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Currency Diversification of Banks: A Spontaneous Buffer Against Financial Losses

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Currency diversification of banks: a spontaneous buffer against financial losses

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ABSTRACT:

The Basel Committee on Banking Supervision has introduced in December 2010 a Basel III framework for more resilient banks and banking system. We posit in this paper that, in addition to the current regulatory instruments currently under the review of authorities, the currency diversification of banks' balance sheets can be a source of banking stability considering both assets and liabilities simultaneously. Our conclusions are based on a simplified definition of a globalized bank's balance sheet. As banks' balance sheets are expressed in domestic currency, our model implies an exchange rate conversion of each foreign component. Risks are introduced with stochastic processes in assets, liabilities and exchange rate. In accordance with the Basel III framework and the Basel III Leverage ratio, the bank's leverage ratio is limited. Our model provides detailed information in each risk faced by global banks including foreign exchange risk. Although our conclusions depend on the variance covariance matrix of assets, liabilities and foreign exchange rate, our main results confirm the positive impact of currency diversification on banking stability considering the current banking system.

JEL classification: F01, F3, F4, F6, G01, G1, G15

Keywords: Basel III, Bank, Financial integration, Financial Stability, Currency , Diversification, Financial Volatility.

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1 Introduction

Following Diamond and Rajan [2000], banks' capital is a buffer against financial losses. Thus, limiting the volatility of capital should improve the resilience of banks. By introducing a Basel III framework, the Basel Committee on Banking Supervision wants to strengthen this natural buffer.[1] A countercyclical ratio forces banks to rise capital buffer during good time making them more comfortable during periods of stress. The Basel III liquidity ratio ensures banks to have an access to liquidity even in periods of stress. And finally, the Basel III leverage ratio avoids excess increase of banks' balance sheets and leverage. These ratios are still in discussion, but they would become fully effective in January 2019.

An additional ratio which is not included in the Basel III framework could reinforce capital buffer: the currency diversification of banks' balance sheet. Currency diversification introduces a diversification of risks in both assets and liabilities. Depending on the correlation between financial markets and the exchange rate regime, currency diversification may also decrease capital volatility thanks to spontaneous risk coverage between assets and liabilities.

Theory on portfolio diversification provides interesting conclusions on risk diversification. Markowizt [1952] shows that when returns are not perfectly correlated, diversification decreases risk. Levy and Sarnat [1970] and Driessen and Laeven [2007] focus on international diversification, and they conclude to an optimal portfolio which implies a diversification of international assets. However, they do not explicitly develop the role of exchange rate. Focusing on CAPM definition, Reeb et al. [1998] , Kwok and Reeb [2000] and Pedrono [2016] posit the benefit of international diversification on the decrease of systemic risk. In the CAPM definition, Pedrono [2016] develops explicitly the exchange

[1]See BIS [2010] for more details.

rate impact on beta. Depending on the exchange rate correlations with assets, international diversification decreases systemic risk even though foreign assets bring more volatility.

Another part of the literature analyzes the effect of currency diversification on banking leverage. Pedrono [2015b] and Pedrono [2015a] look at the effect of currency diversification on leverage procyclicality. Focusing on banks located in France between 1999 and 2014, Pedrono [2015a] shows that currency diversification increases leverage responsiveness to the value of assets.

Finally, Farhi et al. [2011] and Bénassy-Quéré and Pisani-Ferry [2011] analyze the potential impacts of a multipolar International Monetary and Financial System. They posit that a second international currency increases and diversifies the supply of global liquidity. Thus, the system should be more stable at least in the medium term.

The current literature demonstrates the importance of currency and international diversification in some aspect of banking stability. However, it does not include a general analysis of banking stability considering simultaneously risks from both assets and liabilities. Thus, the purpose of our paper is to assess the role played by currency diversification in banking stability. By introducing simultaneously assets and liabilities in the definition of capital, our paper contributes to the current literature. Additionally, it implies a fixed leverage ratio similar to the Basel III leverage ratio. Thus, our analysis fits into the new Basel III framework. Finally, our model provides detailed information on each source of risks. We believe that our results may feed current discussions on regulation. Relatively to the variance covariance matrix of assets, liabilities and foreign exchange rate, our main results confirm the positive impact of currency diversification on banking stability considering the current banking system.

The remainder of the paper is organized as follows. Section 2 explains briefly the global framework and the definition of a global bank. Section 3 develops the theoretical framework based on a simplified definition of a bank's balance sheet. We analyze in section 4 the volatility of capital depending on the level of integration. This section allows us to describe each source of risks in the determination of capital volatility and to define an optimal level of currency diversification which ensures a minimum volatility of capital. Finally, we illustrate our results with simulations in section 5.

