposure, pension funds became natural resident purchasers of FX short exposure, providing hedging to other residents that were financial intermediaries or were structurally short in foreign currency, such as banks and the non-financial sector. Chilean residents with structural short positions would have an incentive to purchase insurance against the possibility of exchange rate depreciation increasing their liabilities (exchange rate risk) or resulting in interruptions in financing (funding risk). The main instruments traded in the Chilean derivatives markets are NDFs, which can mitigate exchange rate and (indirectly) funding risk. This may also have contributed to the lower financing costs faced by Chilean borrowers during normal times.

The empirical evidence presented suggests that pension funds contributed to increasing the resilience of Chilean derivatives markets, notably during the period

that followed the Lehman bankruptcy. Since AFPs continued hedging a large fraction of their ample foreign asset portfolio, they offered banks and the non-financial sector FX coverage that exceeded the total short-term external debt of both sectors, and allowed banks to continue providing liquidity to derivatives markets. The fact that the central bank could provide foreign currency to ease funding stress for Chilean banks, thus reducing counterparty risk for AFPs, probably helped as well. In the end, Chilean financial markets suffered significantly less stress than those in most other emerging markets during the global crisis, especially considering the relatively small size of Chile's international reserve buffer.

The case of Chile suggests that resilient FX derivatives markets can supplement foreign reserves in dampening severe episodes of financial stress. Intuitively, these institutional and market arrangements insure two different risks: foreign currency funding risk, which central bank foreign reserves can address, and exchange rate risk, which can be addressed by FX derivatives markets that remain resilient during episodes of financial stress. In Chile, market resilience was apparently enhanced by the need of AFPs holding net foreign assets to continuously roll over their short hedging positions.

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