Limits to Foreign Exchange Net Open Positions and Capital Requirements in Emerging Economies*

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Abstract

Many emerging economies have regulatory limits on foreign exchange rates net open positions of banks. We show that such limits leave the capital adequacy ratios of banks with investments in foreign subsidiaries more exposed to exchange rate fluctuations. We discuss alternative policies for overcoming this trade-off.

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Keywords: Foreign Exchange Open Positions, Capital Requirements.

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1 Introduction

The internationalization of the banking sector in emerging market economies (EME) is on the rise. As reported by the Committee on the Global Financial System (BIS (2014)) aggregate cross-border claims in the three major emerging market regions increased almost threefold during the last decade. An important driver of this internationalization process has been the expansion of banking conglomerates from larger EME countries to smaller economies within the same region. For example, Colombian financial conglomerates now hold more than 50% of banking assets in El Salvador, more than 20% in Nicaragua and Panama, and close to 20% in Honduras, Costa Rica and Guatemala. BIS (2014) reports that South African banks hold more than 80% of total bank assets in Swaziland. A similar pattern has emerged in Southeast Asia and the former Soviet Republics.[1]

The increasing cross-regional presence of EME financial institutions poses regulatory and supervisory challenges, both for home countries (where the financial headquarters of parent banks are located) and the receiving countries. If the current trend continues, these new challenges are likely to become even more relevant and could lead to a revision of prudential management, and the regulation of balance sheet mismatches by national supervisory authorities.[2] This paper studies the regulatory conflict between the limits on a bank's foreign exchange net open position (FXNOP) and Basel's risk-adjusted capital requirements arising from the internationalization of EME banks.

Limits on banks' FXNOP – an explicit restriction on the difference between its claims and liabilities in foreign currency – are part of the regulatory framework of foreign exchange risk in several emerging countries. Colombia, Mexico, Brazil and Peru are part of a longer list that also includes small economies in Europe

[1] This pattern is consistent with the theoretical and empirical literature on banking internationalization in developed economies. See De Blas and Russ (2013) and Niepmann (2015) for a theoretical approach to the expansion of bank to foreign markets and Okawa and Van Wincoop (2012) for empirical evidence.

[2] The BIS (2014) report suggests that the current expansion of the EME banking sector is likely to continue as "larger EME banks appear to have the balance sheet strength and resources to make larger-scale investments in foreign markets going forward"

like Iceland, Croatia and Macedonia, among others. After the issuance of the EU directive in 1993 and the Basel Committee proposal on market risks in 1996 (BIS (1996)), most developed countries replaced the explicit limits on its foreign exchange rate position with capital requirements that treat foreign exchange rate risk as any other market risk.

Explicit limits on a bank's FXNOP can contradict maintenance of a specific capital adequacy ratio because a matched currency risk position, inasmuch as protecting a bank's income against losses due to fluctuations in the exchange rate, leaves the capital adequacy ratio more exposed to exchange rate movements. The potential conflict between the limits on foreign currency exposure and Basel's capital requirements was identified early by Basel's committee (see for instance, BIS (2016)). With the internationalization of many EME banks via the acquisition of subsidiaries abroad, and more recently, the adoption of the International Financial Accounting Standards (IFRS), which require that banks properly translate the balance sheet of foreign subsidiaries into domestic currency, the conflict between limits on foreign positions and capital has reemerged. We contribute to the related literature by examining the role of such limits on the tensions that emerge with capital adequacy ratios when EME banks control foreign subsidiaries.

Using a simplified balance sheet, we model how the capital adequacy ratio of a bank with explicit limits on its FXNOP varies with fluctuations in the exchange rate, depending on the leverage of its foreign subsidiary; the size of the subsidiary relative to the parent bank; and the risk factor associated with the foreign exchange rate risk used to construct the capital adequacy ratio. We contrast these results with the case where there are no explicit limits on the FXNOP.

We find that with explicit regulatory limits on the FXNOP, the capital adequacy ratio of a bank with foreign investments in subsidiaries is much more sensitive to changes in the exchange rate, particularly if the foreign subsidiaries exhibit high levels of leverage or low levels of capital. Moreover, we find that the optimal prudential policy requires a higher capital adequacy ratio for the banks' foreign subsidiaries.

Enforcing higher capital ratios for foreign subsidiaries requires perfect coor-

dination between national financial supervisory and regulatory agencies in different countries. If coordination is unfeasible or imperfect, we discuss two alternative policies that can induce higher capital ratios for the foreign subsidiaries. The most effective policy would be to demand asymmetric capital requirements for the parent and consolidated banks: this would lead to higher capitalizations in the foreign subsidiaries and dampen the effect of exchange rate movements on the capital adequacy ratio of the holding bank. Alternatively, authorities could raise the risk weight associated with the exchange rate risk. This would have two effects. On the one hand, it would increase the capitalization of the holding. On the other hand, it would leave the holding's capital ratio more vulnerable to exchange rate fluctuations where the capitalization of the subsidiary is low. To reduce the exposure of the holding's capital adequacy ratio to exchange rate fluctuations, any increase in capital should be centered primarily on the foreign subsidiaries. This form of capitalization is not guaranteed by increasing the risk weight associated with the foreign exchange rate risk- hence why we prefer the first policy– but it does provide incentives for banks to move in that direction.

Our paper contributes to the long literature on prudential policies aimed at mitigating foreign currency risk. Several papers including Canales-Kriljenko (2003), Cayazzo, Pascual, Gutierrez, and Heysen (2006), Luca and Petrova (2008) and Ostry, Ghosh, Chamon, and Qureshi (2012) study prudential policies in the context of domestic emerging markets that are dollarized or which are experiencing international capital inflows. Other papers in this literature discuss prudential policies and bank stability in the context of the exchange rate regimes or policy transitions towards flexible exchange rates (Calvo and Mishkin (2003), Fernandez, Karacadag, and Duttagupta (2004), Claessens, Ghosh, and Mihet (2013), and Galati and Moessner (2013), among others). In this paper we focus on policies that set explicit limits on the FXNOP as well as other alternative foreign risk prudential policies for when domestic banks have structural investments in foreign markets. Our paper also contributes to the literature on shocks and how their transmission is facilitated by more interconnected financial systems (Hale, Kapan, Mae, and Minoiu (2016))

The paper is organized as follows. Section (2) describes the limits of the FXNOP in several emerging markets. Section (3) analyzes the effects of such limits on the relationship between capital ratios and the exchange rate fluctuations of a domestic bank that owns a foreign subsidiary whose assets and liabilities are denominated in foreign currency. Section (4) suggests alternative polices to imposing direct limits on the FXNOP that can achieve a stable capital ratio in the presence of exchange rate fluctuations. Section (5) discusses liquidity shocks and section (6) concludes.

