A Positive Analysis of Deposit Insurance Provision:

Regulatory Competition Among European Union Countries*

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Abstract

On 30 September 2008, Ireland unexpectedly declared unlimited deposit insurance for its largest banks. Within days many European countries responded by increasing their deposit insurance limits. This paper tries to understand this response as an equilibrium strategic response. A simple model is developed in which deposit insurance effects deposit flows between countries, and countries non-cooperatively choose deposit insurance provision. A country that provides a higher level of deposit insurance may compel other countries to closely follow suit. The new equilibrium may decrease welfare.

JEL: D78, G21, G28. Keywords: Banking, Deposit Insurance, Regulatory Competition, European Union.

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1 Introduction

Germany’s surprise decision to guarantee retail deposits came after it loudly denounced Ireland’s beggar-thy-neighbour decisions to guarantee the liabilities of its banks. Germany’s volte-face may have been prompted by a large number of electronic withdrawals of deposits at the weekend, said Nigel Myer, an analyst at Dresdner Kleinwort in London.

The Economist (Lifelines), 9 October 2008.

On 30 September 2008, in the midst of the recent global financial crisis, the government of Ireland unexpectedly guaranteed all deposits at their six largest banks. Within a few days several other European Union (EU) member states responded by also increasing their deposit insurance. In particular, on 5 October 2008 Germany guaranteed all deposits held at their domestic banks. The lead quote strongly suggests that noncooperation in setting deposit insurance appears to have contributed, at least temporarily, to destabilizing European banking.

Issues regarding regulatory competition are highly relevant to the EU due to the required mutual recognition of member state products, including financial services. Regulatory competition is particularly strong between the member states in the Eurozone. The 1994 EU deposit-guarantee directive required that required members cover bank deposits of at least 20,000 Euros per individual (European Union, 1994). This directive, however, imposed no upper limit on the level of deposit insurance members states can provide. This lack of specification created room, above and beyond the minimum, for inter-member deposit insurance competition to exist. This and other problems with cross-border banking in Europe have been extensively discussed by Eisenbeis and Kaufman (2008) and the Forum on Cross-Border Financial Groups (2009). Meanwhile deposit insurance has been harmonised to 100,000 Euros per individual in a directive amending the 1994 EU deposit-guarantee directive (European Union, 2009).

Motivated by this recent European banking crisis, this paper develops a positive theory of deposit insurance provision as a non-cooperative policy outcome of a game between nations that can compete for deposits. Abstracting from normative efficiency rationales for deposit insurance,
we develop a two-country model in which countries non-cooperatively set deposit insurance levels. Depositors decide on where to deposit considering deposit insurance levels. Our analysis starts with a scenario similar to that above. First, the foreign country (e.g. Ireland) exogenously declares full deposit insurance. The home country’s (e.g. Germany) government anticipates a loss of deposits abroad were it not to respond. A loss of deposits would put stress on the home country’s banking system putting it at a greater probability of failing. It is optimal to respond by raising the level of the home deposit insurance, when the additional stress is relatively large. The home government chooses partial deposit insurance if the banking system can be stabilized without having to fully match the foreign countries coverage. The last possibility arises in our model because deposit insurance is a net cost to society, a necessary condition for low levels of deposit insurance being a policy equilibrium initially.

We next extend the model to examine possible reasons why the foreign country would, in the first place, unilaterally increase its deposit insurance from a low level to full deposit insurance. We find that shocks that impact the Irish and German banking sectors asymmetrically or affect whether depositors coordinate on the efficient equilibrium can indeed rationalize the increase to move to full insurance. However, in our model, these changes need not be associated with a beggar-thy-neighbour policy as in the lead quote. Instead, the foreign government often increases its insurance to ensure that their citizens deposit domestically, while attracting foreign agents may actually be a negative side effect of high levels of deposit insurance, because it makes providing deposit insurance more expensive. The only potential way to capture the beggar-thy-neighbour rationale is by a liquidity shock in which depositors withdraw deposits from the banking system which could lead to competition for the remaining depositors by the constituencies. In the European case withdrawals in Ireland may have spurred its government to move to full insurance to attract German deposits and stabilize the Irish banking sector. However, this story based on a liquidity shock cannot explain Ireland’s move to full deposit insurance if it anticipated the response by Germany. It is also not clear that retail depositors withdrew funds from the banking sector as a whole. For example, Gatev and Strahan (2006) show that the funding position of
banks improves with liquidity shocks in the commercial paper market, a phenomenon that may be attributed to the tendency of governments to protect the sector in times of crisis.

Research in the area of regulatory competition points to the increasing importance of international competition. Dalen and Olsen (2003) find that the international scope of banking has made the competitiveness of banks increasingly dependent on the financial regulations and policies of the countries in which they operate. They point to deposit insurance as a policy that gives one country’s banks a competitive advantage over others. If the competitive advantage is sufficiently large it may entice governments to set regulations that promote the international competitiveness of domestic industries. Likewise, if a country is sufficiently disadvantaged due to another country’s regulations, that country may be forced to level the playing field by responding with similar regulations.

Recently, several empirical papers have directly addressed the area of regulatory competition via deposit insurance. Huizinga and Nicodème (2006) examine how national deposit insurance schemes affect the location of international deposits. They find that non-bank depositors are attracted to countries with explicit deposit insurance schemes. Demirgüç-Kunt, Kane and Laeven (2008) attempt to identify the key factors that influence the adoption and shape of deposit insurance. They find that internal politics and external pressures play a large role in the adoption and shaping of deposit insurance schemes.

The theoretical literature on cross-border banking competition concentrates almost entirely either on capital adequacy assuming no deposit insurance, or on multi-national banking assuming deposits.

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1. Issues regarding regulatory competition are highly relevant to the European Union (EU) due to the required mutual recognition of member state products, including financial services. Regulatory competition is particularly strong between the EU member states in the Eurozone. The EU deposit insurance directive required until 2008 that required members cover bank deposits of at least €20,000 per individual (EurLex, 1994). This directive, however, imposes no upper limit on the level of deposit insurance members states can provide. This lack of specification creates room, above and beyond the minimum, for inter-member deposit insurance competition to exist. This and other problems with cross-border banking in Europe have been extensively discussed by Eisenbeis and Kaufman (2008) and the Forum on Cross-Border Financial Groups (2009).

2. Capital adequacy regulation has received considerable attention. Acharya (2003) and DellArigcia and Marquez (2006) examine international bank regulator competition in models with capital adequacy regulation but without deposit insurance and multinational banks. DellArigcia and Marquez (2006) examine the gains from international cooperation on capital adequacy regulation. Acharya (2003) shows that cooperation on capital requirements can result in non-cooperation in extending forbearance to banks that should be closed.
complete deposit insurance\textsuperscript{3}. An exception is a recent paper by Hardy and Nieto (2008). In their analysis, national regulators competively choose the levels of deposit insurance and levels of bank supervision. Supervision reduces the probability of bank failure but also reduces bank profits. Deposit insurance reduces the \textit{ex post} severity of bank losses. However, higher levels of deposit insurance increase the probability of bank failure, the presumed effect of deposit insurance inducing moral hazard. Moral hazard motivates the regulator to choose less than full deposit insurance. Externalities connect the countries. An increase in the home level of deposit insurance increases the probability of losses in the foreign country, an assumption based on the observation that a crisis in one country often spills over to other countries. With this set up, Hardy and Nieto (2008) compare the equilibrium to various regimes that differ in international cooperation. They find greater cooperation results in lower levels of deposit insurance and higher levels of supervision. This is because deposit insurance generates a negative externality and supervision generates a positive externality.

Our paper contributes to the literature by modeling cross-border deposits and by analysing the level of deposit insurance as the key policy variable affecting the flow of deposits. We model the decisions of investors to deposit abroad in response to changes in policy. In turn, the level of deposits affects the viability of the banking system and national regulator’s responses. Though our focus is on the positive analysis of international regulator competition, our model with optimizing investors permits a normative analysis of welfare.

The paper proceeds as follows. Section 2 presents the framework. Section 3 examines the equilibrium response of the home government to a shock from the foreign government implementing full deposit insurance and Section 4 solves the general model. Section 5 documents the

\textsuperscript{3}In Dalen and Olsen (2003) and Calzolari and Loranth (2005) prudential regulation is chosen to minimize the cost of providing full deposit insurance. Dalen and Olsen (2003) show that non-cooperation between nations leads to regulation with lower capital adequacy requirements but higher bank asset quality. Multinational banks are more likely to fail when organized with foreign bank branches versus foreign subsidiaries. The form of bank organization is important because foreign subsidiaries operate under the host country regulation and deposit insurance whereas foreign branches operate largely under the originating countrys regulations and deposit insurance. Under complete information, Calzolari and Loranth (2005) show that the host country regulator of a subsidiary-organized bank has less incentive to intervene than the originating country regulator of a branch-organized multinational bank. With incomplete information the results are complicated by the fact that intervention may impede good quality bank projects rather than just limit losses of bad quality investments.
relevant events that occurred during the financial crisis in 2008. Section 6 applies the model to analyse the European case. Section 7 concludes.

