International Banks, Cross Border Guarantees and Regulation

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Abstract

In this paper we develop a simple model of an international bank as a fully guaranteed core and a periphery of subsidiaries where the liability of the bank is limited to the capital invested. The solvency of the bank is then akin to the value of a portfolio of forwards (the core) and a portfolio of call options (the periphery). We argue that a bank will wish to place riskier subsidiaries in the periphery and minimize the capital invested in those units. Hence while consolidated banking supervision may play an important role in considering the risk of the entire bank, we argue that host banking regulation has an important role to play and discuss alternatives.

1 First author: Inter American Development Bank and Universidad Torcuato Di Tella. Second author: World Bank. The views expressed in this paper are strictly the views of the authors and do not necessarily represent the views of the IDB, the World Bank, the boards of either institution or the countries they represent or any other institution. We thank Juan Francisco Martinez Sepulveda for research assistance. Naturally any mistakes remain our own.
1 Introduction

The tremendous growth in international banking over the last decades has sparked increased diplomacy between bank regulators who, on the one hand, may have specific legal responsibilities regarding financial institutions in their own jurisdictions, and on the other recognize that large banks have become highly complex and in some cases, truly international organizations. This has become a particular issue for developing country host regulators regarding the international bank subsidiaries and branches in those countries. Figure 1 plots the total foreign claims of international banks on developing countries illustrating the increased global reach of international banks and, in particular, the growth in local claims - the claims of the branches and subsidiaries of international banks in developing countries in local currency. While the total foreign claims of international banks on developing countries amounts to around US$2.3tr, this is only about 10% of those banks’ total cross-border portfolio - as also graphed in Figure 1.

Figure 1 here

The 1974 creation of the Basel Committee on Banking Supervision (BCBS) itself reflected the importance placed on cross border supervision by the international community. Only one year later, in 1975, a new set of principles for international cooperation in bank supervision, widely known as the Basel Concordat, was issued. A significant, 1983 revision of the Concordat attempted to clarify the division of responsibilities between home and host supervisors in the domain of solvency, liquidity and currency mismatches. In 1988, Basel I documented the first international Accord on minimum capital requirements for internationally active banks1 and in 1992 the principles of the Concordat were reformulated as the Minimum Standards for the Supervision of International Banking Groups. As a result of this diplomacy across regulators a consensus regarding the guiding principles for international cooperation developed, especially among G10 bank supervisors. An over-riding principle in this process has been the importance of consolidated supervision by the home (or consolidator) regulator2.

More recently, the issue of cooperation between home and host supervisor has gained renewed attention3. To a large extent this renewed attention has been a product of the planned introduction of Basel II and the strong efforts of the Basel Committee regarding outreach to emerging countries in that process4.

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1 See Basel Committee for Banking Supervision (1988).
2 Bank regulator diplomacy and the principal of consolidated supervision were also motivated in large part by a series of bank failures and associated regulatory coordination failures including the 1974 Herstatt and the 1993 BCCI crises.
However, discussions have at times risen to what Ben Bernanke once suggested “we may delicately call tensions”\textsuperscript{5}. Typically, an international bank will have a very large fraction of its assets in a few large industrialized countries and only a very small fraction of its assets in a large number of emerging countries that may be characterized by significantly higher risk. At the same time, what is small for the international bank may be very significant for the host country. The relations between regulators in the large industrialized countries and their emerging country colleagues are naturally tempered by these real-world considerations.

Related to this discussion is the fact that banks have expanded internationally in different forms through subsidiaries and branches and through more or less integrated or centralized structures. Alternative legal entities may have implications for the extent of guarantees offered. For example, if a bank has entered a particular country as a branch then it may be considered more likely that it would be supported in the case where the return on the branch’s assets are very low, as the head office would know that local uninsured liability-holders would have a stronger case seeking recompense in international courts. In particular, US law is more specific regarding the responsibilities of international banks relative to their branches in other countries\textsuperscript{6}. Still, the legal position of a branch of a US bank in Bangkok or Buenos Aires may be quite different to that of one in Boston or Boise. On other hand, a bank that has expanded through highly autonomous subsidiaries may consider its liability limited only to the capital invested. Then again, a fully owned subsidiary, managed as part of a fully integrated international organization, may in fact be extending more guarantees, depending on the final instance on the legal interpretations of largely untested intricacies of international law\textsuperscript{7}.