2 Prudential management and the regulation of foreign exchange rate risk: limits on the FXNOP and Basel's regulation of market risk

The EME set explicit limits on the exposure of domestic banks' balance sheets to foreign assets as part of their prudential regulation. A non-exhaustive list of countries or territorial entities where limits on open currency positions are currently in place includes Argentina, Bolivia, Brazil, Colombia, Costa Rica, Croatia Cyprus, Georgia, Guatemala, Honduras, Hong Kong, Iceland, Macedonia and Peru. Limits are used to control both the exposure to foreign exchange rate risk and the indebtedness in foreign currency of the domestic financial sector. Countries with explicit limits on foreign currency positions, have also partially adopted Basel's capital requirements demanding that banks maintain minimum capital levels as a buffer against potential losses due to other sources of market risk.

Countries limit their FXNOP in different ways.[3] In Iceland the maximum amount of foreign exposure in a single currency is set at 20% of a banks' equity

[3]The definition of the FXNOP of banks is similar across countries. This position is defined as the sum of the net spot position, the net forward position, all irrevocable guarantees and uncovered credit letters and foreign currency option positions, including gold. The net spot position is the difference between all foreign assets and liabilities, including accrued interest positions. The net forward position is the difference between amounts to be received and paid in the form of foreign exchange forward contracts and the principal on currency swaps not included in the spot position.

while the total FXNOP is set at 30% of regulatory capital.[4] Croatia, Macedonia, and Georgia, limit their respective FXNOP based on bank's regulatory capital base, though there are different interpretations regarding what constitutes the latter. In Colombia, where impressive increases in the local financial sector's investments abroad have made tensions in regulation more latent, foreign currency positions have to be between -5% and 20% of a banks' capital base, except for banks that control foreign subsidiaries, where the upper limit is 30% of regulatory capital. In other cases, the limits are more flexible and are set at the discretion of the supervisory authority. The Hong Kong monetary authority, for instance, limits the FXNOP of authorized institutions based on their scale, risk tolerance policy and market proficiency. Institutions with an FXNOP higher than 25% of capital base are required to provide a rationale for their net asset positions. Costa Rica allows financial institutions to set their own FXNOP limits depending on their business model, but requires that each bank justifies its figures to the Central Bank by disclosing its internal models of risk management of currency mismatches.[5]

Setting limits on the FXNOP is also used as an instrument for stabilizing foreign exchange rate markets, especially during economic crises. During the Tequila crisis of 1995, for example, Mexico set the limit on foreign currency open positions at 40% of a bank's capital, later reducing it, in July 1998, to 15% once the market returned to normal. Colombia eased its lower limit on the FXNOP from 0% to -5% in 1999, so as to allow banks to be net debtors in foreign currencies at a time when it was difficult to access external credit. As documented in Tobal (2014),

[4]Regulatory capital includes the banks' equity but also other components of Tier 1 capital and Tier 2 capital such as revaluation reserves, undisclosed reserves, hybrid instruments and subordinated term debt.

[5]For Iceland see the rule No. 707 of August 2009. For Croatia see the Croatia Official Gazette Narodne novine no. 36/2001. For Macedonia the reference is the Gazette of the Republic of Macedonia no. 17/2008. For Colombia the reference are Resolucion Externa No. 5 de 1999 of Banco de la Republica de Colombia and Resolucion Externa No. 3 de 2017 of Banco de la Republica de Colombia that increased the limit to the FXNOP from 20% to 30% for banks with foreign subsidiaries, partially motivated by the high costs of closing the positive FXNOP of domestic conglomerates with foreign subsidiaries. For Hong Kong the reference is Supervisory Policy Manual on Foreign Exchange Risk Management of Hong Kong Monetary Authority, January 14, 2009. For Cosa Rica see the Sugef 23-17 of the Consejo Nacional de Supervision del Sistema Financiero (CONASSIF) of June 14 of 2017.

other Latin America countries, such as Bolivia, Brazil, Guatemala, Costa Rica and Honduras, have tightened limit positions in order to reduce foreign exchange rate volatility.[6]

In contrast with EME, most developed economies abandoned setting limits on the FXNOP during the 90s. They replaced them with capital requirements: in line with Basel's Accords, foreign exchange risk is treated as other types of market risk, such that banks are required to allocate a specific amount of capital to shield them against foreign currency exposures. Following Basel's methodology, supervisory agencies in developed countries use the FXNOP as a measure of foreign currency risk exposure. The FXNOP is adequately weighted by a risk parameter and added to other market risk exposures in order to compute the capital adequacy ratio. In the last revision of Basel's minimum requirements of market risk -carried out by the Basel Committee in January 2016- the risk parameter weight for foreign exchange rate exposure was set at 30% for all currencies, with the exception of selected pairs of currencies for which the risk parameter is close to 21%. Most countries currently have a risk weight associated to exchange rate risk of 8% (notably, the US, UK and Canada), though some emerging economies have lower risk weights (for example, Colombia at 5.5%).

These two approaches toward prudential management and the regulation of foreign exchange risk procure different objectives: explicit limits on foreign currency positions reduce potential fluctuations in income caused by exchange rate fluctuations, while capital requirements rely on the use of capital to buffer the balance sheet of banks against potential losses. These two objective can be in direct conflict when banks have structural positions of a non-dealing nature vis-à-vis foreign currencies. For instance, the capital adequacy ratio of a parent bank with foreign subsidiaries can change because of exchange rate fluctuations when the bank must comply with limits on foreign currency positions. The next section discusses the interaction between these two polices.

[6]This in in line with the findings by Cerutti, Correa, Fiorentino, and Segallad (2017). Using a large data set of prudential tools they document that foreign-currency reserve requirements are counter-cyclical in EME.