2 The Framework

2.1 Overview

There are two countries: home and foreign. Foreign variables are distinguished with a * superscript. Unless otherwise specified, the home and foreign countries have the same structure and parameter values. Initially, both countries have no (or low levels of) deposit insurance. The timing of actions and events is as follows.

Stage 1: Foreign government sets deposit insurance policy $d^*$. 

Stage 2: Home government sets deposit insurance policy $d$. 

Stage 3: Banking subgame; depositors choose whether to deposit in the Home or Foreign banking sector. Banking returns are realised.

Here the foreign government is the Stackelberg leader, as was Ireland in the fall of 2008.

In order to keep the analysis tractable, we keep the banking subgame as simple as possible. Like Acharya (2009) depositors are risk neutral and invest in one-period bank debt contracts because they have no other opportunities. There is no liquidity risk intermediation in our model, and no interim period in which information is revealed about the fitness of assets, banks or managers. These features would only complicate the analysis while obscuring the general character of our results.

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4 Under our assumptions it is sufficient to model just the one foreign country, the one with the highest level of deposit insurance.

5 Allen and Gale (2000) and Acharya (2009) discuss when debt is an optimal contract (e.g. in case of costly state verification). The lack of viable alternative investments could be justified by banks having expertise in investments, or by investments being lumpy and too large for individual investors. Introducing an alternative investment, storage, may generate additional equilibria making the banking system potentially more fragile.
2.2 Depositors

There is a unit mass of risk-neutral depositors in each country. Each depositor is endowed with one unit of a homogenous good and can either invest in a home bank or a foreign bank. A depositor choosing to invest abroad incurs a transaction cost, which captures the extra costs of holding savings abroad, including the shoe-leather costs of maintaining savings in a system that is dissimilar and remote.\(^6\)

We distinguish a depositor’s type according to the transaction cost they face. The home country’s population into two groups: bound depositors ("homebound"), and loose depositors ("footloose"). Bound depositors consist of proportion \(B \in (0, 1)\) of the home population and the remaining \(1 - B\) depositors are loose depositors. Bound depositors face a sufficiently large transaction cost that they never move their deposits abroad. They will invest in a domestic bank because they have no other investment opportunities. Loose depositors face a relatively low transaction cost \(\varepsilon > 0\). Transactions costs differ between bound and loose depositors because they differ in sophistication (e.g. computer abilities) or different opportunities (e.g. access to banks and lawyers). The foreign country’s depositors is similarly described.

2.3 Banks

There are a large number of one-period lived banks in the home country. Each bank invests its deposits in an uncertain home productive investment project, which, we assume has two possible outcomes. With probability \(P\) it yields a low gross return of \(r\), and with probability \(1 - P\) the project yields a high gross return \(R > r\). The high return state will be called “success” and the low return state “failure”; however we may have \(r \geq 1\), that is, absolute losses will not drive our results.

Banks are assumed to be perfectly competitive and pay out the expected return on the investment to their depositors. As depositors are risk-neutral, there is a competitive equilibrium in

\(^6\)The holding cost is a marginal cost. A fixed cost of changing deposit location may lead to a first mover advantage.
which the gross returns are paid to investors. We focus on this particular competitive banking equilibrium. This is consistent with banks issuing debt contracts promising gross return $R$; with success a bank pays in full, and with failure depositors become the residual claimants to $r$. We interpret success as the usual solvent state for banking, and failure as the relatively rare bankrupt state (but ignore any bankruptcy costs). Since all home banks offer the same *ex ante* deposit returns, we can speak of a representative home bank.\(^7\)

The foreign banking system is similar, however we allow the expected return from a project to differ. The project returns and bank deposit returns in the cases of success and failure are identical across the countries, i.e. \(R^* = R\) and \(r^* = r\). The potentially different expected return is modelled by assuming the probability of failure of the respective banking systems, \(P\) and \(P^*\), may differ.

We believe an important feature of the financial system is that there are economies of scale external to individual banks. We model these economies of scale by assuming that the probability of home bank failure \(P\) is a non-increasing function of the level of aggregate deposits, denoted \(D\).\(^8\) Specifically we assume:

\[
P'(D) \leq 0 \quad \text{and} \quad 0 < P(D \geq 1) = p < P(B) = b \leq 1
\]

In our analysis the ratio \(\frac{b}{p}\) often appears. We refer to \(\frac{b}{p}\) as the *stress ratio*. The higher is the ratio the greater is the stress from the decrease in scale from a larger banking system with failure rate \(p\) to a smaller banking system with failure rate \(b\). The assumption of constant probability of failure, \(P(D) = p > 0\), beyond a certain scale \(D = 1\) simplifies the analysis and also avoids that one country’s banking system dominates the international market due to economies of scale. The

\(^7\)Since depositors are risk neutral they are unconcerned with the correlation of realized returns among banks. The correlation returns may matter for the probability of failure \(P\), though we do not explicitly model it. Deposit insurance is funded in a way that correlation of returns does not matter.

\(^8\)More generally, the scale of deposits would affect the distribution function. In the two-state case, we could rewrite the model with \(r\), \(R\) and \(1 - P\) non-decreasing in \(D\). Our risk neutral specification ensures we get similar results as agents only care about expected returns. We assume that \(r\) and \(R\) are invariant to \(D\) to not only to simplify things but also because it appears to roughly fit the recent history. A fixed \(R\) provides a benchmark for 100% deposit insurance.
broader idea here is that greater levels of deposits become less important beyond a certain scale, while banks may still fail due to internal causes such as mismanagement, “bad luck”, etc.

Economies of scale may arise within the banking system because economies to inputs such as well trained banking staff as well as of synergies from having larger networks of banks. A bigger banking system will be better able to diversify asset risks, yet troubled banks, and provide interbank liquidity. Further, as the banking system is the conduit for saving to investment, we suppose there are economies to scale from the better selection as well as greater levels of domestic investment in which domestic banks may have a native advantage over foreign banks. Finally, the form of the failure function could be viewed as capturing the banking system under the added stress of accommodating withdrawals in a multi-period setting. If, in a multi-period extension of the model, loose agents regularly turn over deposits domestically, then the decision of the loose to deposit abroad would boil down to withdrawals from the local banking system and a subsequent outflow of deposits. The added stress could come from forced asset sales, which would initially lower the stock of liquid assets and thus make all home banks more vulnerable to marking-to-market losses from fluctuations in the value of its remaining illiquid assets. Also, depositors in a banking system with fewer liquid assets would more likely find sunspot signals on which to coordinate in an \textit{ex post} self-fulfilling bank panic.\footnote{Cooper and Ross (1998) explicitly model bank panic equilibrium as coordinated by an indicator that is described by a probability. This reason for failure can be eliminated by a sufficiently high level of deposit insurance. On the other hand, a higher level of deposit insurance might increase risk taking for reasons of moral hazard. To the extent that deposit insurance would mitigate such risks it would encourage deposits and reduce bank failure.}

The foreign banking system is treated symmetrically. The foreign failure function is $P^* = P^*(D^*)$, where $D^*$ is the level of deposits held at the foreign bank.\footnote{Because our depositors are risk neutral, they do not care about the correlation of failures across countries. Risk adverse agents would diversify their deposit holdings across countries when failures are imperfectly correlated and transactions costs are small. We view the movement of funds following Ireland’s increase in deposit insurance as attracting funds for higher expected returns rather than for reasons of portfolio diversification, \textit{per se}.} Since depositors must deposit either domestically or abroad, total world deposits satisfy $D + D^* = 2$. Thus, if only home bound agents deposit in the home country we have $D = B$, then $D^* = 2 - B$, and the probabilities of bank failure become $P(B) = b$ and $P(2 - B) = p^*$ at home and abroad respectively.
2.4 Deposit Insurance

Deposit insurance in the home country is expressed as fraction $0 \leq d \leq 1$ of the bank contracted gross return $R$. Deposit insurance, $dR$, is effective when it yields depositors more than what they can get from their failed bank, $dR > r$. Then $d > r/R$, and insurance provides a supplement $dR - r$ that guarantees total return $dR$. If insurance rate $d$ is sufficiently small $d \leq r/R$, then deposit insurance is ineffective. Overall, deposit insurance provides $\max\{0, dR - r\}$ additional funds on top of $r$ such that the depositor’s total return is $\max\{r, dR\}$. The situation is similar for the fraction $d^*$ of deposits guaranteed by the foreign government.

A key assumption in our model is that governments are not allowed to discriminate between depositors by nationality, an assumption that fits the European situation. For example, if loose depositors at home decided to deposit abroad, they would receive $\max\{r, d^*R\}$ in the event of foreign bank failure, the same as its domestic depositors. Also, governments in our model only chooses the level of deposit insurance coverage $d$, and not choose the design of the deposit insurance scheme. In reality there are a multitude of design features of the deposit insurance schemes (Demirgüç-Kunt, Karacoevali and Laeven, 2005), including some that may affect international deposit flows.

2.5 Utility

All depositors are risk neutral. Home loose depositors maximize their expected utilities (or expected return) by choosing between investing either in a home bank or in a foreign bank:

$$U_L = \max \{ (1 - P(D))R + P(D) \max\{r, dR\}, (1 - P^*(D^*))R + P^*(D^*) \max\{r, d^*R\} - \varepsilon \} - T$$

where $T$ is the tax paid by each depositor as a taxpayer and is independent of individual investment behaviour.