2 A global framework

We consider two international currencies, a domestic and a foreign one. We define global banks as a banks with a diversified balance sheet between the two currencies. Investments are both in domestic and in foreign currency and funding are also denominated in both currencies. Global framework is illustrated in Figure 2. As the system is symmetric, we focus in this paper on the domestic global bank where its capital is denominated in denominated in domestic currency.

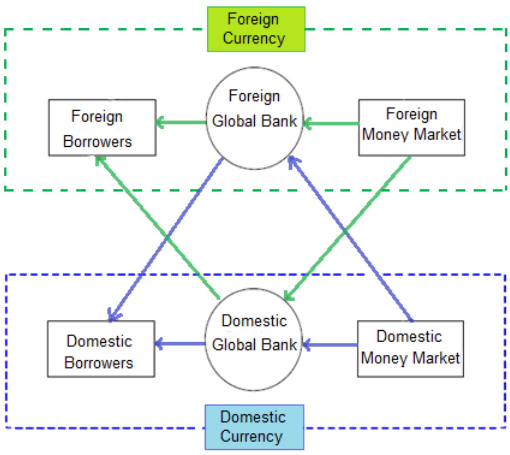


Figure 1: Global framework with two international currencies.

Currency diversification introduces a diversification of risks in both assets and liabilities. Depending on the correlation between financial markets and exchange rate regime, currency diversification may allow a decrease of capital volatility through a spontaneous risk coverage.

3 Definition of Capital:

3.1 Assets

Bank's total asset A is composed of domestic asset C and foreign asset converted in domestic currency $SC^\star$ where S is the foreign exchange rate. The share of domestic and foreign asset are given by ψ and $(1-\psi)$ respectively.

$$A = C + SC^\star \tag{1}$$
$$\frac{C}{A} = \psi \ ; \ \frac{SC^\star}{A} = (1-\psi)$$

Exchange rate and both assets follow stochastic processes with marginal variations defined such that:

$$d\tilde{C} = \frac{dC}{C} = r\ dt + \sigma_C dZ_C \tag{2}$$
$$d\tilde{C^\star} = \frac{dC^\star}{C^\star} = r^\star\ dt + \sigma_{C^\star} dZ_{C^\star} \tag{3}$$
$$d\tilde{S} = \frac{dS}{S} = \mu\ dt + \sigma_S dZ_S \tag{4}$$

r, $r^\star$ and μ are the constant terms of the marginal variation of domestic asset, foreign asset and foreign exchange rate respectively. White noises are denoted dZ such that $dZ_C \sim N(0; dt)$, $dZ_{C^\star} \sim N(0; dt)$ and $dZ_S \sim N(0; dt)$. Defining stochastic processes introduces risks in our model.

3.2 Liabilities

Bank's total debt D consists of domestic liabilities L and foreign liabilities converted in domestic currency $SL^{\star}$. Denote λ and $(1-\lambda)$ the share of domestic and foreign liabilities respectively.

$$\begin{aligned} D &= L + SL^{\star} \\ \frac{L}{D} &= \lambda \ ; \ \frac{SL^{\star}}{D} = (1-\lambda) \end{aligned} \tag{5}$$

Introducing stochastic processes, we get the following Stochastic Differential Equations (SDE) for each liability:

$$d\tilde{L} = \frac{dL}{L} = i\ dt + \sigma_L\ dZ_L \tag{6}$$

$$d\tilde{L^{\star}} = \frac{dL^{\star}}{L^{\star}} = i^{\star} dt + \sigma_{L^{\star}} dZ_{L^{\star}} \tag{7}$$

Where dZ_L and $dZ_{L^{\star}}$ are white noises and i and $i^{\star}$ are the constant term of the marginal variation of domestic liability and foreign liability respectively also known as the constant terms of the total cost of debt.

3.3 Capital

Bank's capital is defined through K such that:

$$K = A - D \tag{8}$$

Bank's leverage l is the ratio of total assets over capital. Following the Basel III framework, we assume that leverage is defined by authorities. Using the definition of l, we obtain the bank's capital SDE:

$$
\begin{aligned}
d\tilde{K} = \frac{dK}{K} &= (1+l)\frac{dA}{A} - l \cdot \frac{dD}{D} \\
&= (1+l)\left[(\psi \cdot r + (1-\psi)(r^\star + \mu))\,dt + \psi \cdot \sigma_C dZ_C + (1-\psi)(\sigma_{C^\star} dZ_{C^\star} + \sigma_S dZ_S)\right] \\
&- l\left[(\lambda \cdot i + (1-\lambda)(i^\star + \mu))\,dt + \lambda \cdot \sigma_L dZ_L + (1-\lambda)(\sigma_{L^\star} dZ_{L^\star} + \sigma_S dZ_S)\right] \qquad (9)
\end{aligned}
$$

In absence of diversification (e.g. ψ=1 and λ=1), the marginal variation of capital does not depend on foreign component. The effect of total assets on capital is larger than the effect of total liabilities because of their relative size (e.g. $A > D$). The introduction of leverage ratio induces this asymmetry.