3 Capital adequacy ratios, the FXNOP, and exchange rate fluctuations

To study the regulatory conflict between limits on the FXNOP and capital requirements, we develop a model based on a simplified balance sheet of an EME holding bank with a subsidiary institution abroad. We first analyze the model and the effects of exchange rate fluctuations in a setting without FXNOP limits. We incorporate them into the second part of the section.

3.1 Capital adequacy ratios and foreign currency risk without explicit limits on the FXNOP

We begin by analyzing the simplified balance sheet of the foreign subsidiary, the parent bank and the consolidated balance sheet of the holding company. Table (1) presents the balance sheet of all three. We assume that the bank controls 100% of the foreign subsidiary whose balance sheet is converted into US dollars (denoted with the superscript US). The balance sheet of the parent bank is expressed in the local currency (superscript LC) while the assets controlled by the foreign subsidiary are accounted for in the domestic books using the equity method.[7] Assets are denoted by A, liabilities by L, and net worth by NW. Initially, we normalize the exchange rate between the local currency and the US dollar at one. We also assume that the quality of the net worth of the consolidated holding is sufficient enough to be considered Tier 1 Capital.

[7] Under the equity method the parent bank recognizes its share of the earnings or losses of the foreign subsidiary in its balance sheet by changing the value of the investment. The share of the foreign bank earnings that appear in the parent bank's balance sheet is calculated based on the percentage ownership of the parent bank.

Table 1: Simplified Balance Sheet of the Subsidiary, Parent Bank and Consolidated Holding

Foreign Subsidiary	
A^{US}	L^{US}
	$NW^{US} = A^{US} - L^{US}$

Parent Bank	
A^{LC}	L^{LC}
$NW_p^{US} = A^{US} - L^{US}$	$NW^{LC} = A^{LC} + NW_p^{US} - L^{LC}$

Consolidated Holding	
A^{LC} A^{US}	L^{LC} L^{US}
	$NW^{LC} = A^{LC} - L^{LC} + \left(A^{US} - L^{US}\right)$

Under these assumptions the capital adequacy ratio (CR) of the consolidated bank is defined as the ratio of the net worth to the risk-weighted assets (RWA) plus the market risk (MR) of the holding:

$$CR = \frac{NetWorth}{RWA + MR} = \frac{NW^{LC}}{\alpha A^{LC} + \beta A^{US} + MR} \tag{1}$$

where α and β are the risk-weights of the bank's domestic and foreign assets, respectively. Without a loss of generality, we assume that these two parameters are equal to one (a risk weight of 100%) as if the bank's assets were exclusively

commercial credit.[8]

Given that our purpose is to assess the effect of having limits on the currency position of banks, we focus exclusively on foreign currency risk and ignore any other type of risk present in the balance sheet, whether associated with the foreign subsidiary or the parent bank. Adding other sources of market risk leaves our conclusions unchanged, but does add complexity to our calculations.[9]In section (5) we discuss the case of liquidity shocks, and compare how capital ratios with and without explicit limits are affected by them. For now, assuming that the capital adequacy ratio required by the supervisory authority is θ, the market risk of the holding bank is defined as:

$$MR = f\,(1/\theta)\left(A^{US} - L^{US}\right)$$

where f is the weight of foreign currency risk exposure and $A^{US} - L^{US}$, the difference between assets and liabilities in the foreign currency, is the (unconstrained) FXNOP of the bank.

We now introduce the possibility of exchange rate movements between the US dollar and the local currency and study their effects on the capital ratio. Let D be the percentage change in the LC with respect to the US dollar, such that, if D is positive, the local currency depreciates against the dollar. Table (2) presents the balance sheet of the foreign subsidiary, the parent bank and the consolidated holding.

[8]In the construction of the capital adequacy ratio under the standardized approach, banks should weight commercial credit by a risk factor of 100% according to Basel's guidance. Other assets have different risk weights depending on their nature. As long as exchange rate fluctuations do not alter the composition of the bank's assets or the intrinsic risk weights, the assumption that assets only take the form of commercial credit has no effect on our analysis.

[9]Other sources of market risk that are not correlated to foreign exchange rate risk would appear as an additive constant term in the denominator of equation (1).

Table 2: Simplified Balance Sheet after percent change D of the local currency (LC) against the dollar (USD)

Foreign Subsidiary	
$(1+D)\,A^{US}$	$(1+D)\,L^{US}$
	$NW^{US} = (1+D)\left(A^{US} - L^{US}\right)$

Parent Bank	
A^{LC}	L^{LC}
$(1+D)\,NW_p^{US}$	$NW^{LC} = A^{LC} + (1+D)\,NW_p^{US} - L^{LC}$

Consolidated Holding	
A^{LC} $(1+D)\,A^{US}$	L^{LC} $(1+D)\,L^{US}$
	$NW^{LC} = A^{LC} - L^{LC} + (1+D)\left(A^{US} - L^{US}\right)$

The capital adequacy ratio of the consolidated bank, allowing for changes in the value of the domestic currency, CR^D, can be written as:

$$CR^D = \frac{NW^{LC} + D\left(A^{US} - L^{US}\right)}{A^{LC} + (1+D)\,A^{US} + MR} \tag{2}$$

We analyze below how this expression is affected by changes in the exchange rate and how these effects depend on the other characteristics of the bank and the regulation. To gain some intuition about the key elements explaining these interactions, it is useful to express CR^D relative to CD, that is, relative to the capital