\textit{Figure 2 Here}

In general, rating agencies appear to consider guarantees to be highly incomplete. In Figure 2, we plot the ratings of international bank groups and their branches and subsidiaries in emerging economies. A regression of the rating of the subsidiary on the rating of the international bank and the rating of the host country reveals that in general both are significant. In Table 1 we give the results from such an experiment on a cross section of 79 subsidiaries across different countries and on a subset of 44 subsidiaries in developing countries using current ratings from Standard and Poors. If international banks extended full guarantees then we would expect only the rating of the parent to matter and with a coefficient close to unity whereas if there was no guarantee then the coefficient on the host should be significant and the rating of the bank not significant. As we find that in general both the host country rating and the

\textsuperscript{5}Bernanke (2004).
\textsuperscript{6}See Del Negro and Kay (2002) for an interesting discussion.
\textsuperscript{7}Again see Del Negro and Kay (2002) for comments on the "veil of ownership".
rating of the parent are significant, we conclude that perceived guarantees are partial\(^8\).

To our knowledge, while there has been quite intense diplomacy between international regulators, there has been very little previous academic work that examines why banks may wish to expand in different forms and hence the implications for regulation and supervision\(^9\). In this paper we first provide a benchmark model (section 2) that shows that banks may wish to offer full guarantees or may wish to limit liability to the capital invested depending on a set of bank and country characteristics. We then simulate the model (section 3) employing a simple example to illustrate a set of results. Section 4 concludes drawing out the implications of the results for cross border regulation and supervision.

2 The Model

Consider a bank that operates in a set of countries and let us suppose that the bank may either extend a full guarantee to a subsidiary or limit its liability only to the capital invested. We are the first to admit that this is a fairly stark characterization, however, we believe it may be a useful way to contrast two different styles of entry of international banks into foreign markets. Technically what we have in mind here is that the bank itself can commit to support a set of operating units that then defines the core of the bank. This core then self-insures itself such that it fails or survives as one. On the other hand, the bank may define a set of subsidiaries as outside the core (we refer to this as the periphery) and here the liability of the bank is limited only to the capital invested. We assume that the bank starts with a simple initial balance sheet where the bank raises \(D_m\) deposits in each unit and lends \(L_m\) with total initial capital, \(K = \sum_{m=1}^{n} (L_m - D_m) \geq 0\). We presume that the only uncertainty is related to asset returns and we denote the asset return in each unit as \(a_m\). Suppose that \(I\) represents the set of units in the core and \(J\) the set of subsidiaries in the periphery. Taking the initial capital as given, we can then write the solvency of the bank after the uncertainty on asset returns is realized as:

\[
S = \sum_{m \in I} L_m (a_m - r (1 - k)) + \lambda \sum_{m \in J} \max [L_m (a_m - r_m (1 - k_m)), 0]
\]

\(^8\) It might be thought that ratings are limited to sovereign ratings. However, the three major rating agencies including Standard and Poor’s all now allow ratings to exceed those of the sovereign, especially where there is an outside guarantor.

Where we have assumed that the interest rate that must be paid by core units on liabilities is \( r \) and in each subsidiary in the periphery is \( r_m \), and where \( k \) is the capital to assets ratio of the core \( k = \sum_{m \in I} \frac{K_m}{L_m} \) and where \( k_m \) is the capital to asset ratio in the \( m^{th} \) subsidiary in the periphery.

The first term in Equation 1 may be positive or negative reflecting the success of the bank’s core activities. The second term is always non-negative. This reflects the fact that the loss that the bank may suffer on its activities in the periphery is limited to the capital invested. If the solvency of a subsidiary falls below zero then we assume that the subsidiary is abandoned without further cost but also without any future potential profits for the bank. We introduce a parameter, \( \lambda (0 \leq \lambda \leq 1) \), to reflect the fact that the international bank may value the capital in the periphery as less than its book value. Typically investment in foreign subsidiaries is subject to the risk of expropriation of one sort or another. We also have in mind here a more complex game where the local authorities may hold up the bank by choosing a \( \lambda \) after the investment has been made. However for now we consider \( \lambda \) as exogenous and leave such an extension for future research. We discuss below the implications of assumptions regarding this parameter.

One way of thinking about the future solvency of the bank is as a portfolio of forwards (the bank’s core) where the "delivery" price is \( r(1-k) \) plus a portfolio of call options (the bank periphery) with exercise prices \( r_m (1-k_m) \). Note that the exercise price is endogenous as it is a function of the capital invested.

Suppose that interest rates in the core and the periphery are exogenous. Given an assumption that the shareholders will always recapitalize the core of the bank then the funding cost of the core should equal the riskless rate of interest. We also assume that the funding costs of the subsidiary are exogenous. This might be the case if for example there is local deposit insurance in each host country. However, we presume that this local exogenous interest rate may be higher than the riskless rate of interest reflecting the country risk of the host or the possibility that the deposit insurance fund itself may fail - but we assume that this is exogenous in relation to the decisions of an individual bank. A further extension might consider an endogenous interest rate for non-insured liabilities in the periphery, again an assumption of the capital invested\(^{10}\).

