

Comparing Mortgage Credit Risk Policies

An Options-Based Approach

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May 2003



Abstract

Buckley, Karaguishiyeva, Van Order, and Vecvagar analyze the structure of approaches to mortgage credit risk that are now being used in a number of OECD and transition economies. The authors' basic approach is to show how option pricing models can help measure and evaluate the risks of various schemes. They find that:

- Mortgage default insurance can be a cost-effective tool for both improving housing affordability and efficiently addressing some of the rationing that characterizes this market. When correctly structured, as

it is in a number of transition and market countries, this kind of program can be expected to reduce nonprice rationing at an actuarially fair price. At the same time, considerable care must be exercised in the development of such instruments.

" Geographical risk diversification, particularly across borders, can play a major role in the success of these programs. Such diversification could be important not only in smaller transition economies but in EU countries as well.

This paper—a product of the Urban Unit, Transport and Urban Development Department—is part of a larger effort in the department to study low-income housing. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Oumi Himid, room F4K-300, telephone 202-458-0225, fax 202-522-3232, email address uhimid@worldbank.org. Policy Research Working Papers are also posted on the Web at <http://econ.worldbank.org>. Robert Buckley may be contacted at rbuckley@worldbank.org. May 2003. (23 pages)

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Comparing Mortgage Credit Risk Policies: An Options Based Approach

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This work was initiated for a conference on mortgage credit risk that was held in Vilnius Lithuania in Oct. 2001. The conference was co-hosted by the World Bank, the Government of Lithuania, and the Canadian Government. Preliminary simulations were reported to the conference and the results reported here reflect discussions and other presentations at the conference. Van Order and Vecvagare were supported by a Dutch Trust Fund at the World Bank for low-income housing. We thank Mirja Adler, Hans-Åke Palmgren, Andrea Cirman, Achim Duebel, Britt Gwinner, Olivier Hassler, Austin Jaffee, Larry Jones, Eric Klopfer, Alenka Krassing, Kare Lilleholdt, Hans Mersmann, Bertrand Renaud, Bengt Turner, Andreas Trofimovas, Gediminas Tuarjonas, Aivis Reinholds, Judy Sanders and Gerhard Wieringa for comments on earlier drafts and assistance in interpreting the data and behavior of a number of different companies.

I. Introduction

Because of concern with credit risk and information problems, lenders ration mortgage credit. They do this mainly in two ways: first, they limit access to credit only to those able to afford to make significant down payments; and second, they limit eligibility for loans to those able to pay less than a specific share of their income for repayments.¹ This rationing may make mortgage lending more prudent, but at the same time it also reduces the welfare of those who are rationed out of the market by non-price means. For instance, Schmidt-Mohr (1997) argue that lenders' reliance on high down payment lending can be a very costly as well as regressive way to solve the informational problems associated with such loans.

Reliance on rationing to determine loan eligibility arises because of lenders' reluctance to lend against borrowers' future income, or, alternatively, borrowers' inability to pledge their human capital. It also arises because mortgage credit risk is largely driven by the behavior of house prices so that the risk is geographically concentrated. As a result, lenders, and particularly those lenders with geographically concentrated mortgage portfolios, in effect, purchase prudence by allowing only those with accumulated savings access to credit.²

Such rationing characterizes mortgage lending in most countries. Indeed, outside of the five transition countries that we examine down payments of 40 percent or more of initial house value is the situation in most transition economies. A similar if not as extreme situation also characterizes lending in many OECD countries, and it has generated a variety of subsidy and insurance schemes to help address the costs posed by this rationing, particularly for first-time homebuyers.³

In general two types of public policy solutions that have been developed. One is to provide subsidies for households so that they are able to save enough in a second mortgage to "top up" the low loan-to-value ratio loan they can get from banks. The other is the provision of default insurance whereby borrowers pay an insurance fee to be able to borrow loans with larger loan to value ratios.⁴ One of the questions we address is: how do these approaches compare as

¹ The first type of constraint rations those households without savings from homeownership. The second rations out those households who have enough savings for the down payment but cannot satisfy the payment-to-income constraints lenders use to qualify borrowers. An extensive literature indicates that in the U.S. and U.K. the first constraint is more binding. It is also the case that lenders ration based on borrower credit history, which in the U.S. is increasingly important.

² The potential macroeconomic consequences of such rationing have also long been a subject of discussion. For instance, in his Nobel Lecture Akerlof (2002) discusses credit rationing as one of the information problems that can have significant macroeconomic consequences.

³ Hendershott and White (2000) discuss various tax subsidy schemes used in Australia, Canada, Germany, Sweden, Ireland and the U.S. Other public programs are operative in the UK, France, Norway, Finland and Denmark. These latter programs are discussed in Turner, Whitehead and Jakobsson (2000).