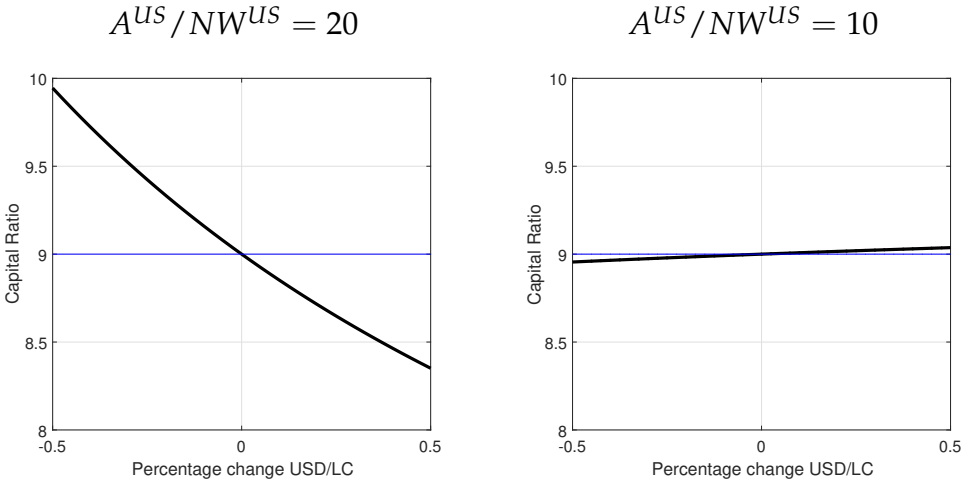
ratio when the exchange rate is normalized:

$$\frac{CR^D}{CR} = \frac{1 + D\frac{NW^{US}}{NW^{LC}}}{1 + D \cdot CR\left(\frac{A^{US}}{NW^{US}}\frac{NW^{US}}{NW^{LC}} + f\left(1/\theta\right)\frac{NW^{US}}{NW^{LC}}\right)} \tag{3}$$

The exchange rate movements have an ambiguous effect on this ratio. The effect depends in particular on two bank characteristics: (i) the ratio of the net worth of the foreign subsidiary to the net worth of the holding $\left(NW^{US}/NW^{LC}\right)$ and (ii) the ratio of the foreign assets to the net-worth, namely, the leverage of the foreign subsidiary $\left(A^{US}/NW^{US}\right)$. The impact of the exchange rate also depends on parameters f and θ. To simulate the effects of the sensitivity of the capital ratio on exchange rate movements, we begin by calibrating these parameters to the Colombian regulation: $f = 5.5\%$, $\theta = 9\%$. In the simulations reported below, we allow the exchange rate to change in either direction up to 50% against the dollar. Moreover, without loss of generality, we assume that the initial (normalized) capital adequacy ratio is equal to the regulatory level: $CR = \theta$.

We first examine the role of foreign assets to the net-worth ratio, $\left(A^{US}/NW^{US}\right)$. Initially, we assume that $NW^{US}/NW^{LC} = 20\%$, a figure consistent with the levels of the internationalization of Colombian banks. Figure (1) shows the capital ratio of the consolidated holding as a function of changes in the exchange rate under two scenarios: high leverage, where the asset-to-net worth ratio of the foreign subsidiary is equal to 20; and low leverage where it is equal to 10. These two levels are arbitrary and correspond to capital adequacy ratios of 5% and 10%, respectively, absent of any market risk. We later generalize our findings to any level of leverage.

Figure 1: Capital ratio and exchange rate fluctuations under two different level of leverages

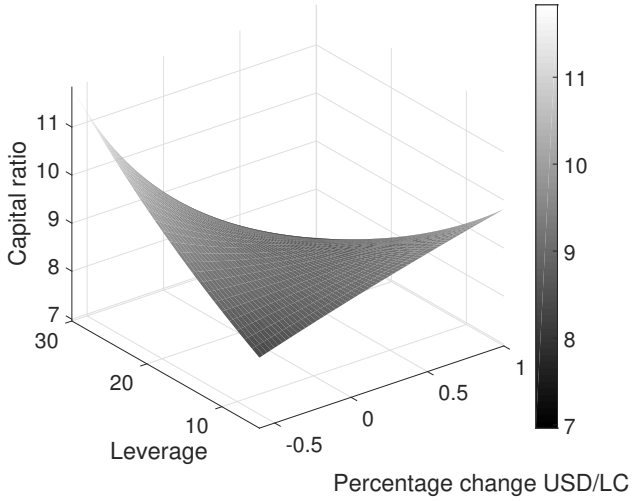


The graph shows that the capital adequacy ratio of the holding bank is very sensitive to changes in the exchange rate in the case of high leverage, but not when leverage is low. For instance, in the high-leverage case, a 20% depreciation of the domestic currency leads to a decline in the capital ratio to 8.7%, whereas in the low-leverage case the effect is negligible, with the capital ratio increasing to 9.01%. (Recall that $\theta = 9\%$ is the capital adequacy ratio required by the supervisory authority). Intuitively, changes in the dollar denominated assets of the foreign subsidiary are absorbed by the changes in the subsidiary's capital when the latter has low-leverage. In other words, in the low-leverage case, both the numerator and the denominator of the capital ratio move in the same direction with exchange rate fluctuations, thus dampening movements in the capital adequacy ratio. In the high leverage case, the value of foreign assets expressed in domestic currency drive the changes in the capital ratio.

Figure (2) extends the analysis of the relationship between the capital adequacy ratio and exchange rate fluctuations to continuous values of leverage of the foreign subsidiary. This figure confirms that the capital ratio of the consolidated holding does not fluctuate much with foreign currency changes when the

foreign subsidiary has low levels of leverages. It also suggests that there exists a level of leverage at which the capital adequacy ratio is independent of exchange rate movements. Later in the paper, we discuss this point further.

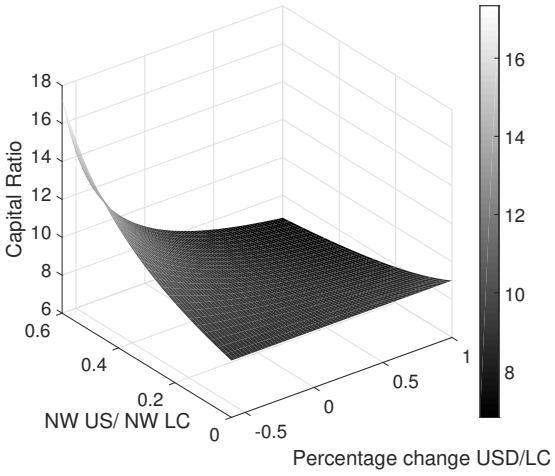
Figure 2: Capital ratio, exchange rate fluctuations and leverages (A^{US}/NW^{US})