Home bound depositors have a similar objective and face the same choice, however by assumption their costs of moving abroad are so high that investing at home dominates for all possible
parameters. Hence their utility becomes:

\[ U_B = (1 - P(D))R + P(D) \max\{r, dR\} - T \]

2.6 Government

We assume the home government chooses \( d \) to maximize the sum of the expected utilities of home citizens, subject to their optimization choices and the government budget constraint:

\[
\max_d W = BU_B + (1 - B)U_L \quad \text{subject to} \quad T = (1 + c)P(D)D \max\{0, dR - r\}
\]

The constant \( c > 0 \) in the budget constraint is the deadweight taxation cost premium per unit paid out to insured depositors. It is the net cost of deposit insurance. Observe that the tax is positive, \( T > 0 \), only if deposit insurance is effective, \( d > \frac{r}{R} \).

The government budget constraint above has been expressed in expected terms. The budget constraint ensures that the (expected) tax revenue matches the (expected) cost of providing deposit insurance. The tax is consistent with either an actuarially fair insurance payment, or a cost-recovering tax in the event of a failure of the banking sector. Note that the tax is a general revenue tax. It is not financed by a direct deposit insurance premium which would influence agents actions and allow for more control. This makes the analysis easier, yet it is more realistic to the extent that existing funded bank insurance pools are inadequate to handle banking system crises.\(^{11}\)

\(^{11}\)Costs/benefits that are external to the individual are not modeled but could be included. For example, the efficiency of the payment system might be thought to fall with \( D \). Similarly, a reduction in the size of the home banking system might reduce the level of financial expertise which might be valuable to the home country. Also, banking profits would be declining in the size of the deposits. These factors could be modeled as an external net benefit to individuals \( X(D) \) where \( X'(D) > 0 \). Then a necessary condition for the government initially choosing incomplete deposit insurance, \( d < 1 \), is \( X(1) < c \).
3 Equilibria Given Full Foreign Deposit Insurance

In this section we recursively solve the model under the assumption that the foreign country has implemented full deposit insurance \( d^* = 1 \) in Stage 1.

3.1 Stage 3: Banking Subgame Given Full Deposit Insurance

In the banking subgame \( d^* = 1 \) and \( d \) are given. First, consider foreign loose depositors. Their gross return (before taxes) from investing domestically is \( (1 - P(D^*))R + P(D^*) \max\{r, d^*R\} = R \). Foreign loose depositors have a dominant strategy to deposit domestically rather than abroad, yielding them net return:

\[
U^*_L = \max\left\{ R, (1 - P(D))R + P(D) \max\{r, dR\} - \varepsilon^* \right\} - T^* = R - T^*
\]

Now consider home loose depositors. Their net return from investing in the foreign country is \( R - \varepsilon - T \). Investing domestically (weakly) dominates depositing abroad when

\[
U_L = \max\left\{ (1 - P(D))R + P(D) \max\{r, dR\}, R - \varepsilon \right\} - T = (1 - P(D))R + P(D) \max\{r, dR\} - T
\]

which implies \( \varepsilon \geq P(D)(R - \max\{r, dR\}) \). The home loose deposit at home when the cost of going abroad, \( \varepsilon \), is at least as large as the net benefits i.e. the probability \( P(D) \) of failure domestically times the difference in the returns on deposits held abroad and domestically in case of failure, \( (R - \max\{r, dR\}) \). Observe that the net benefit of investing abroad is largest when home deposit insurance is ineffective. If the transaction cost is too large, then the home loose will invest at home. The interesting case is when the transaction cost \( \varepsilon \) is sufficiently small that the home loose always invest abroad (where there is full foreign deposit insurance) in the absence of effective home deposit insurance:

\[
\varepsilon < p(R - r) \equiv \bar{\varepsilon}
\]
where $\overline{\epsilon} > 0$ as $p > 0$ and $R > r$. Henceforth $0 < \epsilon < \overline{\epsilon}$ is assumed.

The condition for the loose investing at home can now be rewritten in terms of the deposit insurance level $d$ satisfying the following threshold:

\[
\text{Home loose deposit at home} \iff d \geq d_{P(D)} \equiv 1 - \frac{\epsilon}{P(D)R} \tag{2}
\]

The restriction $0 < \epsilon < \overline{\epsilon}$ implies that the threshold involves effective deposit insurance, $\frac{\epsilon}{P(D)R} < d_{P(D)} < 1$, and $d_{P(D)} \to 1$ as $\epsilon \to 0$.

The individual decision whether to deposit at home described in equation (2) generally depends on the amount of deposits $D$, and hence on the decisions of the other depositors. A Nash equilibrium in the subgame, involves all depositors optimizing given the behavior of other depositors. In our basic model, the proportion $B^*$ foreign and $B$ domestic bound depositors trivially deposit domestically. The $1 - B^*$ foreign loose investors also invest domestically. Overall, we have $D \geq B$ and $D^* \geq 1$. The behavior of the $1 - B$ home loose depositors consistent with equation (2) determines the equilibrium.

**Proposition 1** Given policies $d$ and $d^* = 1$, Nash equilibrium deposit behaviour is as follows:

(i) **Home Loose Leave Equilibrium.** If the level of deposit insurance $d$ is below a threshold $d_b = 1 - \frac{\epsilon}{bR}$, then an equilibrium exists in which the home loose depositors invest abroad and other depositors invest domestically: $D = B$ and $D^* = 2 - B$

(ii) **Domestic Banking Equilibrium.** If the level of effective deposit insurance $d$ exceeds a threshold $d_p = 1 - \frac{\epsilon}{P(D)R} < d_b$, then an equilibrium exists in which all depositors invest domestically: $D = 1$ and $D^* = 1$

**Proof.** If all home loose invest in foreign deposits then $D = B$ and $D^* = 2 - B$. Hence $P(D) = P(B) = b$ and by equation (2) depositing in the foreign country is optimal when home deposit insurance is below $d_b = 1 - \frac{\epsilon}{bR}$. This is the Home Loose Leave Equilibrium.

Conversely, suppose all the home loose invest in home deposits. Then, $D = 1$ and $D^* = 1$, 

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and $P(D) = P(1) = p$. The home loose are optimizing if home deposit insurance is effective and exceeds $d_p$. ■

Table 1 arranges these equilibria into intervals using the fact that $d_p < d_b$. If $d < d_p$, then the Home Loose Leave Equilibrium is unique. At the other end of the range, $d \geq d_b$, the Domestic Banking Equilibrium is unique. In the intermediate interval, $d_p \leq d < d_b$, either equilibrium is possible. Without a refinement the equilibrium is indeterminate.

In Table 1 expected utility is net of taxes. In the Home Loose Leave Equilibrium the tax is $T(i) = Bb(1 + c) \max\{0, dR - r\}$. When deposit insurance is ineffective, the tax is zero and welfare $W(i)$ is at its maximum:

$$ W(i) = (1 - b)Bc(1 + c) \max\{0, dR - r\} $$

Observe that $W(i)$ can be written as the expected return on deposits invested at home plus a term that represents the utility boost of the loose depositors from moving abroad, i.e. $(b(R - r) - \varepsilon)$, times the fraction of loose depositors. In contrast, in the Domestic Banking Equilibrium the tax is $T(ii) = p(1 + c)(dR - r)$, and since both the bound and the loose deposit domestically they have the same utility.

<table>
<thead>
<tr>
<th>Interval</th>
<th>Equilibrium</th>
<th>Expected Utility</th>
<th>Welfare</th>
</tr>
</thead>
<tbody>
<tr>
<td>$[0, d_p)$</td>
<td>(i) HLLE</td>
<td>$U_B(i) = (1 - b)R + bdR - T(i)$</td>
<td>$W(i) = W(i) - Bc \max{0, dR - r}$</td>
</tr>
<tr>
<td>$[d_p, d_b)$</td>
<td>either (i) or (ii)</td>
<td>either $U_B(i)$ and $U_L(i)$ or $U(ii)$</td>
<td>either $W(i)$ or $W(ii)$</td>
</tr>
<tr>
<td>$[d_b, 1]$</td>
<td>(ii) DBE</td>
<td>$U(ii) = (1 - p)Bc(1 + c) \max{0, dR - r}$</td>
<td>$W(ii) = U(ii)$</td>
</tr>
</tbody>
</table>

We can eliminate multiple equilibria with a refinement from Allen and Gale (2007). Specifically, assume home loose depositors coordinate on the essential equilibrium, that gives them the
greater utility in the indeterminate interval \([d_p, d_b]\). They compare utilities and choose the Domestic Banking Equilibrium if and only if deposit insurance is sufficiently high that \(U^{(ii)} \geq U^{(i)}_L\). The essential equilibrium refinement yields a level of deposit insurance \(\tilde{d}\) that separates the equilibria. Interestingly, \(\tilde{d}\) depends on the stress ratio \(\frac{b}{p}\) implied in taxes. The following proposition gives the value of \(\tilde{d}\) and summarizes the results.