Now suppose that the bank has an overall capital requirement, \( KR \), but that capital may be allocated to any part of the bank such that \( K = \sum_{m \in I} L_m k + \sum_{m \in J} L_m k_m \geq KR \). We assume that the cost of capital for the bank is \( r_k > r \).

We further assume that if actual capital falls below this regulatory minimum, then the shareholders must recapitalize at a higher cost than the original cost.

\(^{10}\)Interestingly, if the interest rate \( r_j \) is made endogenous and applies to all liabilities (there is no local deposit insurance) then, for constant capital, the expected value of the subsidiary in the periphery is a constant with respect to the volatility of asset returns. As the volatility rises so too does the funding costs and these two exactly cancel each other out.
of capital. This is justified as the regulator may impose additional penalties on the bank or shareholders may demand higher returns given a forced recapitalization. More precisely the shareholders must inject capital to the regulatory minimum. For this calculation we do not include the parameter $\lambda$ or in other words we assume that the consolidating regulator values one dollar of capital in the periphery as one dollar of capital in the consolidated bank.

$$S_r = \sum_{m \in I} L_m(a_m - r(1 - k)) + \sum_{m \in J} \text{Max}[L_m(a_m - r_m(1 - k_m), 0] (2)$$

The penalty is like a short position in a put option where the exercise price of the put is the regulatory minimum capital. Note that the distribution of the underlying asset in this case ($S_r$) does not have a standard distribution as the regulatory solvency of the bank is, as discussed, akin to a portfolio of forwards (the core of the bank) plus a portfolio of calls (the subsidiaries in the periphery). Regulation works ex post in the sense that the bank must decide its level and structure of capital knowing the probability distribution of its future solvency and subject to a penalty if solvency falls short of the regulatory minimum. We consider this as a more realistic description of reality than say a constraint on the ex ante (known) level of capital. Now consider that the structure decision has been taken and the bank has then already decided which subsidiaries will be in the periphery and which will be in the core. The bank will maximize the expected value of the bank with respect to the capital in each unit:

$$\text{Max}_{k,m} V = E\{S - rK - \pi \text{Max}[KR - S_r, 0]\} (3)$$

$$\text{s.t. } K = \sum_{m \in I} L_m + \sum_{m \in J} L_m k_m, k \geq 0, k_m \geq 0 (4)$$

$$K \geq KR (5)$$

The first order conditions for $k$ and for $k_m$ for this problem can be written respectively as:

$$r(1 + \pi \Delta_p) = r_K (6)$$

$$r_m(\lambda \Delta_c + \pi \Delta_{pc}) = r_K (7)$$

where $\Delta_p$ is the probability that the $KR > S_r$ or in other words that the put is "in the money" and shareholders must recapitalize the bank, $\Delta_c$ is the probability that $a_m > r_m(1 - k_m)$ or in other words that the call is in the money and the subsidiary in the periphery is solvent and $\Delta_{pc}$ is the probability that call representing the expected value of the $m^{th}$ subsidiary and the put are both in the money at the same time. The left hand of the first equation is the benefit to increasing the capital in the core, made up of the riskless rate (which
is what otherwise the bank must pay to a depositor for funding) plus the benefit of decreasing the expected penalty - to be paid if the bank’s solvency falls below that of the minimum capital requirement. Note that the change in the value of the option for a small change in the price of the underlying asset is equal to the delta of the option which is also the probability that the option is "in the money". The left hand side of the second equation represents the benefit of increasing capital in the subsidiary in the periphery. Again this is made up of two terms. The first term in the parenthesis represents the benefit of using own capital instead of raising deposits at the interest rate $r_j$ but this is reduced by the factor $\lambda$ as capital placed in the periphery is not valued at par and the term is also multiplied by $\Delta_c$ as with probability $1 - \Delta_c$ the bank walks away and does not pay depositors anyway. The second term represents the benefit of reducing the expected penalties if capital falls below the regulatory minimum. This benefit is the penalty multiplied by the probability that simultaneously the call and the put are in the money. If the call is out of the money and the bank walks away from its subsidiary in the periphery then putting extra capital there does no good and if the put is out of the money and hence penalties do not apply then there is little benefit in committing extra capital. It follows therefore that if there is an interior solution then at the optimum,

$$\frac{r}{r_j} = \frac{\lambda \Delta_c + \pi \Delta_{pc}}{1 + \pi \Delta_p}$$

and for two subsidiaries in the periphery, if there is an interior solution then,

$$\frac{r_m}{r_l} = \frac{\lambda \Delta_{c_l} + \pi \Delta_{pc_l}}{\lambda \Delta_{c_m} + \pi \Delta_{pc_m}}$$

which implies that if $r_m > r_l$ then $k_l > k_m$. If $r_m > r_l$ implies that the environment of subsidiary $m$ is more risky then this suggests that a bank would place less capital at risk in riskier environments in the periphery. We stress however that this assumes an interior solution is present.