Although our analysis focuses on the capital volatility, studying the mean of capital marginal variation also holds our interest. As diversification offers a second source of both incomes and costs, the mean of capital marginal variation depends on interest differentials and exchange rate impacts. The mean of capital marginal variation is defined such that:

$$
\begin{aligned}
\mathrm{E}(\frac{d\tilde{K}}{dt}) &= (1+l)[\psi \cdot r + (1-\psi)(r^\star + \mu)] - l[\lambda \cdot i + (1-\lambda)i^\star + \mu)] \\
&= (1+l)[r^\star + \psi(r - r^\star)] - l[i^\star + \lambda(i - i^\star)] + \mu[1 - \psi + l(\lambda - \psi)] \qquad (10)
\end{aligned}
$$

The expected marginal variation of capital is the difference between the total expected return and the total expected total cost of debt. As assets and liabilities are diversified, this definition includes the effect of foreign exchange rate on both assets and liabilities. The first two components illustrate what the second source of investment and debt implies regardless of exchange rate. The last component introduces the effect of exchange rate. It shows an interesting result regarding currency mismatch. Even through ψ=λ, the exchange rate still has an effect on capital except if there is not asset diversification (e.g. ψ=1). This is due to the relative size of A and L and the leverage ratio.

4 Volatility of capital with currency diversification

We look at three potential frameworks. First, we study the capital volatility when the two economies are not integrated. Although this framework seems unlikely considering the current European banking system, it provides a first simple baseline. Second, we add partial integration by introducing a variance covariance matrix related to assets. Finally, we allow a complete globalized framework where liabilities are also integrated. This last framework is more likely considering our current framework.

4.1 No integration:

In this framework, we assume that components of the bank's balance sheet are not linked together. In addition, we suppose that the exchange rate is also completely independent. When the two economies are not integrated, the variance of capital marginal variation is thus defined such that:

$$\begin{aligned}\mathrm{Var}(\frac{d\tilde{K}}{dt}) =&((1+l)\psi)^2\sigma_C^2 + ((1+l)(1-\psi))^2\sigma_{C^\star}^2 + (1-\psi+l(\lambda-\psi))^2\sigma_S^2 \\ &+ (l\cdot\lambda)^2\sigma_L^2 + (l(1-\lambda))^2\sigma_{L^\star}^2 \\ &= \Sigma^2\end{aligned} \tag{11}$$

The volatility of capital Σ^2 depends positively on risks from C, $C^\star$, L, $L^\star$ and S. As mentioned earlier, a currency match does not remove exchange rate risk except if ψ=1.

Regarding currency diversification, we notice that the variance is quadratic function of ψ and λ. Thus, a currency diversification should allow a minimum capital volatility.

4.1.1 Optimal diversification

The optimal level of asset denominated in domestic currency $\widehat{\psi}$ is defined as the level of diversification which allows a minimum volatility of capital. In the absence of integration, $\widehat{\psi}$ is defined such that:

$$\begin{aligned} \frac{\partial \Sigma^2}{\partial \psi} &= 0 \\ \widehat{\psi} &= \frac{\sigma^2_{C^\star}}{\sigma^2_C + \sigma^2_{C^\star} + \sigma^2_S} + \frac{(l\lambda + 1)}{(1+l)} \frac{\sigma^2_S}{\sigma^2_C + \sigma^2_{C^\star} + \sigma^2_S} \end{aligned} \tag{12}$$

The first component is the ratio of foreign asset volatility to total assets volatility. Saying differently, it is the share of total assets volatility driven by foreign asset volatility. The higher the foreign asset volatility plays an important role in total asset volatility, the lower the optimal asset diversification would be. The second component introduces the exchange rate determinant. If λ=1 (e.g. no liabilities diversification), the exchange rate volatility is as important as the foreign asset volatility in the determination of optimal asset diversification. In this situtation, $\widehat{\psi} < 1$ if σ^2_C is positive. If λ <1 (e.g. liabilities are diversified), the foreign exchange risk becomes less important as foreign liabilities induce a cover for this risk. Finally, the optimal asset diversification positively depends on the diversification of liabilities.