**Proposition 2** Given policies \(d\) and \(d^* = 1\), the essential banking equilibrium is the Home Loose Leave Equilibrium if and only if \(d < [0, \tilde{d})\) and the Domestic Banking Equilibrium if and only if \(d \geq [\tilde{d}, 1]\), where \(\tilde{d} = \max\{d_p, \min\{d^*, d_b\}\}\) and \(d^* = \frac{1}{R} \left[ r + \frac{\tilde{r} - \varepsilon}{1 + c} - pc \right]\) is the insurance level that equates \(U^{(i)}_L = U^{(ii)}\). The level of \(\tilde{d}\) depends on taxes or, equivalently, the stress ratio \(\frac{b}{p}\) as follows:

(a) \(\tilde{d} = d_p\) if and only if \(T^{(ii)} \leq T^{(i)}\) or, equivalently, \(\frac{b}{p} \geq \frac{1}{B}\).

(b) \(\tilde{d} > d_p\) if and only if \(T^{(ii)} > T^{(i)}\) or, equivalently, \(\frac{b}{p} < \frac{1}{B}\); \(\tilde{d}\) continuously increases with reductions in the stress ratio over interval \([d_p, d_b)\).

**Proof.** For given \(d\) we have \(T^{(ii)} \leq T^{(i)}\) if and only if \(\frac{b}{p} \geq \frac{1}{B}\). We can also verify that \(d^* \leq d_p\) if and only if \(\frac{b}{p} \geq \frac{1}{B}\). Therefore, if \(\frac{b}{p} \geq \frac{1}{B}\), then \(d^* \leq d_p\) and \(\tilde{d} = d_p\). Conversely, if \(\frac{b}{p} < \frac{1}{B}\), then \(d^* > d_p\) and \(\tilde{d} = \min\{d^*, d_b\}\). In this later case \(d^*\) increases continuously over the interval with a decrease in \(b\) or an increase in \(p\); changes that continuously decrease the stress ratio. ■

Taxes play a decisive role because home loose depositors internalize the cost of taxes in the essential equilibrium. Without this refinement, taxes are ignored in decision making. For example, consider the lower bound value \(d = d_p\) in the intermediate interval \([d_p, d_b)\). The Domestic Banking Equilibrium is a Nash equilibrium because the return net of taxes from banking at home is at least as great as abroad \((1 - p)R + pd_pR = R - \varepsilon\). In contrast the Domestic Banking Equilibrium is the essential equilibrium when \(U^{(ii)} \geq U^{(i)}_L\). Substituting \(U^{(ii)} = (1 - p)R + pd_pR - T^{(ii)} \geq R - \varepsilon - T^{(i)} = U^{(i)}_L\) implies \(T^{(ii)} \leq T^{(i)}\).

The stress ratio can be derived and interpreted from comparing the taxes: \(T^{(ii)} = p(1+c)(dR-r) \leq T^{(i)} = bB(1+c)(dR-r)\) implies \(p(1) \leq bB\). Thus, the stress ratio must satisfy \(\frac{b}{p} \geq \frac{1}{B}\); i.e. the stress ratio, which is the ratio of the failure probabilities, must be at least as great as \(\frac{1}{B}\).
i.e. the ratio of the relative populations insured in the Domestic Banking Equilibrium (namely $D = 1$) and the Home Loose Leave Equilibrium (namely $D = B$). Below this threshold, $\frac{b}{p} < \frac{1}{B}$, taxes are lower in the Home Loose Leave Equilibrium for a given level of deposit insurance $d$, and a decrease in the stress ratio increases the range of this equilibrium by increasing $\tilde{d}$.

3.2 Stage 2: The Home Government’s Choice of $d$ Given $d^* = 1$

The home government chooses $d$ to maximize welfare while anticipating the banking equilibria described in Stage 3. First consider the government’s choice under the essential equilibrium described in Proposition 2. The government can uniquely choose a Domestic Banking Equilibrium over the range $d \geq \tilde{d}$. Among this set of choices $d = \tilde{d}$ maximizes welfare because it minimizes the deadweight loss from taxation. The government can uniquely choose a Home Loose Leave Equilibrium over the range $d < \tilde{d}$. Among this set of choices ineffective deposit insurance, $d \leq \frac{c}{B}$, maximizes welfare at $W^{(i)}$ since it minimizes the deadweight loss from taxation. The government’s problem reduces to a binary choice: either ineffective deposit insurance and the Home Loose Leave Equilibrium is chosen, or else $d = \tilde{d}$ and the Domestic Banking Equilibrium. The Domestic Banking Equilibrium prevails if and only if

$$W^{(ii)}(\tilde{d}) \geq W$$

or the transaction cost $\varepsilon$ satisfies:

$$\frac{[p(1 + c) - Bb(R - r) - cp(1 - \tilde{d})R]}{1 - B} \leq \varepsilon < \varepsilon$$

Observe that the left-hand side of this equation is negative when $p(1 + c) \leq Bb$, or equivalently, the stress ratio is sufficiently large $\frac{b}{p} \geq \frac{1 + c}{B}$. This bound on the stress ratio differs from the bound found in Proposition 2 (namely $\frac{b}{p}$) because the government internalizes the deadweight loss $c$ of providing effective deposit insurance (of the Domestic Banking Equilibrium).

**Proposition 3** Assume $d^* = 1$, and the equilibrium is determined uniquely by the essential banking equilibrium in Proposition 2. For a high enough stress ratio, $\frac{b}{p} \geq \frac{1 + c}{B}$, the government sets $d = \tilde{d} = d_p$ to realize the Domestic Banking Equilibrium. If $\frac{b}{p} < \frac{1 + c}{B}$ then for sufficiently high transaction costs $\varepsilon < \varepsilon$ the government sets $d = \tilde{d}$ to realize the Domestic Banking Equilibrium;
otherwise, the government sets ineffective deposit insurance \((d \leq r/R)\) to realize the Home Loose Leave Equilibrium.

**Proof.** When \(\frac{b}{p} \geq \frac{b+p}{r/R} \Rightarrow \frac{b}{p} \geq \frac{1}{R}\); from Proposition 2(a) we get \(\tilde{d} = d_p\). We can also observe directly that (3) is satisfied. Now consider \(\frac{b}{p} < \frac{1+c}{r/R}\). If \(\varepsilon \to 0\), then \(\tilde{d} = \max\{d_p, \min\{d^r, d_b\}\} \to \max\{1, \min\{d^r, 1\}\} = 1\) so that (3) is violated. Hence we complete the proof if we establish that (3) is satisfied for \(\varepsilon < \varepsilon\) sufficiently large. Consider the limiting case \(\varepsilon \to \varepsilon\). Then \(\tilde{d} = \max\{d_p, \min\{d^r, d_b\}\} \to \max\{r/R, \min\{r/R, d_b\}\} = r/R\) and it can be shown that the left-hand side of (3) must be strictly smaller than \(\varepsilon\). □

Interestingly, Proposition 3 does not rule out the possibility of the home government responding with near complete deposit insurance \((d = 1)\). This happens when \(\frac{b}{p} \geq \frac{1+c}{r/R}\) and the transaction costs \(\varepsilon\) are small as we have \(d_p \to 1\) if \(\varepsilon \to 0\).

The analysis without the essential banking refinement is more complicated as there are two banking equilibria in the intermediate interval \([d_p, d_b]\) described in Table 1. However, near complete deposit insurance will also a possibility in this case as we will show below. The government’s problem reduces to selecting deposit insurance that corresponds to the interval which maximizes overall welfare:

\[
W = \max\{W^{(i)}(d_p), qW^{(i)}(d_p) + (1-q)W^{(ii)}(d_p), W^{(ii)}(d_b)\}
\]

The middle expression is the expected utility from a gamble over the two equilibria in the intermediate interval, where \(q\) is the sunspot probability that depositor coordinate on the Home Loose Leave Equilibrium. We assume the home government knows the sunspot probability \(q\), and, for simplicity, that \(q\) does not vary with \(d\). If \(q\) does not vary with \(d\), then \(d = d_p\) dominates other values of \(d\) on the intermediate interval \([d_p, d_b]\).

To see how the optimum depends on parameters, let us discuss a few results. First, the length of the intermediate interval increases in the transaction cost \(\varepsilon\). The intermediate interval
approaches maximum length as $\varepsilon \to \varepsilon^*$ and, in this limit case, the lower bound approaches $d_p \to r/R$. Second, as Proposition 3 shows the Domestic Banking Equilibrium dominates the Home Loose Leave Equilibrium for sufficiently high transaction cost $\varepsilon$. It follows that for a sufficiently high transaction cost the optimum is therefore either barely effective deposit insurance $d = d_p \approx r/R$, or ‘high’ deposit insurance $d = d_b$. Barely effective deposit insurance reduces the deadweight loss of deposit insurance to nearly zero but may result (with probability $q$) in the unfavorable Home Loose Leave Equilibrium. By contrast, the deadweight loss of insurance is higher for $d = d_b$ but implies the favorable Domestic Banking Equilibrium.

**Proposition 4** Assume full foreign deposit insurance ($d^* = 1$) and that depositors coordinate on the Home Loose Leave Equilibrium with a given probability $q \in (0, 1)$ if home deposit insurance $d$ is in the gamble interval $[d_p, d_b]$.