However, to ensure that this is an optimum it must be the case that $|V_{k,k_m}| < 0$ where $V_{k,k_m}$ is the matrix of the second derivatives with respect to $k$ and $k_m$—where all the $m$ subsidiaries are placed in the periphery ($m \in J$). However, in general there is no internal maximum. To see this consider the second derivative, $\frac{\partial^2 V}{\partial k_m^2}$. This may be written as follows:

$$\frac{\partial^2 V}{\partial k_m^2} = r_j \left( \frac{\lambda \Delta_c}{\partial k_m} + \pi \frac{\partial \Delta_{pc}}{\partial k_m} \right)$$

As capital in the periphery rises, the probability that the call option will be in the money increases or $\frac{\partial \Delta_c}{\partial k_m} > 0$. Moreover, it can be shown that the sign of $\frac{\partial \Delta_{pc}}{\partial k_m}$ is ambiguous. This implies that in general there is no internal solution
for capital allocation. Below, we outline an example where there is an internal solution for capital in the core but where the bank would prefer to have zero capital in the periphery. For reasonable parameter values, we consider this as then most likely optimum for the international bank.

It can be shown that \( \lim \frac{\partial \Delta_c}{\partial k_m} \rightarrow 1 \) and \( \lim \frac{\partial \Delta_p}{\partial k_m} \rightarrow 1 \). These results are intuitive. As capital is increased in the periphery it becomes less and less likely that a subsidiary would fail. Hence the marginal benefit of increasing capital in the periphery rises. In the limit, as the probability of the subsidiary failing tends to zero, the expected value of a call option rises exactly with the price of the underlying asset and hence, \( \frac{\partial \Delta_c}{\partial k_m} = 1 \). Placing capital in the periphery also reduces the probability of shareholders having to recapitalize the bank. But only to the extent that the call is in the money and the put in the money simultaneously. As capital in the subsidiary goes to one, the call will always be in the money and hence placing capital in the periphery is akin to putting capital in the core in this regard. Hence \( \frac{\partial \Delta_p}{\partial k_m} \rightarrow 1 \).

Considering the first order conditions above, together with these results and for small enough \( \lambda \) it follows that \( \frac{dV}{dk_m} < \frac{dV}{dk} \) at any specified value for \( k \) and \( k_m \). This implies that for small enough \( \lambda \) it will be optimal for the bank to have zero capital in a subsidiary in the periphery.

Now consider the decision regarding structure assuming that capital allocation is fixed. The expected solvency of the bank would be greater with the \( m \)th subsidiary in the periphery rather than the core if:

\[
E\{\max[L_m(a_m - r_m(1 - k_m), 0)]\} > E\{L_m(a_m - r(1 - k_m))\}
\]

(11)

The trade off is that in the periphery the left tail of the distribution of returns is curtailed but the bank must pay greater funding costs. If the subsidiary is placed in the core and hence given a full guarantee, the funding cost drops to the riskless rate (given our assumption that shareholders always recapitalize) but that implies that the bank will have to bail out the subsidiary if it is insolvent. As discussed above, the left hand side represents the value of a call option with exercise price equal to \( r_m(1 - k_m) \). The right hand side is akin to the value of a forward where the delivery price is equal to \( r(1 - k) \) and hence may be written as:

11 A sufficient condition for small enough \( \lambda \) is that \( \lambda < \frac{\Delta_p}{r_m} - \pi \Delta_p (1 - \frac{r}{r_m}) < 1 \). However, as reported below we find what we consider reasonable parameter values that do not satisfy this sufficient condition but still the incentive of the bank is to have zero capital in a subsidiary in the periphery.

12 This condition is derived simply with independent asset returns. It is also approximately true given correlated asset returns depending on the relation between the truncated and the non truncated covariance of \( a_m \) with rest of the bank’s portfolio.
As the volatility of the asset returns in the subsidiary ($\sigma_m$) rise then the value of the call option rises but the value of the forward does not. There is then a critical volatility $\sigma_m^c$ such that for $\sigma_m > \sigma_m^c$ the bank would prefer to place the subsidiary in the periphery and for $\sigma_m \leq \sigma_m^c$, the bank would prefer to place the unit in the core.