The definition of optimal share of domestic liability $\widehat{\lambda}$ is the level of liability diversification that ensures a minimum volatility of capital. $\widehat{\lambda}$ is such that:

$$\begin{aligned} \frac{\partial \Sigma^2}{\partial \lambda} &= 0 \\ \widehat{\lambda} &= \frac{\sigma^2_{L^\star}}{\sigma^2_L + \sigma^2_{L^\star} + \sigma^2_S} + \frac{(\psi(1+l) - 1)}{l} \frac{\sigma^2_S}{\sigma^2_L + \sigma^2_{L^\star} + \sigma^2_S} \end{aligned} \tag{13}$$

The first component introduces the role of foreign liability in total liabilities volatility while the second component adds the role of the foreign exchange volatility. If ψ=1, then the two components have equal weight in the determination of $\widehat{\lambda}$. If domestic liability induces risk, $\widehat{\lambda}$ is lower than 1 and the model implies a currency diversification of liability even through assets are not diversified. If ψ <1, foreign exchange risk implied by liability diversification would be partly covered by asset diversification. Thus, foreign exchange risk is less determinant than foreign liability risk.[2] Finally and because of the foreign exchange risk, $\widehat{\lambda}$ depends positively on ψ.

4.2 Partial Integration

We extend the previous framework by introducing correlations between assets and exchange rate and between the two assets. Thus, $\sigma_{CC^{\star}}$, σ_{SC} and $\sigma_{SC^{\star}}$ denote the covariance between the two assets, the covariance between the domestic asset and the exchange rate and the covariance between the foreign asset and the exchange rate respectively. The variance of capital marginal variation is such that:

$$\begin{aligned}\mathrm{Var}(\frac{d\tilde{K}}{dt}) &= \Sigma^2 + 2(1+l)^2\psi(1-\psi)\sigma_{CC^{\star}} \\ &+ 2(1-\psi+l(\lambda-\psi))(1+l)\left[\psi\sigma_{SC}+(1-\psi)\sigma_{SC^{\star}}\right] \\ &= \Sigma^2_{partial}\end{aligned} \tag{14}$$

$\sigma_{CC^{\star}}$ introduces the potential systemic risk between the two assets. It adds volatility compare to the previous framework volatility Σ^2. The second line of $\Sigma^2_{partial}$ develops the effect of introducing correlations with exchange rate. If diversification of assets is complete, ψ=$(1-\psi) = 0.5$, the impact of exchange rate is removed when $\sigma_{SC^{\star}} = -\sigma_{SC}$. Finally and as mentioned previously, a currency match does not remove the additional foreign exchange risk if ψ <1.

[2]Regarding the determinant role of σ^2_S, $\frac{(\psi(1+l)-1)}{l}$ is positive for $l > \frac{1-\psi}{\psi}$.

4.2.1 Optimal diversification

Considering this new framework, the optimal asset diversification $\widehat{\psi}_{partial}$ is such that:

$$\begin{aligned}
\frac{\partial \Sigma^2_{partial}}{\partial \psi} &= 0 \\
\widehat{\psi}_{partial} &= \frac{\sigma^2_{C^\star} - \sigma_{CC^\star} + \sigma_{SC^\star}}{\sigma^2_C + \sigma^2_{C^\star} + \sigma^2_S + 2\left(\sigma_{CC^\star} + \sigma_{SC} - \sigma_{SC^\star}\right)} \\
&\quad + \frac{(l\lambda + 1)}{(1+l)} \frac{\sigma^2_S + \sigma_{SC^\star} - \sigma_{SC}}{\sigma^2_C + \sigma^2_{C^\star} + \sigma^2_S + 2\left(\sigma_{CC^\star} + \sigma_{SC} - \sigma_{SC^\star}\right)}
\end{aligned} \tag{15}$$

The first line illustrates the share of net foreign asset volatility in total asset volatility while the second line introduces the net share of exchange rate volatility. With these two components, $\widehat{\psi}_{partial}$ highlights the additional risks of diversifying assets regardless of risks implied by domestic asset. If λ=1 the two determinants are equally important in the determination of $\widehat{\psi}_{partial}$. The larger the share of net foreign asset volatility is, the lower $\widehat{\psi}_{partial}$ (and similarly for the share of net foreign exchange volatility).