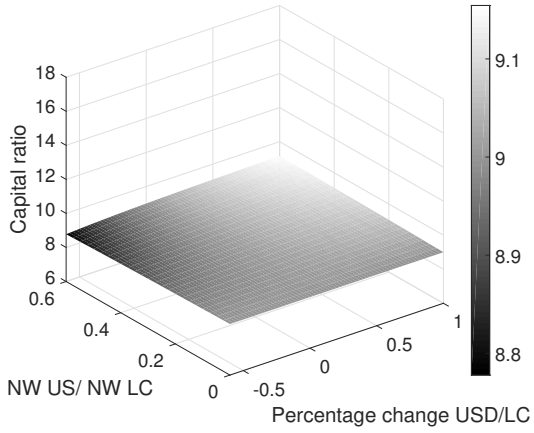
We now turn to the role of NW^{US}/NW^{LC}, the ratio of the net-worth of the foreign subsidiary to that of the consolidated holding. Figure (3) depicts the capital ratio of the consolidated holding as a function of changes in the exchange rate and different values of NW^{US}/NW^{LC}. The top plot depicts these relationships when the leverage is high (20) and the bottom panel when it is low (10). These graphs reinforce our previous conclusion: the capital adequacy ratio becomes more sensitive to exchange rate fluctuations as the leverage of the foreign subsidiary increases. Moreover, this sensitivity is exacerbated the more the foreign subsidiary weighs in the balance sheet of the consolidated bank. As a bank expands abroad and increases its participation in foreign markets, its capital adequacy ratio becomes more exposed to fluctuations in the exchange rate, particularly if the foreign subsidiaries are poorly capitalized and/or exhibit relatively high leverage levels.

Figure 3: Capital ratio and exchange rate fluctuations for different levels of leverage

$$A^{US}/NW^{US} = 20$$



$$A^{US}/NW^{US} = 10$$



3.2 The capital ratio and foreign currency risk with explicit limits on the FXNOP

We extend our previous analysis to incorporate explicit limits on the bank's FX-NOP, and analyze it's effects on the sensitivity of the capital ratio to exchange rate fluctuations. We contrast the two cases under the assumption that, as before, the bank begins with a capital ratio equal to the level required by the supervisory agency.[10]

Table (3) presents the balance sheets of the foreign subsidiary, the parent bank and the consolidated group, under the assumption that the bank faces a regulatory limit on the FXNOP. For simplicity's sake, we assume that the limit on the FXNOP is zero, which means that the bank is forced to fully hedge its foreign currency exposure. Provided that the subsidiary has a positive net-worth, its assets will be greater than its liabilities, thus creating a currency mismatch for the holding not permitted by the constrained FXNOP. To fully hedge this mismatch, the bank has to open a short-position in US dollars via the derivative markets or by issuing US denominated debt, and then use the proceedings to buy domestic currency assets.

The balance sheet of the parent bank reported in Table (3) includes the short-position in US dollars on the liability side (SP^{US}), together with the corresponding domestic-currency asset ($SP^{LC,US}$). Because of the hedging, the net worth of the consolidated bank is now equal to the net worth of domestic assets plus the domestic-currency assets resulting from closing the FXNOP. Changes in the exchange rate have no effect on the net worth of the consolidated bank. The capital ratio, however, fluctuates with exchange rate movements, as the value of the risk-weighted assets of the foreign subsidiary, now converted into domestic currency, varies with the exchange rate.

[10] We also study the case where the initial capital ratio under explicit limits is higher than the initial level without explicit limits but this level effect doesn't modify our conclusions. Given our baseline parameter values the initial level of capital ratio with explicit limits should be 9.1% because with a zero net foreign asset position the market risk is also zero.

Table 3: Simplified balance sheets of the subsidiary, the parent bank and the consolidated holding, with explicit limits on the net foreign open position

Foreign Subsidiary	
A^{US}	L^{US}
	$NW^{US} = A^{US} - L^{US}$
Parent Bank	
A^{LC} $SP^{LC,US}$ $NW_p^{US} = A^{US} - L^{US}$	L^{LC} SP^{US} $NW^{LC} =$ $A^{LC} + NW_p^{US} - L^{LC}$
Consolidated Holding	
A^{LC} A^{US} $SP^{LC,US}$	L^{LC} L^{US} SP^{US}
	$NW^{LC} =$ $A^{LC} - L^{LC} + SP^{LC,US}$

We assume that the proceedings derived from the issuance of USD denominated debt are invested in domestic-currency assets that bear no risk. These assets could be government bonds, which are regarded as risk free from a regulatory point-of-view. In this case the capital ratio of the consolidated group under explicit limits (CR^{EL}) is given by the following expression:

$$CR^{EL} = \theta = \frac{NW^{LC}}{A^{LC} + A^{US}}$$

Note that in this expression there is no market risk term as the bank has a zero

net foreign position. How does the capital ratio of the bank respond to exchange rate movements in this case? In $CR^{D,EL}$, the numerator remains constant, but the domestic-currency value of the risk-weighted foreign assets change with the exchange rate:

$$CR^{D,EL} = \frac{NW^{LC}}{A^{LC} + (1+D)\, A^{US}}$$

This ratio can be rewritten as follows:

$$CR^{D,EL} = \frac{1}{\frac{1}{\theta} + D\frac{A^{US}}{NW^{US}}\frac{NW^{US}}{NW^{LC}}}.$$

Ultimately, it depends on the leverage of the foreign subsidiary (A^{US}/NW^{US}) and the weight of the foreign subsidiary in the consolidated bank's net worth (NW^{US}/NW^{LC}).

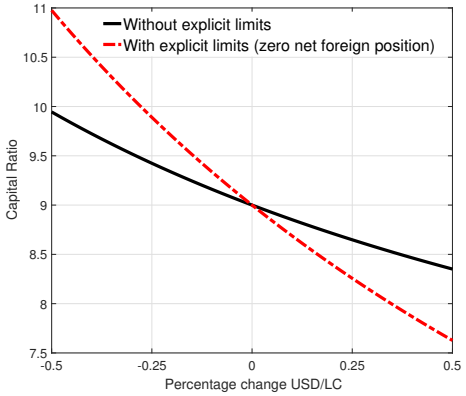
Using the baseline parameter $NW^{US}/NW^{LC} = 0.2$, figure (4) shows that, subject to exchange rate fluctuations, the capital ratio of a holding bank with explicit limits on the FXNOP is more volatile than one without FXNOP limits.[11]

The national supervisory authority is confronted with a trade-off between stabilizing the income statement, which is achieved by imposing explicit limits on the net foreign open position, and stabilizing the capital ratio. Basel regulation prioritizes the capital ratio as the key measure of financial stability. In countries where domestic banks have investments in foreign subsidiaries, explicit limits on the FXNOP conflict with Basel's objective of maintaining a stable capital adequacy ratio. How can this regulatory conflict be resolved? What prudential policies could replace explicit limits on the FXNOP to buffer the capital ratio from exchange rate fluctuations? We address these questions in the next section.