Note that as the capital in the unit increases, the value of the call option increases at a slower pace than the value of the forward. It is possible then that for a particular level of volatility, if $k_m$ is small it is best to place the subsidiary in the periphery but for large $k_m$, it is more attractive for the bank to place the subsidiary in the core. We come back to this point below in discussing the role of host capital regulation. A sufficient condition for the bank to prefer to place the subsidiary in the periphery is that $\sigma_m > \sigma_m^c (k_m \to 1)$ where the parenthesis makes explicit that the critical volatility is a function of the capital in the unit.

Now let us combine the arguments stated above. On the one hand a subsidiary with greater asset return volatility should be placed in the periphery rather than in the core. On the other hand the incentive for the bank may be to reduce the capital in subsidiaries in the periphery to zero. The conclusion is that a bank should compare the expected value of the bank with riskier subsidiaries placed in the periphery and with zero capital, against placing them in the core with a higher capital ratio - given by the first order condition for $k$ above. It follows that the bank would wish to place only the riskiest subsidiaries in the periphery.

This result may give rise to a serious concern for host regulators in countries. If the decision of the bank is to place a subsidiary in the periphery with zero capital then it will have a relatively high probability of failure, or in other words $1 - \Delta_c$ will be large. Naturally host regulators will not in general allow this to happen. Hence the model provides a strong motivation for host capital regulation. Host regulators would wish capital in a subsidiary in the periphery to be such that $1 - \Delta_c$ approaches a very small percentage - Basel II we are told is calibrated such that $1 - \Delta_c = 0.1\%$. This leads to an interesting possibility. If host regulators insist on capital to ensure only a 0.1\% of failure then now the bank must compare the expected value of the bank with that level of capital in the subsidiary in the periphery versus the expected value of the bank placing that subsidiary in the core. It may be the case that at that level of capital it is best for the bank to place the subsidiary in the core. Moreover, it follows that there is a critical level of capital that the host regulator may insist on $k^c_m$ such that $k > k^c_m$, it would be best for the bank to place the subsidiary in the core.

\[ C[Volatility = \sigma_m, Exercise Price = r_m (1 - k_m)] > f[Delivery Price = (1 - k_m)] \]
\[ (12) \]
In general this critical level of capital will be a function of the volatility of the asset return with \( \frac{\delta k_m^c}{\delta \sigma_{km}} > 0 \).

Finally, consider the effect of the penalty for non-compliance with the consolidated capital requirements, \( \pi \). As \( \pi \) increases it is more important for the bank to ensure that the put option is out of the money by avoiding the worst outcomes with respect to solvency. It follows therefore that the bank may now wish to place a subsidiary in the periphery that, given a lower \( \pi \), it would have preferred to have placed in the core. Another way to state this result is that \( \frac{\delta \sigma_{km}^c}{\delta \pi} < 0 \). In other words, the critical volatility for deciding whether a subsidiary should be placed in the core rather than the periphery is reduced as the penalty for non compliance with the consolidated capital requirement rises. And as we know from above, if the unit is placed in the periphery then it is likely that the bank would wish to have zero capital in that subsidiary. Hence as a lead or consolidating regulator becomes tougher in terms of higher penalties for non compliance, it is more likely that a bank would choose to have units in a periphery and with little capital than in the core\(^{14} \).

### 3 A Simple Example: a Two Unit Bank

In this section we present the results of a simulation exercise based on a simpler version of the model to illustrate the ideas above. Consider the example of a bank with just two units; a home bank which we consider as always a core unit in the terminology above and a second unit that may be considered as within the core or as a subsidiary in the periphery as defined above. If the unit is considered as a subsidiary in a periphery, then the expected value of the bank is given by:

\[
Max_{k, k_m} V = E\{S - r_k K - \pi Max[KR - S, 0]\} \tag{13}
\]

\[
s.t. K = L_1 k_1 + L_2 k_2. \tag{14}
\]

\[
K \geq KR \tag{15}
\]

where:

\[
S = L_1(a_1 - r(1 - k)) + Max[L_2(a_2 - r_2(1 - k_2), 0] \tag{16}
\]

Note that in this simpler version we assume that the bank treats capital in the periphery as capital in the core both in terms of considering its own value and to comply with consolidated regulations. In other words, the parameter \( \lambda = 1 \). We will check below for interior versus limit solutions. In this case the\(^{14} \)