(a) If the stress ratio satisfies $\frac{b}{p} \geq \frac{1+c}{B}$ then there is a critical transaction cost level, say $\varepsilon^*$, such that if $\varepsilon \leq \varepsilon^*$ the government sets $d = d_b$ resulting in the Domestic Banking Equilibrium; if $\varepsilon > \varepsilon^*$ the government sets $d = d_p$ resulting in a “gamble” between the two equilibria.

(b) If $\frac{b}{p} < \frac{1+c}{B}$ then: (b1) For sufficiently low transaction cost $\varepsilon$ the government chooses ineffective deposit insurance resulting in the Home Loose Leave Equilibrium. (b2) For sufficiently high transaction cost $\varepsilon$ the government chooses $d = d_b$ if $\frac{b}{p} \geq \frac{cR}{rqB}$ and $d = d_p$ if $\frac{b}{p} < \frac{cR}{rqB}$ (choosing ineffective deposit insurance to end up in the Home Loose Leave Equilibrium is suboptimal).

Proposition 4 shows that the home government will again choose near complete deposit insurance when the stress ratio $b/p$ is large enough while the transaction costs $\varepsilon$ are small enough. It also shows that for sufficiently high transaction costs the Home Loose Leave Equilibrium is dominated by either a gamble between the two equilibria; or else certainty in the form of the Domestic Banking Equilibrium. The government chooses ‘high’ deposit insurance, $d = d_b$ and certainty if the stress ratio $b/p$ is large enough.
4 The General Analysis

4.1 The Banking Equilibrium

We proceed by generalizing the analysis of the banking equilibrium (stage 3) for arbitrary values \( d \) and \( d^* \) of home and foreign deposit insurance. Depositing in the home country dominates investing in the foreign country for home loose agents if and only if

\[
(1 - P(D))R + P(D) \max \{r, dR\} \geq (1 - P^*(D^*))R + P^*(D^*) \max \{r, d^*R\} - \varepsilon \quad \text{or} \quad \max \left\{ \frac{r}{R}, d \right\} \geq 1 - \frac{\varepsilon}{P(D)R} - \frac{P^*(D^*)}{P(D)} \left[ 1 - \max \left\{ \frac{r}{R}, d^* \right\} \right]
\]

(4)

The situation abroad is similar; foreign loose depositors deposit domestically if and only if:

\[
(1 - P(D))R + P(D) \max \{r, dR\} - \varepsilon^* \leq (1 - P^*(D^*))R + P^*(D^*) \max \{r, d^*R\} \quad \text{or} \quad \max \left\{ \frac{r}{R}, d \right\} \leq 1 + \frac{\varepsilon^*}{P(D)R} - \frac{P^*(D^*)}{P(D)} \left[ 1 - \max \left\{ \frac{r}{R}, d^* \right\} \right]
\]

(5)

The analysis in Section 3 was the special case for which \( d^* = 1 \). In that special case equation 5 is satisfied, and the last term of equation 4 vanishes and simplifies to equation 2 (for \( \varepsilon \) is not too large).

There are three possible banking equilibriums. In the Domestic Banking Equilibrium we have \( D = D^* = 1 \). The two conditions reveal that this equilibrium exists if

\[
\max \left\{ \frac{r}{R}, d \right\} \geq 1 - \frac{\varepsilon}{pR} - \frac{p^*(d^*)}{p} \left[ 1 - \max \left\{ \frac{r}{R}, d^* \right\} \right] \equiv d_{\text{DBE}}(d^*)
\]

(6)

\[
\max \left\{ \frac{r}{R}, d \right\} \leq 1 + \frac{\varepsilon^*}{pR} - \frac{p^*(d^*)}{p} \left[ 1 - \max \left\{ \frac{r}{R}, d^* \right\} \right] \equiv d_{\text{DBE}}^*(d^*)
\]

(7)

Observe that \( d_{\text{DBE}}^*(d^*) < 1 \) and that \( d_{\text{DBE}}^*(d^*) < d_{\text{DBE}}(d^*) \). This implies that the Domestic Banking Equilibrium exists for high enough deposit insurance \( d \) provided that \( d_{\text{DBE}}(d^*) > r/R \). Com-
parative statics follow immediately from these equations too. For example, the parameter space
for which the home banking equilibrium exits expands if the costs of moving abroad for home and
foreign depositors increases. Also, for a fixed crisis odds ratio $p^*/p$, the parameter space shrinks
with increases in the probability of a crisis $p$ at home. An increase in foreign deposit insurance
$d^*$ softens the impact of possible changes in the crisis odds ratio.

The Home Loose Leave Equilibrium ($D = B$ and $D^* = 2 - B$) exists if, in equilibrium, the
home loose (and hence also the foreign loose) prefer to deposit abroad. This happens if

$$\max \left\{ \frac{r}{R}, d \right\} \leq 1 - \frac{\varepsilon}{bR} - \frac{p^*}{b} \left[ 1 - \max \left\{ \frac{r}{R}, d^* \right\} \right] \equiv d_{H\text{LLE}}^\varepsilon(d^*)$$

Finally, there is a potential Foreign Loose Leave Equilibrium in which the foreign loose prefer
to deposit abroad: $D = 2 - B^*$ and $D^* = B^*$. This equilibrium exists if

$$\max \left\{ \frac{r}{R}, d \right\} \geq 1 + \frac{\varepsilon^*}{pR} - \frac{b^*}{p} \left[ 1 - \max \left\{ \frac{r}{R}, d^* \right\} \right] \equiv d_{F\text{LLE}}^\varepsilon(d^*)$$

Combining the last four equations gives us the following generalisation of Proposition 1

**Proposition 5** Given policies $d$ and $d^*$, Nash equilibrium deposit behaviour is as follows:

(i) **Home Loose Leave Equilibrium.** If the level of deposit insurance $d$ is below the threshold
$d_{H\text{LLE}}^\varepsilon(d^*)$, then an equilibrium exists in which the home loose depositors invest abroad and
other depositors invest domestically: $D = B$ and $D^* = 2 - B$

(ii) **Foreign Loose Leave Equilibrium.** If the level of deposit insurance $d$ exceeds the threshold
$d_{F\text{LLE}}^\varepsilon(d^*)$, then an equilibrium exists in which the foreign loose depositors invest abroad
and other depositors invest domestically: $D = 2 - B^*$ and $D^* = B^*$

(iii) **Domestic Banking Equilibrium.** If the level of effective deposit insurance $d$ satisfies $d_{DBE}^\varepsilon(d^*) \leq$
$\max \left\{ \frac{r}{R}, d \right\} \leq d_{DBE}^\varepsilon(d^*)$, then an equilibrium exists in which all depositors invest domes-
tically: $D = 1$ and $D^* = 1$
We saw in Section three that there may be multiple equilibria for \( d^* = 1 \). There may also be multiple banking equilibria for other levels of \( d^* \). For instance, we have \( d^{-\varepsilon}_{\text{DBE}}(d^*) < d^{-\varepsilon}_{\text{HLLE}}(d^*) \) so that for \( \max \left\{ \frac{r}{R}, d \right\} \in [d^{-\varepsilon}_{\text{DBE}}(d^*), d^{-\varepsilon}_{\text{HLLE}}(d^*)] \) both the Home Loose Leave and Domestic Banking Equilibriums exist. We also have \( d^*_{\text{HLLE}}(d^*) < d^*_{\text{DBE}}(d^*) \) so that for \( \max \left\{ \frac{r}{R}, d \right\} \in [d^*_{\text{HLLE}}(d^*), d^*_{\text{DBE}}(d^*)] \) both the Home Loose Leave and Domestic Banking Equilibrium exist. Finally, if \( d^* < 1 \) and if both transaction costs \( \varepsilon^* \) and \( \varepsilon \) are “small” we have

\[
d^*_{\text{FLLE}}(d^*) - d^{-\varepsilon}_{\text{HLLE}}(d^*) = \frac{\varepsilon^*}{pR} + \frac{\varepsilon}{bR} + \left( \frac{p^*}{b} - \frac{b^*}{p} \right) \left[ 1 - \max \left\{ \frac{r}{R}, d \right\} \right] < 0
\]

because \( \left( \frac{p^*}{b} - \frac{b^*}{p} \right) < 0 \). Consequently, for \( d^* < 1 \) and small enough transaction costs \( \varepsilon^* \) and \( \varepsilon \) all three equilibriums exist in the interval \( \max \left\{ \frac{r}{R}, d \right\} \in [d^*_{\text{FLLE}}(d^*), d^*_{\text{HLLE}}(d^*)] \).

### 4.2 The Policy Equilibrium

Having established the equilibrium in the banking subgame we will now turn to the policy game (stages 1 and 2). Let us simplify the analysis by assuming throughout that if the Domestic Banking Equilibrium exits then depositors coordinate on it. Recall that the Domestic Banking Equilibrium is the efficient equilibrium and note from Proposition 3 above that we can conjecture that for high enough stress ratios at home and abroad, the Domestic Banking Equilibrium is also the essential equilibrium in case of multiple equilibria.