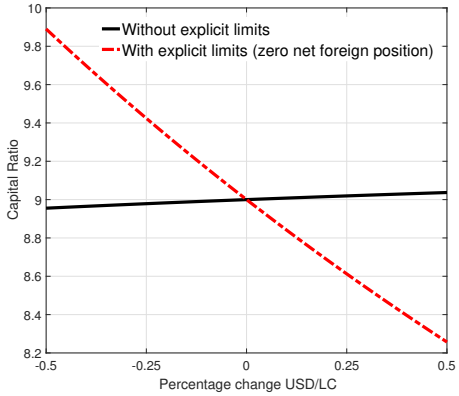
[11] We don't present the analysis with a higher level NW^{US}/NW^{LC} but from the previous analysis it is straightforward to verify that the difference in volatility from the case with and without explicit limits is increasing in NW^{US}/NW^{LC}.

Figure 4: The capital ratio and exchange rate fluctuations with and without explicit limits on the net foreign open position

$A^{US}/NW^{US} = 20$



$A^{US}/NW^{US} = 10$



4 Alternatives to FXNOP limits

In this section, we analyze two alternative policies to setting limits on the FXNOP that could maintain a stable capital adequacy ratio in the presence of exchange rate fluctuations. To set the stage, we first discuss the optimal level of leverage in a foreign subsidiary, defined as the one producing a capital adequacy ratio that doesn't fluctuate with the foreign exchange rate.

As mentioned at the end of section 3.1, equation (3) implies that there exists a leverage level for a foreign subsidiary that immunizes the capital ratio of the holding bank against exchange rate variations. The latter is true, if the following holds:

$$\frac{A^{US}}{NW^{US}} = \frac{1-f}{\theta} \tag{4}$$

For the benchmark parameters, this leverage is equal to 10.5. If the leverage of a foreign subsidiary is higher than this threshold, a depreciation of the domestic currency relative to the USD dollar will reduce the bank's capital ratio. Conversely, if the leverage of a foreign subsidiary is lower than this threshold, the

opposite happens.

The key point of this equation is that the leverage threshold is consistent with a particular capital ratio for the foreign subsidiary: for the baseline parameters, the leverage threshold implies a capital ratio for the foreign subsidiary of 9.52%, 52 basis points higher than the 9% capital ratio of the consolidated group. That is, one way to shield the consolidated group's capital adequacy ratio from exchange rate variations is to demand a higher capital ratio for the subsidiary. This introduces a problem of coordination for the supervisory authorities of the countries where the bank operates. If the foreign supervisory authority requires a capital ratio of 9% for the foreign subsidiary, and the domestic agency requires the same level of capital for the the bank's domestic operation, the consolidated balance sheet will be exposed to foreign currency risk, as the capital ratio of the foreign subsidiary will fall short of the optimal level. As Basel's capital requirements for market risk make no distinction between foreign and domestic banks, the optimal level of capital for the foreign subsidiary is unattainable under current prudential policies. We discuss two alternative policies that would induce banks to increase their foreign capital to the higher (optimal) level needed to achieve a capital ratio immune to exchange rate fluctuations.

4.1 Asymmetric capital ratio requirements for the parent and consolidated banks

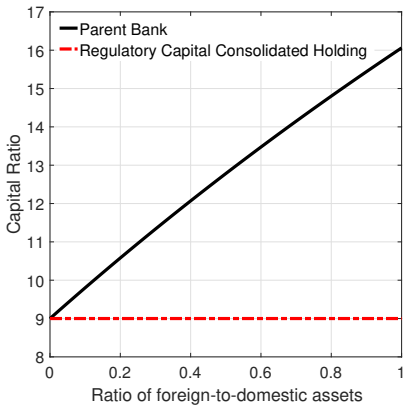
The conventional practice is for national supervisory authorities to require identical minimum capital adequacy ratios for both the parent bank, whose balance sheet is purely domestic, and for the consolidated bank. Nevertheless, national authorities could induce a higher capital ratio for the foreign subsidiary by demanding asymmetric capital adequacy ratios for the parent and consolidated holding. In particular, using the simplified balance sheet in table (1), we find that the capital ratio of the parent bank (CR^{Parent}) is consistent with the optimal threshold level of leverage for the foreign subsidiary (taken from equation 4). We report the CR^{Parent} in equation 5. It is a function of the regulatory capital ratio of the con-

solidated bank (θ); the risk weight factor for the exchange rate risk (f), and the foreign-to-domestic assets ratio (A^{US}/A^{LC}), which captures the importance of the foreign subsidiary in the overall balance sheet of the consolidated bank:

$$CR^{Parent} = \frac{\left(1 - f + \frac{A^{US}}{A^{LC}}\right)\theta}{(1-f) + (f+\theta)\frac{A^{US}}{A^{LC}}} \tag{5}$$

Using the baseline parameters for f (5.5%) and θ (9%) we report in Figure 5 the optimal capital requirements for different foreign-to-domestic assets ratios. As the weight of the subsidiary grows, the optimal capital ratio for the parent bank becomes bigger. If the weight goes to zero, the capital ratio of the parent bank converges to the consolidated capital ratio- that is, 9%. If the ratio of foreign-to-domestic assets is 1/4, the national supervisory authority requiring of the consolidated bank a 9% capital ratio, could induce it to mantain the optimal level of capitalization of the foreign subsidiary, if the capital ratio of the parent bank is 10.9%.