Furthermore, we note that if capital requirements are endogenous to the decision to walk away from a subsidiary, then this effect may be exacerbated.
two first order conditions for \( k \) and \( k_j \) may be written as:

\[
\begin{align*}
    r \left( 1 + \pi \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} f(a_1, a_2) da_2 da_1 \right) &= r_K \\
    r_j \left( \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} f(a_1, a_2) da_2 da_1 + \pi \int_{-\infty}^{\infty} \int_{-\infty}^{\infty} f(a_1, a_2) da_2 da_1 \right) &= r_K
\end{align*}
\]

where \( a_1^* = \frac{KR}{2} + r(1 - k) \), \( a_2^* = \frac{KR}{2} - \frac{L_1}{L_2} (a_1 - r(1 - k)) + r_j (1 - k_j) \), and \( X = r_j (1 - k_j) \). It can be shown that the conditions for an interior maximum are in general not satisfied. In particular we consider that for reasonable parameter values we would have the following signs in the matrix of second derivatives:

\[
\begin{align*}
    \frac{d^2 V}{dk} &< 0 \\
    \frac{d^2 V}{dkd_j} &< 0 \\
    \frac{d^2 V}{d^2 k} &< 0 \\
    \frac{d^2 V}{d^2 j} &> 0
\end{align*}
\]

Consider a simulation of the model with the parameter values as included in Table 2 below. These parameters contemplate a larger core unit and a smaller and more volatile subsidiary. The asset returns are correlated and the covariances calculated such that the correlation coefficient is 0.5. The interest rates are expressed in the table as net but in the model they are gross. The penalty to recapitalize the bank if solvency falls below the overall requirement is set at 50% (such that in the model \( \pi = 1.5 \)) which is significantly higher than the assumed (ex ante) cost of capital, \( r_k \) of 18%. In this version we set the parameter \( \lambda \) equal to one such that banks value capital in the periphery at par. We still find for the parameter values chosen that there is no internal solution for capital if the subsidiary is placed in the periphery. The consolidated capital requirement, \( KR \), is set to be the Basel I basic capital requirement of 8% of the initial loan portfolio, \((L_1 + L_2)\) which is 60. (ie: \( KR = 4.8 = 60 \times 8\% \)).

Given these base parameter values, assuming that the bank puts the larger unit in the core and the smaller more volatile one in the periphery, there is an interior maximum for the capital in the core but not for capital in the periphery. The expected value of the bank for different combinations of \( k \) and \( k_j \) is plotted in Figure 3. As can be seen, the maximum expected value of the bank is given when \( k_j \) (the capital in the periphery) is zero but there is an internal maximum for the capital and at in the core. At \( k_j = 0 \), this turns out to be 8.25%. The maximum expected value then turns out to be 2.209.

\[Figure 3\]
However, we must compare that to the expected value if the bank decides to place the subsidiary in the core. This is then given by the solution to the following problem:

\[
\text{Max}_k V = E\{S - r_k K - \pi \text{Max}[KR - S, 0]\}
\]

\[\text{s.t. } K = L_1 k + L_2 k.\]

\[K \geq KR\]

where:

\[S = L_1(a_1 - r(1 - k)) + L_2(a_2 - r(1 - k))\]

The first order condition for the choice of \(k\) is given by:

\[r \left(1 + \pi \int_{-\infty}^{a_1^*} \int_{-\infty}^{a_2^*} f(a_1, a_2) da_2 da_1\right) = r_K\]

where \(a_1^* = \frac{KR}{L_1} + r(1 - k)\) and \(a_2^* = \frac{KR}{L_2} - \frac{L_1}{L_2}(a_1 - r(1 - k)) + r(1 - k)\).

For the parameter values in Table 2 the maximum is found at \(k = 7.2\%\) and the expected value for the bank is 2.48\(^{13}\). It is therefore better for the bank to place the subsidiary in the core. However, if we increase the variance of the asset return of the subsidiary further, then this result changes. In Table 3, we compare the maximum value of the bank with the subsidiary in the periphery (where the capital in the subsidiary is always zero) to the maximum value of the bank with the subsidiary in the core.

\[\text{Figure 4 Here}\]

Figure 4 plots the expected value of the bank as a function of \(k\) and \(k_j\) assuming the subsidiary is placed in the periphery for a variance of 15\%. In this case, the bank would prefer to set \(k_j = 0\) but now the maximum value of the bank rises to 2.3 with this structure. The increased volatility increases the value of the call option. On the other hand, if the subsidiary is placed in the core, the maximum value of the bank is reduced to 1.84. The value of the put option also rises and hence there is now a much greater expected penalty for recapitalizing the bank with this risky subsidiary in the core. It is then now better for the bank to maintain the subsidiary in the periphery rather than in the core.