With the simplifying assumption that the Domestic Banking Equilibrium would be the prevailing equilibrium if it exits, we know that the Stage-2 response of the home country is either to choose ineffective deposit insurance, or else \( d = d^{-\varepsilon}_{\text{DBE}}(d^*) \) (Note though that \( d = d^{-\varepsilon}_{\text{DBE}}(d^*) \) may well be ineffective). As in Section 3 the choice boils down to a binary choice because welfare decreases in the level of deposit insurance – the home government chooses the minimum level of deposit insurance that yields the preferred equilibrium. The analysis of stage 2 is now intuitively clear. First of all, the home government avoids to attract more than \( D = 1 \) in deposits if possible. This implies that the Foreign Loose Leave Equilibrium (with \( D = 2 - B^* \) and \( D^* = B^* \)) is only consistent with ineffective deposit insurance by the home government. The Home Loose Leave
Equilibrium (with $D = B$ and $D^* = 2 - B$) is also only consistent with ineffective $d$ because the home loose leave in this equilibrium anyway. The only possible binding level of deposit insurance is chosen in case of the home banking equilibrium (with $D = D^* = 1$). As was the case before, the home government will aim for the Domestic Banking Equilibrium if the stress ratio $b/p$ is “high enough” (see Proposition 3).

Finally, in stage 1 the foreign government chooses $d^*$ while anticipating the response by the home government and the banking equilibrium. A logic analogous to the reasoning in the paragraph above reveals that the Home Loose Leave and Foreign Loose Leave Equilibria are only consistent with ineffective deposit insurance. Thus we have

**Lemma 1** *In the Home Loose Leave and Foreign Loose Leave Equilibria deposit insurance must be ineffective in both the home and foreign country.*

This lemma shows any possible binding level of deposit insurance $d = d^*_\text{DBE}(d^*)$ can only be justified by the aim for the foreign government to end up in the Domestic Banking Equilibrium. Since we made the simplifying assumption that the Domestic Banking Equilibrium would be the prevailing equilibrium if it exits, the lemma also shows that a necessary condition for either the Home Loose Leave or the Foreign Loose Leave Equilibrium to exist is that the conditions for existence of the Home Banking Equilibrium are not satisfied if $d$ and $d^*$ are ineffective. Equations 6 and 7 show that this is the case if either $r/R < d^*_\text{HBE}(r/R)$ or if $d^*_\text{HBE}(r/R) < r/R$. Simplifying shows that a necessary condition for either the Home Loose Leave Equilibrium or the Foreign Loose Leave Equilibrium to exist is

$$(p - p^*) (R - r) > \varepsilon$$ or $$(p^* - p) (R - r) > \varepsilon^*$$ that is $|p^* - p| > \min\{\varepsilon, \varepsilon^*\} \frac{1}{(R - r)}$$

In words the first expression says that the expected return difference between a dollar deposited in the foreign and the home country exceeds the cost $\varepsilon$ for the home loose to move the dollar abroad. Clearly $(p - p^*) > 0$ is for $(p - p^*) (R - r) > \varepsilon$, i.e. the foreign banking sector is a safer place to deposit than the home banking system. The second expression is satisfied if the
expected return difference between a dollar deposited in the home and foreign country exceeds the cost $\varepsilon^*$ for the foreign loose to move a dollar abroad.

**Proposition 6** Assume the Domestic Banking Equilibrium would be the prevailing banking equilibrium if it exits.

(i) Ineffective deposit insurance is the only policy equilibrium that implies the Domestic Banking Equilibrium if the home and foreign banking system are close enough in terms of the risk of a banking crisis (in equilibrium). Specifically, if the difference in the crisis probability satisfies

$$|p^* - p| \leq \min \left\{ \varepsilon, \varepsilon^* \right\} \frac{1}{(R - r)}$$

then deposit insurance at home and abroad are ineffective ($d \leq \frac{r}{R}$ and $d^* \leq \frac{r}{R}$) and implies the Domestic Banking Equilibrium.

(ii) If $(p - p^*)(R - r) > \varepsilon$ then

If the stress ratio $b/p$ of the home banking sector is “large enough” then deposit insurance at home and abroad are given by $d = d^*_{\text{HBE}}(r/R) > r/R$ and $d^* = r/R$. The banking equilibrium is the Domestic Banking Equilibrium.

If the stress ratio $b/p$ is not large enough we get $d = d^* = r/R$ and the Home Loose Leave Equilibrium

(iii) If $(p^* - p)(R - r) > \varepsilon^*$ then

If the stress ratio $b^*/p^*$ of the foreign banking sector is “large enough” then deposit insurance at home and abroad are given by $d = r/R$ and $d^* = 1 - \frac{\varepsilon^*}{p^* R} - \frac{p}{p^*} \left[ 1 - \frac{r}{R} \right] > \frac{r}{R}$ (i.e. the solution of $d^*_{\text{DBE}}(d^*) = r/R$). The banking equilibrium is the Domestic Banking Equilibrium.

If the stress ratio $b^*/p^*$ is not large enough we get $d = d^* = r/R$ and the Foreign Loose Leave Equilibrium.

Among other things, the Proposition shows that when the countries are in a symmetric enough situation in terms of the risk of their banking sectors if these are not under strain due to withdrawals, then non-cooperation between the countries achieves the cooperative outcome. Deposit
insurance is kept at a minimum and the efficient outcome in which there are no depositors who move abroad prevails. In other words, the foreign government feels safe enough to set ineffective deposit insurance in stage 1 knowing that the home constituency will follow suit.

5 The European Situation

As part of the European Union’s objective to integrate financial markets, the 1994 EU directive on deposit guarantee schemes (Directive 94/19/EC) laid out a minimum standard for deposit guarantee schemes in the member states. Member states were required to guarantee a minimum of €20,000 of each depositor’s aggregate deposits. Interestingly, the 1994 Directive recognizes that differences in the level of coverage could create unequal conditions of competition, and mentions explicitly the possible competition distortions that arise when a credit institution’s branch is located in a host country with different coverage than its home country. Under the 1994 directive branches of credit institutions that are located in member states other than its home country are covered by the home country’s deposit insurance scheme. (For example, the branches of a German bank located in France are covered by the German government’s deposit guarantee scheme.) Thus, branches of banks provide a ready vehicle for soliciting foreign deposits.\(^\text{12}\)

E-commerce has greatly increased the scope of competitive distortions that could be caused by differences in deposit insurance coverage. Consumers now have the ability to quickly move their savings between local branches and even across borders. By moving their savings rapidly between local branches, EU customers can effectively swiftly move between competing deposit insurance schemes. This is exactly what happened in 2008 during the global financial crisis, and governments have reacted in a range of different ways in attempts to shore up their domestic economies. Some of these attempts though, involved deposit insurance and may have distorted competition between banks of some of the member states.

\(^{12}\) As part of the directive, however, members were also required to limit the use of advertising deposit insurance scheme related information. Although deposit insurance scheme information had to be readily available, members had to ensure that credit institutions were not advertising information that would distort competition. (Directive 94/19/EC, Article 9(3)).
On September 30, in the midst of the credit crisis, the government of Ireland announced that they would guarantee all deposits (retail, commercial, institutional and inter-bank) at their largest 6 banks for two years.\textsuperscript{13} The Irish government stated that this decision was in response to “the impact of the recent international market turmoil on the Irish Banking system”, and felt that it would “remove any uncertainty on the part of counterparties and customers of the six institutions” (Government of Ireland, 2008).

On October 3, the United Kingdom announced an increase in their deposit guarantee limit, from £35,000 to £50,000, effective October 7. The previous limit of £35,000 was set only days earlier, on October 1, in response to the run on Northern Rock. Reuters reported that the Irish guarantee caused a flood of cash from UK into the guaranteed Irish banks (Thomson Reuters, 2008). According the British Bankers Association, UK banks in Northern Ireland were particularly disadvantaged by Ireland’s guarantee (British Bankers Association, 2008).

On October 5\textsuperscript{th}, after publicly denouncing Ireland’s “beggar-thy-neighbour” move earlier, the Chancellor of Germany, Angela Merkel, announced that the government would fully guarantee the safety of the public’s deposits (The Economist, 2008).\textsuperscript{14} Previous to this move, Germany had guaranteed €20,000 of deposits. It was reported in the Economist that Germany’s move “may have been prompted by large numbers of electronic withdrawals of deposits at the weekend” (The Economist, 2008).

On the same day, the Austrian Minister of Finance, Wilhelm Molterer, announced that Austria would follow Germany by guaranteeing deposits. At the time no official amount was announced, but by October 8, the Austrian government approved an unlimited guarantee for private customers (European Commission, 2008).\textsuperscript{15} Previously Austria had insured €20,000. As reported by Reuters, Molterer said that this move was to “ensure Austrian savings are not withdrawn and transferred to Germany” (Thomson Reuters, 2008).

\textsuperscript{13}They also guaranteed covered bonds, senior debt and subordinated debt (lower tier II). It was reported that this new scheme guaranteed an estimated €400bn of liabilities (Financial Times, 2008).
\textsuperscript{14}This guarantee was only implicit though, as it was not followed by legislation that would legally bind the guarantee.
\textsuperscript{15}On October 5 Molterer had promised to propose an increased guarantee within days.
On October 6, the government of Denmark announced that they would guarantee all deposits in Danish banks for two years (Government of Denmark, 2008). Previous to this announcement Denmark had insured 300,000 Kroner, or approximately E40,000.