Figure 5: Optimal asymmetric capital ratios



Summing up, the optimal degree of asymmetry in the capital requirements of the parent and consolidated banks, depends on the bank's internationalization: those with a higher foreign-to-domestic asset ratio should be required to

have a higher capital ratio for the parent bank. This means that the policy requirements would need to be tailor-made for different financial institutions, as the one-size-fits-all approach would not be optimal. If the supervisory authority requires the same minimum level for capital ratios to all parent banks based on the maximum foreign-to-domestic asset ratio within the domestic financial system, it would minimize the sensitivity of the capital ratios of local banks to exchange rate movements. It would also, however, induce an excess amount of capital of the foreign subsidiaries of the banks with the lower levels of international participation.[12] We therefore see the first policy, one with specific capital requirements for each parent bank, as the preferred policy.

4.2 The weight of foreign exchange rate risk

In most emerging countries, the risk weights (f) used to compute the market risk of exchange rates in the capital adequacy ratio are below the 30% level recommended by the latest Basel's minimum capital requirements for market risk. For example, in Colombia and Mexico the weight of foreign exchange rate risk is 5.5% and 8%, respectively. Here we analyze the consequences of adopting Basel's suggested risk weights on capital ratios when banks are faced with exchange rate fluctuations. Our conclusion is that with higher risk weights, capital ratios are less sensitive to exchange rate movements only when the foreign subsidiary has very low leverage - that is, when its own capital ratio is high. While this condition is not guaranteed by the higher risk weight *per se*, the latter could push banks to capitalize their foreign subsidiaries in order to prevent exchange rate devaluations pushing the capital of respective consolidated banks below the required levels.

Figure (6) makes this point transparent. It presents the capital ratio of a consolidated bank for different exchange rate changes, risk weights and foreign subsidiaries' leverages. We leave all other variables constant, including the amount of the consolidated bank's regulatory capital. (Note that for a positive FXNOP a

[12]The policy with the same minimum level of capital to all parent banks could also create an externality problem as banks that decided to further expand in international markets will impose higher capital requirements to other domestic banks without international subsidiaries.

bank will be required to increase its capital when moving from a lower to a higher risk weight associated with the foreign exchange rate risk). As this graph shows, increasing the weight associated with the foreign exchange rate risk when computing the market risk, amplifies the sensitivity of the capital adequacy ratio to exchange rate movements. This is true in the two top panels, where the leverage of the subsidiary is higher. In the bottom panel, where the foreign subsidiary has very low leverage- meaning that it has a much higher capital ratio on its own- the sensitivity of the capital ratio to exchange rate fluctuations is lower when f is high.

The capitalization ratio for the foreign subsidiary that keeps the capital ratio of the consolidated bank constant against exchange rate movements is increasing in f, as can be seen by rewritting equation (4) as:

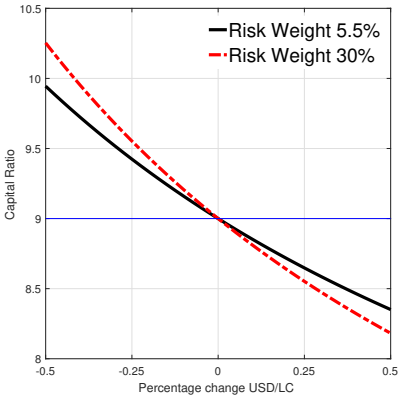
$$\frac{NW^{US}}{A^{US}} = \frac{\theta}{1-f}.$$

Therefore, increasing the risk weight to 30% from the baseline of 5.5% would force a bank to increase the capital ratio of its foreign subsidiary to 12.8% if it desires to reach the optimal leverage threshold.

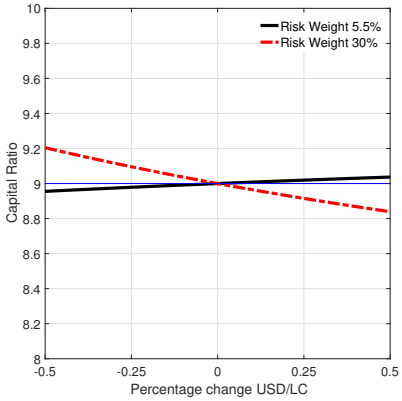
We conclude that increasing the risk weight of foreign exchange risk would push banks towards capitalizing foreign subsidiaries in order to avoid falling short of capital after exchange rate devaluations. If banks are averse to changes in the capital ratio of consolidated holdings, increasing the risk weights of foreign exchange rate risk can be an effective policy for inducing banks to increase capital buffers in foreign subsidiaries. Nevertheless, this policy relies on the aversion of banks to fluctuations in the capital ratio. We therefore conclude that the national authorities should favor the first prudential policy that was suggested.

Figure 6: The capital ratio and exchange rate fluctuations with different risk weights and leverages

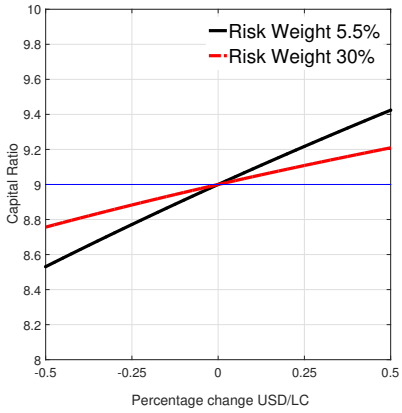
$A^{US}/NW^{US} = 20$



$A^{US}/NW^{US} = 10$



$A^{US}/NW^{US} = 5$



5 Liquidity shocks

As we show before, a prudential policy based on setting explicit limits on the FXNOP leaves a bank more exposed to changes in its capital adequacy ratio due to exchange rate fluctuations. Limits on the FXNOP, however, can be justified if they are more effective at dealing with other sources of risk. In this section,

we analyze whether the setting of explicit limits on the FXNOP helps banks cope with liquidity shock. We analyze two scenarios: in the first, we assume a liquidity shock correlated across markets that simultaneously affects the balance sheet of banks at home and abroad. In the second, we assume that there is a liquidity shock in foreign markets that only affects the balance sheet of bank's subsidiaries. Our conclusion is that banks' reaction to liquidity shocks are almost identical whether or not limits have been set on the FXNOP.