$\widehat{\lambda}_{partial}$ is the optimal liability diversification which minimizes capital volatility. It is defined such as:

$$\begin{aligned}
\frac{\partial \Sigma^2_{partial}}{\partial \lambda} &= 0 \\
\widehat{\lambda}_{partial} &= \frac{\sigma^2_{L^\star}}{\sigma^2_L + \sigma^2_{L^\star} + \sigma^2_S} + \frac{(\psi(1+l) - 1)}{l} \frac{\sigma^2_S}{\sigma^2_L + \sigma^2_{L^\star} + \sigma^2_S} \\
&\quad - \frac{(1+l)}{l} \frac{\psi \sigma_{SC} + (1-\psi)\sigma_{SC^\star}}{\sigma^2_L + \sigma^2_{L^\star} + \sigma^2_S}
\end{aligned} \tag{16}$$

The composition of $\widehat{\lambda}_{partial}$ underlines the additional risks faced by banks when liabilities are diversified. The first component illustrates the direct risk due to foreign liability while the second component introduces the share of direct foreign risk and the currency match. However, part of foreign exchange volatility may come from the diversification of asset. Thus, the third line subtracts this additional volatility of exchange rate in order to only include the foreign exchange risk which is due to liability diversification. The more the underlying risk of liability diversification is, the lower the optimal diversification should be to ensure a minimum volatility.

4.3 Complete globalization

The globalized framework adds covariances relative to liabilities. Denote $\sigma_{LL^\star}$ the covariance between liabilities. It introduces the potential systemic risk between the two sources of funding. As assets and liabilities are potentially linked in a globalized framework, we introduces four covariances denoted σ_{LC}, $\sigma_{L^\star C^\star}$, $\sigma_{L^\star C}$, $\sigma_{LC^\star}$. Finally, $\sigma_{SL^\star}$ and σ_{SL} illustrate the potential dependence between exchange rate and liabilities. Considering this new framework, the variance of capital marginal variation is defined such that:

$$
\begin{aligned}
\mathrm{Var}(\frac{d\tilde{K}}{dt}) &= \Sigma^2 + 2[(1+l)^2\psi(1-\psi)\sigma_{CC^\star} + l^2\lambda(1-\lambda)\sigma_{LL^\star}] \\
&- 2(1+l)l\,[\psi[\lambda\sigma_{LC} + (1-\lambda)\psi\sigma_{L^\star C}] + (1-\psi)[(1-\lambda)\sigma_{L^\star C^\star} + \lambda\sigma_{LC^\star}]] \\
&+ 2(1-\psi+l(\lambda-\psi))[(1+l)(\psi\sigma_{SC} + (1-\psi)\sigma_{SC^\star}) - l(\lambda\sigma_{SL} + (1-\lambda)\sigma_{SL^\star})] \\
&= \Sigma^2_{global} \qquad (17)
\end{aligned}
$$

The first line of Σ^2_{global} posits the potential systemic risk added by currency diversification through the covariances $\sigma_{LL^\star}$ and $\sigma_{CC^\star}$. $\sigma_{LL^\star}$ does not offset $\sigma_{CC^\star}$ except when correlation is negative. The second line introduces a natural risk coverage between assets and liabilities when the two economies are globalized. Shocks on C might be covered by both shocks on L and $L^\star$, and similarly for shocks on $C^\star$. Thus, a positive correlation between the cost of debt and the interest rate of asset makes the capital is more resilient to shocks. Capital volatility is thus reduced by this spontaneous mechanism. Finally, the third line introduces the exchange rate channels due to correlations. When the bank's balance sheet is not diversified, the foreign exchange risk is completely removed. If diversification is complete (e.g. ψ=0.5 and λ=0.5) and if $\sigma_{SC} = -\sigma_{SC^\star}$ and $\sigma_{SL} = -\sigma_{SL^\star}$, then diversification absorbs additional foreign exchange risks introduced by the globalized framework. However, bank still faces foreign exchange risk due to leverage and the relative size of A and D and the leverage ratio.

4.3.1 Optimal diversification

The optimal level of asset denominated in domestic currency in a globalized framework $\widehat{\psi}_{global}$ is defined such as:

$$
\begin{aligned}
\frac{\partial \Sigma^2_{global}}{\partial \psi} &= 0 \\
\widehat{\psi}_{global} &= \frac{\sigma^2_{C^\star} - \sigma_{CC^\star} + \sigma_{SC^\star}}{\sigma^2_C + \sigma^2_{C^\star} + \sigma^2_S + 2\left(\sigma_{CC^\star} + \sigma_{SC} - \sigma_{SC^\star}\right)} \\
&+ \frac{(l\lambda + 1)}{(1+l)} \frac{\sigma^2_S + \sigma_{SC^\star} - \sigma_{SC}}{\sigma^2_C + \sigma^2_{C^\star} + \sigma^2_S + 2\left(\sigma_{CC^\star} + \sigma_{SC} - \sigma_{SC^\star}\right)} \\
&- \frac{(1-\lambda)l}{(1+l)} \frac{\sigma_{SL^\star} + \sigma_{L^\star C^\star} - \sigma_{L^\star C}}{\sigma^2_C + \sigma^2_{C^\star} + \sigma^2_S + 2\left(\sigma_{CC^\star} + \sigma_{SC} - \sigma_{SC^\star}\right)} \\
&- \frac{\lambda l}{(1+l)} \frac{\sigma_{SL} + \sigma_{LC^\star} - \sigma_{LC}}{\sigma^2_C + \sigma^2_{C^\star} + \sigma^2_S + 2\left(\sigma_{CC^\star} + \sigma_{SC} - \sigma_{SC^\star}\right)}
\end{aligned} \tag{18}
$$

$\widehat{\psi}_{partial}$ highlights the additional risks of diversifying assets regardless of risks implied by domestic asset and total liabilities. In order to capture the net effect of asset diversification, line three and four of $\widehat{\psi}_{global}$ subtract risks coming from liability composition. Especially, the third line extracts the underlying risks of asset diversification explained by foreign liabilities while the last line is relative to risks implied by domestic liabilities. Thus, the optimal level of asset diversification is a decreasing function of the direct risk implied by asset diversification and an increasing function of risks implied by liability diversification.

Turning on the optimal level of liabilities denominated in domestic currency, a global framework implies a $\widehat{\lambda}_{global}$ such that:

$$\begin{aligned}
&\frac{\partial \Sigma^2_{global}}{\partial \lambda} = 0 \\
&\quad \widehat{\lambda}_{global} = \frac{\sigma^2_{L^\star} - \sigma_{LL^\star} + \sigma_{SL^\star}}{\sigma^2_L + \sigma^2_{L^\star} + \sigma^2_S - 2(\sigma_{SL} + \sigma_{LL^\star} - \sigma_{SL^\star})} \\
&\qquad + \frac{(\psi(1+l) - 1)}{l} \frac{\sigma^2_S + \sigma_{SL^\star} - \sigma_{SL}}{\sigma^2_L + \sigma^2_{L^\star} + \sigma^2_S - 2(\sigma_{SL} + \sigma_{LL^\star} - \sigma_{SL^\star})} \\
&\qquad - \frac{(1-\psi)(1+l)}{l} \frac{\sigma_{SC^\star} + \sigma_{L^\star C^\star} - \sigma_{LC^\star}}{\sigma^2_L + \sigma^2_{L^\star} + \sigma^2_S - 2(\sigma_{SL} + \sigma_{LL^\star} - \sigma_{SL^\star})} \\
&\qquad - \frac{\psi(1+l)}{l} \frac{\sigma_{L^\star C} + \sigma_{SC} - \sigma_{LC}}{\sigma^2_L + \sigma^2_{L^\star} + \sigma^2_S - 2(\sigma_{SL} + \sigma_{LL^\star} - \sigma_{SL^\star})}
\end{aligned} \tag{19}$$

As for $\widehat{\psi}_{partial}$, $\widehat{\lambda}_{global}$ tries to underline the net risk of liability diversification. Thus, the third line subtracts the potential risk coming from foreign asset while the third line removes risks from domestic asset. Thus, the optimal level of currency diversification is a negative function of its implied risk. The more liability diversification increases risk, the less bank should diversify their liabilities to ensure a minimum volatility of capital.

5 Application

This section develops some simulations based on previous definitions of capital marginal variation. As our interest in this paper in on the stability of global European banks, we use the global framework with floating exchange rate and correlations between each component of banks' balance sheets. Moreover, BIS-Quarterly-Review [March 2015], Pedrono [2015a] show that the US dollar is the first currency of denomination. Thus, we assume that the United States are the second economy in our framework.

We assume that the two economies are alike with similar volatility on assets and liabilities. Considering that economies are both linked to a global financial cycle, we suppose that assets and liabilities are positively correlated. Because of the floating exchange rate, we add four assumptions on exchange rate correlations. First, we assume a positive correlation between foreign assets and exchange rate $\rho_{S,C^\star}$. It means that an increase of the foreign interest rate can be simultaneously observed with an appreciation of the foreign currency. Second and for the same reason, we posit a negative correlation between the domestic interest rate and the exchange rate $\rho_{S,C}$. Third and turning on foreign liabilities, we based our assumption on the observed correlation between 2003 and 2010 between the 3 month Euribor and the euro dollar exchange rate. For this period, the correlation between the our domestic funding market and the exchange rate was negative and significant. Finally and by opposition, we suppose a positive correlation between the foreign cost of debt and the exchange rate.[3] Table 1 summarizes the initial calibration of parameters where ρ denotes the assumed correlation between each source of risks.