\[\text{13It is interesting that the bank would choose a capital requirement less than 8\% - the current minimum. In this simple model there is a positive expected income that counts as capital in the next period.}\]
However, the above simulations discounts the possibility that the home regulator also imposes a minimum capital regulation on the subsidiary in the host country. One suggestion might be that the host regulator should place a capital regulation such that it feels comportable with the resulting default probability assuming the subsidiary is an autonomous unit. This is relatively easy to calculate in the model above as the default probability is simply $1 - \Delta_c$ where $\Delta_c$ is the delta of the call option (the probability that the call is in the money) which is a negative function of $k_j$, the capital in the subsidiary in the periphery. As the host regulator increases the local minimum capital requirement, the value of the call rises but the maximum expected value of the bank declines. This is obvious from Figures 3 and 4; the marginal benefit of increasing the value of the call is less than the assumed cost of capital - at least for the range of parameter values we have focussed on. At the same time, given our assumption that $\lambda = 1$, the value of the bank if the subsidiary is in the core is invariant to how much capital the bank places in the subsidiary. At a certain point as the capital that must be placed in the subsidiary rises, it then becomes better for the bank to place the subsidiary in the core. This critical capital level is a function of the variance of the asset returns in the subsidiary however. The final column of table 3, then gives the critical minimum level of capital that a host regulator would have to apply that would then yield the incentive for the bank to place the subsidiary in the core. As can be seen this value rises quite quickly with the volatility of asset returns in the subsidiary.

4 Conclusions: Implications for Cross Border Regulation and Supervision

The results above have strong implications for cross border regulation and supervision. We have noted in the introduction that in recent years, there has been intense diplomacy between international bank regulators. This diplomacy has tended to stress the need for consolidated banking supervision and hence tends towards considering an international bank as one homogenous unit. This is perfectly understandable as international banks have become more complex and as a response to a set of international bank failures, where the primary responsibility for regulation and supervision was unclear. At the same time, the results indicated above suggest the limits to consolidated supervision especially where banks have the option to enter overseas markets through subsidiary legal structures that may limit the liability of the international bank. We show that in a risky environment it will be in the interest of the bank to consider its liability limited to the capital invested and maintain a very low level of capital. On the other hand, subsidiaries in low risk environments may attract full guarantees - we name this the core of the bank. Within the core, consolidated supervision is fully appropriate as the bank would survive or fail as one but where it comes to the periphery this may not be sufficient.
Indeed the analysis may present a problem for a host regulator in an emerging economy of higher perceived risk and no doubt the host regulator will wish to impose and supervise local regulations to ensure that an acceptable failure probability is attained. Moreover, we suggest that if a sufficiently tight host regulation is imposed then the bank may have the incentive to place a subsidiary in a risky environment in the core. In turn, this might provoke "tensions" between the host regulator and the bank, and possibly even with the home regulator, that may favour a consolidated approach in the name of greater regulatory homogeneity and efficiency. In our view, this is a price that most likely will have to be paid and both consolidated and local capital regulation both have important legitimate roles. However, we also believe that there are many further questions that should be addressed in this area. For example in our work we have not considered the case where the interest rate paid on liabilities in the host country is endogenous to the capital invested. Also, we have not considered the case where the consolidated capital requirement is endogenous to the decision of the bank to exit a particular country nor have we considered how deposit insurance and lender of last resort functions may affect our results. Finally we have not considered issues regarding reputation or other interactions between the units of an international bank that may imply higher costs to exit. These and other considerations provoke many further issues regarding cross border supervision making this a rich area for future research.

5 References

Table 1: Regression Results
Dependent Variable: Rating of Bank Subsidiary
(Numeric Scale, 1-10, 10=AAA)

<table>
<thead>
<tr>
<th>Specification</th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>International Bank Rating</td>
<td>0.315</td>
<td>0.686</td>
</tr>
<tr>
<td></td>
<td>(2.04)*</td>
<td>(4.18)**</td>
</tr>
<tr>
<td>Host Sovereign Rating</td>
<td>0.650</td>
<td>0.225</td>
</tr>
<tr>
<td></td>
<td>(12.93)**</td>
<td>(0.71)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.886</td>
<td>0.237</td>
</tr>
<tr>
<td></td>
<td>(0.69)</td>
<td>(0.06)</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.71</td>
<td>0.30</td>
</tr>
</tbody>
</table>