On October 7, at the EcoFin Council meeting in Luxembourg, EU finance ministers agreed to raise the Union wide deposit guarantee minimum from E20,000 to E50,000 for an initial period of at least one year. In order to prevent a situation from occurring again, the Council laid the framework for Directive 2009/14/EC, that amended the 1994 Directive on deposit insurance in regards to the payout delay and the coverage level. Directive 2009/14/EC came into effect in March 2009. It specified a minimum guarantee of E50,000 until December 31, 2010 and a common level of E100,000 afterwards, unless an assessment by a future Council meeting concludes that the harmonization is not viable (European Union, 2009).

6 Ireland and Germany: Deposit Insurance and the Financial Crisis

The upshot of the previous section is that (i) prior to 2008 all, but a few of the deposits in the EU were effectively insured, while (ii) deposit insurance levels in the EU increased drastically in the midst of the crisis, triggered by the Irish move to full deposit insurance. What might account for the change in the EU from the initially low, essentially ineffective deposit insurance to full deposit insurance in 2008? In this section we use the model as a framework to consider shock scenarios that might replicate this change. Initial low levels of deposit insurance may be desirable in our model since deposit insurance involves a deadweight loss. In fact, in our model we would get ineffective deposit insurance if countries were to cooperate and coordinate their policies. This

16 The new Danish guarantee plan is quite interesting because it takes heed of possible competitive distortions. In particular, the plan allows for branches of foreign banks located in Denmark to participate in this new plan. This allowance helps eliminate possible regional, but international, competitive distortions.

17 The payout delay is the time between a consumer filing for compensation due to his/her deposits being unavailable and when they receive compensation. Previously the limit was 3 months that could be extended under certain circumstances.

18 It was reported that many of the larger members wanted an immediate increase in the minimum to E100,000, but many of the smaller members refused to take on such a large liability.
also means that any outcome in the non-cooperative equilibrium we consider would stem from a lack of coordination.

There are at least three types of scenarios that may explain deviations from ineffective deposit insurance, namely asymmetric changes in expected asset returns, liquidity shocks, and changes in beliefs. In discussing these scenarios we have to consider whether the Irish government in setting \( d^* = 1 \) anticipated the response of \( d = 1 \) from the German government. Germany was on the record that it would not change policy. However, its volte face, as described in the leading quote of this paper, suggests that this commitment turned out not to be credible.

We will assume throughout that the stress ratios in Ireland and Germany were “high enough” in 2008 so that Governments will wanted to avoid an outflow of depositors and put the domestic banking sector under strain. We will also assume, as suggested by the European situation, that the banking equilibrium was the Home Banking Equilibrium both prior to and during the 2008 banking crisis: \( D = D^* = 1 \).

### 6.1 Pre-crisis Equilibrium

Proposition 6(i) provides a reasonable rationale for the pre-crisis equilibrium. Depositors viewed investments in Irish and German banks as about equally safe, so that ineffective deposit insurance in both countries and the Domestic Banking Equilibrium result. What changed during the banking crisis?

### 6.2 Asymmetric Changes in Asset Returns

Bank assets got a hit in the 2008 financial crisis. In the model this hit could be captured by an increase in the probability of failure, \( P(.) \), or, alternatively, by a decrease in \( R \) and/or \( r \). Let us model a change in asset returns by an increase in \( P(.) \). It is unlikely that the 2008 financial crisis hit countries in the European Union symmetrically. Specifically, the crisis may have implied a jump in \( P^*(.) - P(.) \), and in particular \( p^* - p \); deposits in Irish banks became relatively less attractive.
According to this scenario $p^* - p$ jumped to a level greater than $\epsilon^*/(R - r)$. As is shown by Proposition 6(iii) the Irish government raised deposit insurance from ineffective to $d^* = 1 - \frac{\epsilon^*}{p^* R} - \frac{p}{p^*} \left[1 - \frac{r}{R}\right] > \frac{r}{R}$ in light of the presumed Irish’ commitment to safe-guard the stability of the local banking sector.

Was a move to $d^* = 1$ conceivable according to the model? In the worst-case scenario for the Irish government depositors at Irish banks move abroad easily, i.e. $\epsilon^* \approx 0$. If this were the case deposit insurance would be $d^* = 1 - \frac{p}{p^*} \left[1 - \frac{r}{R}\right]$, which shows that an additional necessary condition for the choice $d^* \approx 1$ is that the German banking sector is viewed as very safe ($p \approx 0$). It is very unlikely that depositors viewed deposits in Germany as perfectly safe in the midst of the crisis. Another, bigger problem this scenario has to explain the chain of events in the European case is that Proposition 6(iii) shows that the optimal Home country/German response was to keep deposit insurance ineffective.

Hence, in order to support this scenario we will have to go beyond the scope of current model. One direction would be to assume uncertainty on part of the policy makers about some of the model parameters, for instance regarding the moving costs $\epsilon$ and $\epsilon^*$. Policy makers that do not know some parameters may choose insurance levels that are higher than the levels on which Proposition 6 is based, especially if the stress levels $b/p$ and $b^*/p^*$ are high because this would indicate that the costs of judgment errors are high. It may well be that stress levels peaked in 2008.

With the addition of uncertainty regarding the moving costs $\epsilon$ and $\epsilon^*$ the story may have been the following. The increase in $p^* - p$, perhaps combined with increases in the stress levels $b/p$ and $b^*/p^*$ could have spurred Ireland to err on the safe side and move to almost full deposit insurance. This level of the deposit insurance may have been too high given the actual realizations of $\epsilon$ and $\epsilon^*$.

What about the German reaction of $d = 1$ that followed the Irish choice of $d^* = 1$? The Irish move to $d^* = 1$ means the last term of equation 6 vanishes, that is the move to $d^* = 1$ neutralised the impact of the crisis odd ratio $p^*/p$ of the Irish and German banking sectors. Specifically, if
\[ d^* = 1 \text{ the last term of equation 6 vanishes, and the equation becomes } \max \left\{ \frac{r}{R}, d \right\} \geq 1 - \frac{\varepsilon}{pR}. \]

We have returned to the analysis in Section 3, and specifically Propositions 3 and 4, which have revealed that \( d \approx 1 \) is a rational German response for \( \varepsilon \approx 0 \).

While this story still has issues, for example Germany’s exaggerated response to move to \( d \approx 1 \), we feel the outline of this story has some appeal, especially when considering that the model assumes away potential problem in terms of the credibility of nations’ deposit insurance schemes. There is ample evidence of such unmodeled credibility issues of the deposit insurance scheme during the crisis. The yield spread between Irish and German government bonds spiked during the period of the crisis and has not returned to pre-crisis levels since. The spike in the yield spread has generally been attributed to the potential implicit liability of the Irish government associated with avoiding or reacting to an Irish banking crisis.

Interestingly this analysis shows that according to this version of the story the Irish government’s move to \( d^* = 1 \) was rational even if it anticipated the reaction \( d = 1 \) of the German government. Indeed, the plan could have been to neutralize the implications of a surging asymmetry in terms of the perceived safety of the Irish and German banking sectors, that is to remove the potential effect of the last term in equations 6 and 7.

### 6.3 Depositors Panicked

Consider a change in beliefs where foreign loose agents cease to coordinate on the Home Banking Equilibrium. If the foreign loose “panicked" and coordinated on the Foreign Loose Leave Equilibrium instead it may have made sense for the Irish government to move to full deposit insurance too. Fearing a panic, and in light of its “high" stress ratio \( b^*/p^* \), the Irish government may have avoided the Foreign Loose Leave Equilibrium in which the Irish loose leave Ireland by increasing \( d^* \).

Specifically, if \( d^*_{\text{FLLE}}(r/R) < r/R < d^*_{\text{HBE}}(r/R) \) then the before the crisis both the Home Banking and the Foreign Loose Leave Equilibria with ineffective deposit insurance, where the Irish loose coordinated on the more beneficial Home Banking Equilibrium. If, however, Irish
depositors panicked during the crisis and coordinated on the Foreign Loose Leave Equilibrium then in an attempt to avoid a peril to the Irish banking sector the Irish government may have increased $d^*$ which had the effect of raising $d_{FLLE}^*(d)$ until above $r/R$, thus eliminating the Foreign Loose Leave Equilibrium.

The Irish government was always able to avoid the Foreign Loose Leave Equilibrium by moving to full deposit insurance. Observe from Equation 9 that $d_{FLLE}^*(1) > 1$, which means that the Irish government was always able to avert the Foreign Loose Leave Equilibrium by raising $d^*$ to 1. The response by the German government was student in the previous section.

6.4 Germany’s Banking Sector was in Bad Shape

So far the story line has been that Ireland was hit very hard in the 2008 crisis, while Germany was and stayed a safe haven. However, the German banking sector was in very bad weather as well. For example, Hypo Real Estate, the country’s second largest financial institution after Deutsche bank, was to an unknown but serious extent in financial distress end of September and beginning of October 2008. On 4 October a €35 Bln rescue plan by the German Government and German banks fell apart as reportedly the German bank withdrew their support (Bloomberg 2008a). But it was replaced on October 6 by a €50 Bln rescue package by the German Government and German banks (Bloomberg 2008b).