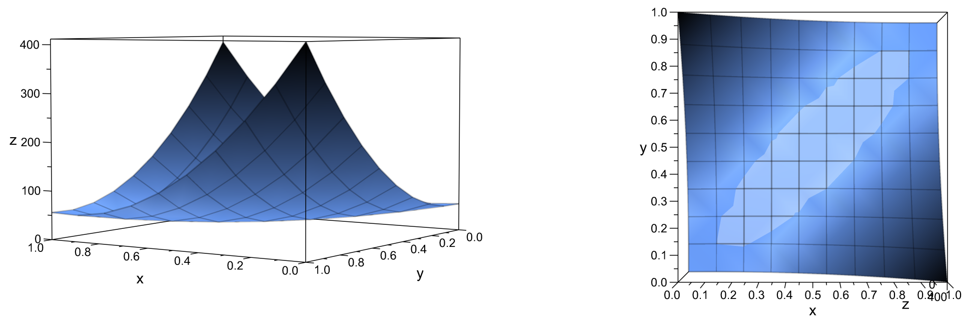
Table 1: Calibration of parameters

σ^2_S	σ^2_C	$\sigma^2_{C^\star}$	σ^2_L	$\sigma^2_{L^\star}$
10%	*15%*	*15%*	*15%*	*15%*
$\rho_{C,C^\star}$	$\rho_{L,L^\star}$	$\rho_{S,C^\star}$	$\rho_{S,C}$	$\rho_{S,L^\star}$
0.7	*0.7*	*0.5*	*-0.5*	*0.5*
$\rho_{L,S}$	$\rho_{L,C}$	$\rho_{L^\star,C^\star}$	$\rho_{L^\star,C}$	$\rho_{L,C^\star}$
-0.5	*0.8*	*0.8*	*0.7*	*0.7*

Figure 1) illustrates the variance of capital marginal variation relative to currency diversification and initial calibrations. We believe that this scenario is close the one faced by global European banks. As illustrated is (a), a complete currency mismatch (e.g. $\psi = 1$ and $\lambda = 0$ or $\psi = 0$ and $\lambda = 1$) leads to the highest volatility of capital. Increasing currency diversification of both assets and liabilities decreases the volatility. The light blue area in (b) shows that capital volatility is reduced with currency diversification: the minimum volatility of capital is not reached when $\psi = \lambda = 1$ or when $\psi = \lambda = 0$. Additionally, our results suggest that currency diversification of assets should be close to

[3]Other assumptions are possible. However, assuming a positive correlation between domestic cost of debt and exchange rate does not change the benefit of currency diversification.

the currency diversification of liabilities in order to reduce capital volatility significantly.

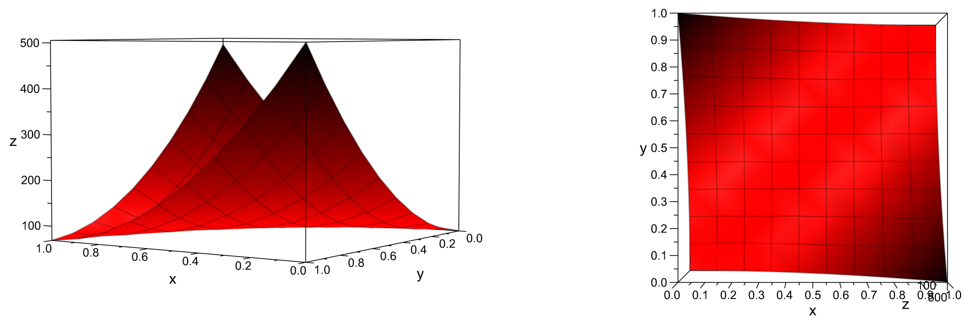


(a) Variance of Capital

(b) Benefit of currency diversification

Figure 2: Globalization with no systemic risk. x is equivalent to ψ the share of assets denominated in domestic currency. The share of liabilities denominated in domestic currency λ is capture by y. The variance of capital marginal variation is equal to z.

We change the initial calibration in Figure 2) by allowing systemic risk between assets and liabilities (e.g. $\rho_{C,C^\star} = \rho_{L,L^\star} = 1$). In this situation, complete currency mismatch still leads to the highest level of capital volatility. Although currency match reduces gradually capital volatility, it does allow a minimum volatility as shown in (b).