* significant 5%; ** significant 1%

Table 2 Parameter Values: Base Case

| L1 | 50 loans of core unit |
| L2 | 10 loans of second unit |
| Mean (a1) | 8.5% mean asset return unit 1 |
| Mean (a2) | 15% mean asset return unit 2 |
| r | 5% riskless rate |
| rj | 12% funding cost of subsidiary in periphery |
| rk | 18% cost of capital |
| pi | 50% penalty cost of capital |
| lambda | 100% relative value of capital in periphery |
| KR | 4.8 (8% of total loans 8%*60=4.8) |
| Variance (a1) | 0.05% |
| Variance (a2) | 5.00% |

Table 3 Increasing Volatility in a Subsidiary

<table>
<thead>
<tr>
<th>Subsidiary Asset Return Volatility</th>
<th>Expected Values</th>
<th>Minimum Subsidiary Capital Level for Incentive to Place in Core</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Subsidiary in Periphery</td>
<td>Subsidiary in Core</td>
</tr>
<tr>
<td>5.0%</td>
<td>2.21</td>
<td>2.48</td>
</tr>
<tr>
<td>6.0%</td>
<td>2.94</td>
<td>1.84</td>
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<tr>
<td>7.5%</td>
<td>2.41</td>
<td>1.69</td>
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<tr>
<td>10.0%</td>
<td>2.58</td>
<td>1.46</td>
</tr>
<tr>
<td>15.0%</td>
<td>2.86</td>
<td>1.11</td>
</tr>
</tbody>
</table>
Figure 1: Bank Globalization

- Total Foreign Claims on Developing Countries
- Local Claims on DC's as % of all claims on DC's
- Foreign Claims on DC's as % all Foreign Claims
Figure 2: Ratings of Bank Subsidiaries and Parents

Rating AAA = 10

ABN AMRO Bank N.V.
LaSalle Bank Corporation
ABN AMRO Bank Mexico
ABN AMRO Bank Chile
ABN AMRO Bank Uruguay

Banca Intesa SpA - IT
Central - European International Bank Ltd. - HUN

Banco Bilbao Vizcaya Argentaria, S.A. - SP
Banco Bilbao Vizcaya Argentaria Mexico
Banco Bilbao Vizcaya Argentaria Brasil
Banco Bilbao Vizcaya Argentaria Uruguay - URG
Banco Bilbao Vizcaya Argentaria Argentina

Banco Santander Central Hispano, S.A. - SP
Abbey National PLC - UK
Banco Santander-Chile S.A. - CL
Banco Santander Puerto Rico - US
Banco Santander Brasil S.A. - BRA
Banco Santander Serfin, S.A. - MEX
Banco Santander Uruguay S.A.

Bayerische Landesbank - GER
MKB Bank Rt. - HUN

Citibank N.A. New York, NY - US
Citigroup Pty Limited - AUS
Citibank N.A. (Canadian Branch) - CAN
Cititrust & Banking Corp. - JAP
Citibank International PLC - UK
Citibank Korea Inc. - KOR
Bank Handlowy w Warszawie S.A. - POL
Citibank N.A. (Brazil Branch)
Citibank N.A. (Uruguay Branch) - URG

Credomatic International Corp. - BAH
BAC International Bank Inc. - PAN
Banco BAC San Jose, S.A. - CR

DBS Bank Ltd. - SIN
DBS Bank (Hong Kong) Ltd. - HK

HSBC Holdings PLC - UK
Hongkong and Shanghai Banking Corp. Ltd. - HK
HSBC Private Bank (Suisse) S.A. - SW
HSBC France - FR
HSBC Bank USA N.A. - US
HSBC USA Inc. - US
HSBC Republic Holdings (Luxembourg) S.A. -
HSBC Bank Brasil S.A. - BRA
HSBC Bank Mexico S.A. - MEX

ING Group NED
ING MEX

KBC Bank N.V. - BEL
K&H Bank - HUN
Kredyt Bank S.A. - POL

National Bank of Greece S.A. - GRE
United Bulgarian Bank A.D. - BUL

Scotiabank Canada
Scotiabank Chile
Scotiabank Mexico

Societe Generale - FRA
Komercni Banka A.S. - CZR
Societe Generale Bank & Trust - MAL

Standard Chartered Bank - UK
Standard Chartered Bank (Hong Kong) Ltd. - HK
Standard Chartered First Bank Korea - KOR
Figure 3: Expected Value of International Bank as a Function of Capital Allocation (Base Case, Volatility of Subsidiary Asset Return = 5%)

Note: x and y axes represent data points, not actual values. Numbers on z axis are values.

Figure 4: Expected Value of International Bank as a Function of Capital Allocation (Volatility of Subsidiary Asset Return = 15%)