The German banking sector may have indeed faced a high volume of withdrawals as is suggested by the leading quote. However, these withdrawals did not necessarily result in deposits made with Irish banks, but deposits in banking sectors that were considered to be safer bets, for example the French banking sector. Thus, according to this possible explanation Germany blamed Ireland for doing something itself did too. Consistent with the prediction of our model in this scenario, the French government did not announce to move to full deposit insurance after Ireland, Germany and others such as Austria had moved to full deposit insurance. Unlike in Ireland and Germany, the French banking sector, as the home country in the model, did not need the implicit government support by moving to full deposit insurance. Its own loose depositors
stayed despite the move to full deposit insurance elsewhere in the EU. In fact, according to this scenario the French government was pleased by the move by Ireland and Germany as it avoided foreign depositors to deposit in a French banking sector which was already sufficiently capitalized.

### 6.5 Liquidity Shocks

None of the above changes describe a “beggar-thy-neighbour” explanation for increasing deposit insurance. The foreign deposit insurance is increased to retain foreign loose agents domestically. That this higher deposit insurance might attract home loose agents is an unfortunate side effect. Attracting the home loose increases the cost of providing insurance without changing asset returns. This follows because the failure rate does not continue to fall with deposits after \( D = 1 \). Allowing instead \( P(D) < 0 \) for \( D > 1 \) as well would yield a benefit to attracting deposits from abroad and more intense deposit competition, possibly with asymmetric Nash equilibria. Also, the initial equilibrium might be quite different.

Here we take a different tack to examine a beggar-thy-neighbour policy. Suppose there is a liquidity shock in the foreign country and that the foreign loose depositors withdraw their deposits from the local bank for reasons that are unmodeled (for instance, to hold safe cash, or a transfer to a third country like France). In this case, attracting the \( B \) home loose depositors has the benefit of reducing the probability of failure. For example, if we assume that \( B^* = B \) then attracting home loose depositors reduces the probability of a banking sector failure from \( b^* \) to \( p^* \). Clearly increasing deposit insurance to \( d^* = 1 \) would beggar the home country because if the foreign country is successful in attracting \( D = 1 \) deposits, the probability of loss in the home country would rise from \( p \) to \( b \).

There are two possible banking equilibriums now. In the Home Loose Leave Equilibruim the \((1 - B) \) home loose depositors leave and condition 8 applies:

\[
\max \left\{ \frac{r}{R}, d \right\} \leq 1 - \frac{\varepsilon}{bR} - \frac{p^*}{b} \left[ 1 - \max \left\{ \frac{r}{R}, d^* \right\} \right] \equiv d_{HLL}(d^*) \leq 1
\]
In what we shall call the Home Loose Stay Equilibrium the home loose stay. This would be an
equilibrium if

$$\max \left\{ \frac{r}{R}, d \right\} \geq 1 - \frac{\epsilon}{pR} - \frac{b^*}{p} \left[ 1 - \max \left\{ \frac{r}{R}, q^* \right\} \right] \equiv d_{\text{HLSE}}(d^*) < 1$$

Multiplicity of equilibriums is an issue here as well as we have

$$d - \epsilon_{\text{HLSE}}(d^*) < d - \epsilon_{\text{HLLE}}(d^*)$$

so that between these thresholds the Home Loose Leave and Home Loose Stay Equilibria co-exist. However, the issue of equilibrium selection is a more salient one than before in this case, because sharing

the depositors so that both countries reach a low probability of failure is no longer an option if enough depositors withdraw from the banking sector.

Can a liquidity shock, as modeled above, explain Ireland’s move to full deposit insurance? It

cannot if the liquidity shortage started from Irish depositors withdrawing even if each country

had a strong commitment to attempt to secure one unit of deposits. To see this observe that

d = 1 is a way for Germany to secure the desired Home Loose Stay Equilibrium. (for d = 1 the

former of the two equations above is not satisfied while the latter is). Thus, even if Ireland were
to start off by choosing full deposit insurance, i.e. d* = 1, then Germany could counter with
d = 1 and no depositor would move.

Clearly therefore Ireland’s move to full deposit insurance would be suboptimal. There are a
few ways that can rationalize the move of Ireland in this liquidity shock scenario. First Ireland
may not have anticipated Germany’s reaction and was thinking it could poach enough depositors
to stabilize its banking sector. Germany was on the record of shunning Ireland’s beggar-thy-
neighbour policy and could have mistakenly believed that Germany had a firm commitment not
to change its deposit insurance. Second, Ireland may have had incomplete information about
(German) policy parameters and calculated that mostly likely they were such that the home
country would not response. For instance, Ireland, as a small country, may have thought that
the move to full deposit insurance would poach a small, but sufficient fraction of the German
depositors. It could have also underestimated Germany’s stress ratio b/p. and hence Germany’s
commitment to keep its 1 − B loose depositors. Third, it could be that loose depositors pay a
transaction cost when moving deposits abroad for each direction of the deposit flows. Ireland could have therefore tried to poach loose German depositors who were unaware that Germany would follow suit a week later. If depositors face a cost to move deposits independently of the direction then these new loose depositors that Ireland attracted were captured to an extent, which may explain Ireland’s initiative to move to full deposit insurance. Finally, we assumed in the liquidity shock scenario of this subsection that the $1 - B$ depositors that withdrew were all Irish depositors. Had part of them been German the analysis changes.

7 Conclusion

In this paper we examine how cross-country deposit insurance differences affected the location of international deposits, and whether a disadvantaged country responds to these differences or not. Specifically, we examined the situation in which the government of a foreign country unexpectedly announces an increase from a modest level of deposit insurance to full deposit insurance. This level of deposit insurance is attractive to home footloose agents who initially only have access to a modest level of deposit insurance in the home country. The flight of the footloose stresses the home banking system, in the absence of a response by the home government.

The home government’s optimal choice of deposit insurance can lead to quite different outcome depending on parameters. When the stress ratio is large, for example, it is worthwhile to raise the level of deposit insurance to unambiguously maintain Domestic Banking. In this case foreign deposit insurance acts like a negative externality. On the other hand, if the stress ratio is somewhat smaller, then the optimal response may be to lower deposit insurance which results in either Home or Foreign Banking. Here foreign deposit insurance acts like a positive externality because it raises the return to the home footloose and lowers the cost of providing deposit insurance to the homebound.

Several modeling issues make it challenging to uniquely match the European situation. Multiple equilibria are possible. The low levels of deposit insurance initially prevalent in the European Union can be viewed as the result of a run equilibrium, but is more likely a domestic banking
equilibrium which exists for low levels of deposit insurance provided that the home and foreign banking sectors are similar enough in terms of the risk of a crisis. With high levels of deposit insurance, run equilibria can be ruled out and domestic banking can be supported as a unique equilibrium.

The other feature of the European situation was Ireland’s sudden adoption of full deposit insurance which was followed by Germany a week later. The model shows that joint increases in levels of deposit insurance have the effect of insulating the banking sectors of each country from the effect of foreign competition. In the extreme, with full deposit insurance, depositors do not care anymore about the safety of the local banking system.

The model suggests a number of possible reasons why a (foreign) country would, in the first place, unilaterally increase its deposit insurance from a low level to full deposit insurance. One possible reason is that the banking sector of the foreign country is hit by an adverse shock while the home country is not (or to a lesser degree). However, the problem of the asymmetric shock scenario is that it can only explain Ireland’s drastic move if it overestimated the soundness of the German banking system or the effect of credibility issues with its own deposit insurance scheme. Without one of these additional assumptions Ireland’s move to full deposit insurance was too drastic. Another, perhaps more realistic reason that the model unveils is that Germany’s banking sector was, like Ireland, in dire straights. In the presence of safer banking systems that depositors could move to at low transaction costs, both Ireland and Germany moved to full deposit insurance in order to retain their depositors at home.

It is difficult to justify a move to full deposit insurance with a beggar-thy-neighbour policy. If there are enough aggregate deposits in the two countries the foreign government may increase its insurance to ensure that their citizens deposit domestically. However, the fact that the insurance is so high that it attracts foreign agents is actually a negative side effect, because it makes providing deposit insurance more expensive. If this happens it is by mistake and not optimal according to the model. Can we capture the beggar-thy-neighbour rationale by a liquidity shock in which case depositors withdraw so as to leave too few deposits in the system? It cannot
unless we are willing to make an additional assumption. One possible additional assumption is that Ireland was not aware that the German banking system was in a dire situation too so that it was committed to retain deposits by increasing deposit insurance after the Irish move to full deposit insurance. Another assumption would be that deposits do not have home bias as such but are to a degree captured by the bank or country in which they deposit. Overall, the beggar-thy-neighbour justification is not too convincing. It is much more convincing that the aim of the increase in deposit insurance in each country was to retain depositors by insulating the country from the effect of competition by banks that resided in safer banking systems than Ireland and Germany.
References