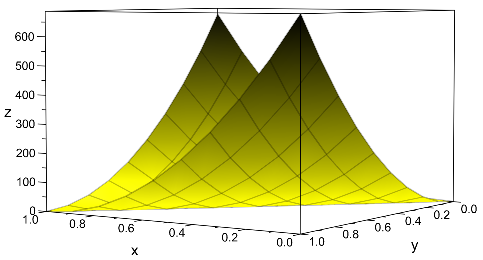


(a) Variance of Capital

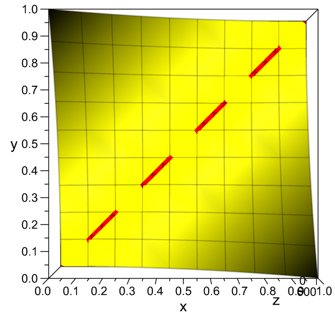
(b) No benefit from currency diversification

Figure 3: Globalization with systemic risk on assets and liabilities. x is equivalent to ψ the share of assets denominated in domestic currency. The share of liabilities denominated in domestic currency λ is capture by y. The variance of capital marginal variation is equal to z.

We suppose in Figure 4 that the two economies are completely integrated. Implicitly, all correlations are at their maximum relative to the initial calibration. As previously, complete currency mismatch implies large capital volatility. As shown in (b), currency diversification with perfect match is as good as single currency framework. Both situations reach the minimum capital volatility.



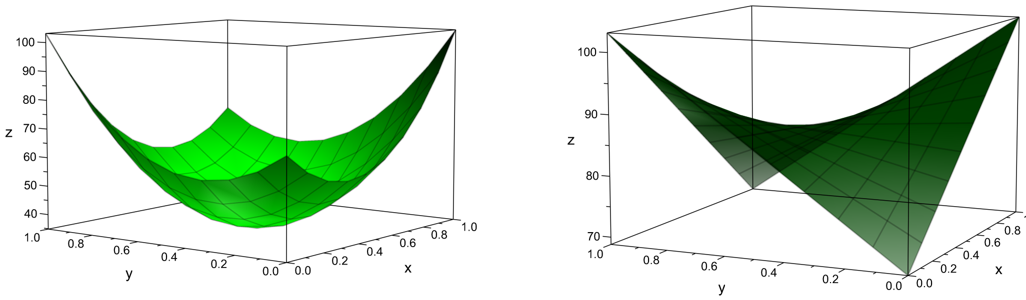
(a) Variance of Capital



(b) Benefit from currency diversification

Figure 4: Complete globalization and integration. Correlations equal either 1 or -1 depending on initial calibration. x is equivalent to ψ the share of assets denominated in domestic currency. The share of liabilities denominated in domestic currency λ is capture by y. The variance of capital marginal variation is equal to z.

Finally, we analysis capital volatility when the exchange rate is fixed in Figure 5). In (a) previous calibrations hold. Maximum capital volatility is reached when banks face complete currency mismatch. As diversification of assets and liabilities allows a diversification of risks, the minimum capital volatility is clearly reached for complete diversification (e.g. $\psi = \lambda = 0.5$). In (b), we introduce systemic risks between assets and liabilities (e.g. $\rho_{C,C^\star} = \rho_{L,L^\star} = 1$). A complete mismatch of diversification leads to higher capital volatility. Although rebalancing mismatch decreases capital volatility, minimum capital volatility is reached when assets and liabilities are not diversified.



(a) With no systemic risk

(b) With systemic risk on assets and liabilities

Figure 5: Variance of capital when exchange rate is fixed. x is equivalent to ψ the share of assets denominated in domestic currency. The share of liabilities denominated in domestic currency λ is capture by y. The variance of capital marginal variation is equal to z.

Conclusion

The Basel Committee on Banking Supervision has introduced in December 2010 a Basel III framework for more resilient banks and banking system. We posit in this paper that, in addition to the current regulatory instruments currently under the review of authorities, the currency diversification of banks' balance sheet can be a source of banking stability when we focus on banks' capital.

Our conclusions are based on a simplified definition of a globalized bank's balance sheet. As banks' balance sheets are expressed in domestic currency, our model implies an exchange rate conversion of each foreign component. Risks are introduced with stochastic processes in assets, liabilities and exchange rate. In accordance with the Basel III framework and the Basel III Leverage ratio, the bank's leverage ratio is fixed by authorities.

Although our conclusions depend on the variance covariance matrix of assets, liabilities and foreign exchange rate, our main results confirm the positive impact of currency diversification on banking stability.

By introducing simultaneously assets and liabilities in the definition of capital, our paper contributes to the current literature and provides detailed information on each source of risks. We believe that our results may feed current discussions on the terms and conditions of Basel III regulation considering the current European banking system.

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