5.1 Correlated shocks

We model liquidity shocks as the elimination of a fraction, δ, of a bank's assets. In the correlated case, the decline in assets is the same on the parent bank's balance sheet as that of the subsidiary. Where there are no explicit limits on the FXNOP, the regulatory capital of the consolidated bank following a liquidity shock of size δ, both at home and abroad, is defined by:

$$CR^{\delta} = \frac{NW^{LC} - \delta\left(A^{LC} + A^{US}\right)}{(1-\delta)\left(A^{LC} + A^{US}\right) + f\left(1/\theta\right)\left(A^{US} - L^{US}\right) - \delta f\left(1/\theta\right)A^{US}} \tag{6}$$

Liquidity shocks affect the capital ratio by reducing the capital of the consolidated bank. This happens as a result of a decline in the parent bank's assets in local currency; in the subsidiary's assets in foreign currency (numerator) ; the amount of risk weight assets; and the FXNOP (denominator). Note that because of the liquidity shock, the bank has a smaller FXNOP, as a fraction$\delta$of its foreign assets are lost even while liabilities remain unchanged.

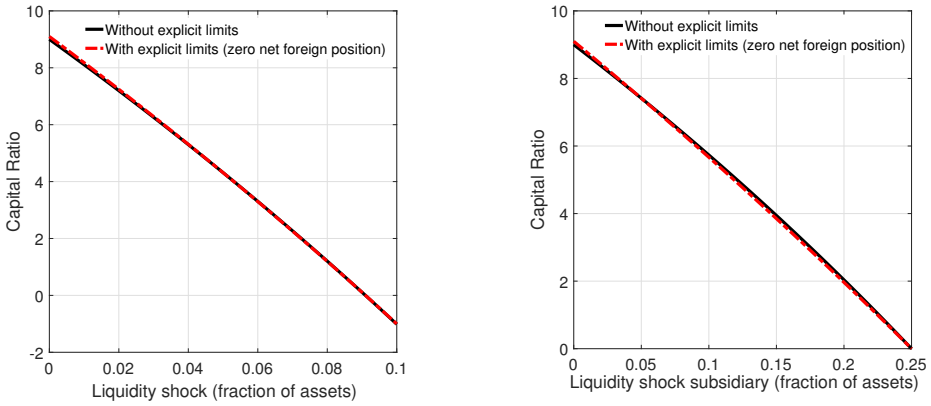
With explicit limits (EL) on the FXNOP, a liquidity shock of this type changes the regulatory capital as follows:

$$CR^{\delta,EL} = \frac{NW^{LC} - \delta\left(A^{LC} + A^{US}\right)}{(1-\delta)\left(A^{LC} + A^{US}\right)} \tag{7}$$

The balance sheet of the holding starts without any market risk associated with the FXNOP. As a fraction$\delta$of assets in the foreign currency disappears, the bank is

Figure 7: Liquidity shocks and the capital ratio with and without explicit limits on the net foreign open

(a) Correlated liquidity shocks (b)Liquidity shocks to the subsidiary



forced to cover the negative FXNOP by selling domestic assets (a short-position in the local currency) and buying assets in the foreign currency (a long position in dollars). For simplicity's sake, we assume that the bank buys foreign currency assets that are risk-free, for instance Treasury Bonds, such that they don't add to the bank's market risk exposure.

The left panel of figure (7) compares the capital adequacy ratio of the bank with and without explicit limits on the FXNOP for different values of δ, and uses the same calibration used in section (3): $f = 5.5\%$, $\theta = 9\%$, $NW^{US}/NW^{LC} = 20\%$ and $A^{US}/NW^{US} = 10\%$. The graph shows that the capital adequacy ratio of the consolidated bank has the same exposure to correlated liquidity shocks both with or without explicit limits on the FXNOP.

5.2 Shocks to the subsidiary

Finally we discuss liquidity shocks that only affect the assets of the foreign subsidiary. In this case, we assume that a fraction, δ^{sub}, of the foreign assets disappears. In this case, the capital ratio of the consolidated bank without explicit limits on

the foreign asset position is defined by:

$$CR^{\delta^{sub}} = \frac{NW^{LC} - \delta^{sub} A^{LC}}{(A^{LC} + A^{US}) + f\,(1/\theta)\,(A^{US} - L^{US}) - \delta^{sub} A^{US}\,(1 + f\,(1/\theta))} \tag{8}$$

Relative to the case of correlated shocks, the capital ratio deteriorates because there is a decline in capital proportional to the fraction of the foreign subsidiary assets that are lost. Additionally, the liquidity shock abroad reduces the level of risk weight assets in the foreign currency and the FXNOP.

For the case involving explicit limits, the capital adequacy ratio of the consolidated bank is:

$$CR^{\delta^{sub},EL} = \frac{NW^{LC} - \delta^{sub} A^{LC}}{(A^{LC} + A^{US}) - \delta^{sub} A^{US}} \tag{9}$$

The right panel of figure (7) show the results. The conclusion is the same as in the previous case: FXNOP limits do not make any difference in terms of the capital ratio's reaction when banks face liquidity shocks.

6 Conclusion

In this paper, we discuss the role of explicit limits on net foreign positions that are still used in many emerging markets. We show that these limits are in potential conflict with the capital requirements of Basel's accords when domestic banks have structural positions of a non-dealing nature in foreign subsidiaries. In this case, exchange rate fluctuations affect the capital ratio of a bank; even where perfectly hedging the foreign open position, the domestic-currency value of risk weighted foreign assets, change with the exchange rate. The capital adequacy ratio of banks with foreign subsidiaries is more stable when respective national authorities do not impose explicit limits on the net foreign open position.

We suggest that national authorities adopt alternative policies in order to avoid fluctuations in the capital ratio of banks with structural positions in foreign markets. We show that there is an optimal level of leverage for the foreign subsidiary, whereby a capital ratio is achieved that does not change with exchange rate fluc-

tuations. This optimal leverage implies a capital ratio for the foreign subsidiary that is higher that for the one of the consolidated holding. In a world where there exist perfect coordination between national authorities, this optimal level could be induced by demanding more capital for foreign than for domestic banks. In the absence of such coordination, the domestic supervisory office can induce higher capital in the foreign subsidiaries of domestic banks by requiring a higher capital ratio for the parent bank than that required for the consolidated holding. Increasing the risk weight associated with foreign exchange rate risk used to compute the bank's market risk, can also compel domestic banks to increase capital in their foreign subsidiaries in order to mitigate changes in the holdings' capital ratio against exchange rate fluctuations.

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