⁴ The most frequently used homeownership subsidy scheme to subsidize second mortgages is the Bausparkassen savings scheme used in Germany, Austria, and France. This scheme takes a number of forms but generally first provides subsidies to young families to save for a number of years, and then provides them with a subsidized loan to top up their mortgage loan. This subsidized loan is for a multiple of the amount saved. The objective is to use subsidies to encourage savings for larger down payments so there is less need for a second loan, and then to subsidize the higher costs of the second loans. Besides default insurance and subsidies as ways to address rationing another approach to address the rationing problem has been proposed by Case, Shiller, and Weiss (1993). It

ways to address the non-price rationing that characterizes mortgage lending? For transition countries this question has some currency because six of them have recently adopted the subsidy approach while five have opted for public provision of default insurance.⁵ In addition, both approaches are now under consideration in other countries, such as Russia, Mexico, and India.

In the five transition economies we review —Estonia, Kazakhstan, Latvia, Lithuania, and Slovenia—the public sector plays a major role in insuring mortgage default, as it does in almost all the OECD countries where it operates.⁶ Hence, direct public sector bearing of mortgage credit risk is a wide-spread phenomenon in both market and newly-emerging transition countries.⁷ Accordingly, a second topic addressed here is how to measure and monitor the public role in the provision of this service.

We address this latter topic at some length because while public provision of insurance can help complete markets and lower credit costs, it can also entail major risks or implicit transfers if the institutions do not manage and price risk properly. The factors that determine which result is obtained are: the reserves held and mortgage insurance fees charged, and the riskiness of the environment. That is, does the company have sufficient capital and charge prices for the guarantee such that the government risk-bearing is fully compensated?⁸ Moreover, if the government risk-bearing is not fully compensated how does the government account for the guarantee in its budget so that public risks are controlled, and any service provided at a price less than cost is treated as a subsidy?

In addition to its fiscal effects, insurance program structures can also be important because of the indirect effects they can have on a country's financial sector development.⁹ For

involves establishing an index-based futures market and options for house prices. This approach has recently been developed in London, see Iacoviello and Ortalo-Mague (2002).

⁵ Bausparkassen subsidy schemes have been introduced in Croatia, the Czech and Slovak Republics, Hungary, Poland, and Slovenia. Public default insurance operates in Estonia, Latvia, Lithuania, and Slovenia. In Kazakhstan the public sector has capitalized a company that will begin operating soon, see Merrill and Whitely (2002).

⁶ OECD countries with publicly-sponsored default insurance include Belgium, Canada, Sweden, the Netherlands, Finland, France, the U.S. and the U.K. The U.S., U.K., Israel, and Canada also have private insurers. In addition, as of September 2002, Spain, like Australia, has only a private default insurer. There are also often public limitations on the provision of private default insurance. In the U.S., for instance, private insurers were prohibited until 1956 following the bankruptcy of the industry during the Great Depression. The strong performance of the public insurer, FHA, led to their re-establishment. See Blood (2002) for a fuller discussion of the terms under which default insurance is provided in OECD countries, and the European Mortgage Federation (1989) for a somewhat dated discussion of many of the details of mortgage-related insurance in a number of European countries.

⁷ Even where there is no direct public role in bearing credit risks, as in Germany, there is often a significant indirect public role. For example, where large loan-to-value mortgage loans are made without a direct guarantee, as is often the case in Germany, there is still frequently a significant public role in mortgage credit risk bearing due either to the public ownership of the banks providing the loans, the regulations on higher risk-weighting for high loan-to-value mortgages, or the guarantees provided to banks by the German Development Bank, KfW. See Schuder (2002) for a discussion of the last approach.

⁸ This is the approach to regulation of Fannie Mae and Freddie Mac, the two large U.S. secondary market institutions, by their regulator, the Office of Federal Housing Enterprise Oversight, OFHEO. See the *OFHEO Report to Congress (2001)*.

⁹ Government involvement in mortgage markets can be an important impediment to financial sector development because of the scale of public support and the fact that this support is often provided in non-transparent ways, see MacLennan, Muelbauer, and Stephens (1998) for a discussion of mortgage credit policies in market economies, and Struyk (2000) for a discussion of transition countries.

example, is it the case that an ongoing public role in the industry is warranted—as some have argued based on the failure of private insurers in the U.S. and Canada during the Great Depression—because the risk is uninsurable?¹⁰

Similarly, in the case of the EU countries, how do national mortgage policies affect lenders' ability to exploit the geographic diversification possibilities that can arise now that there is one large single currency market? For instance, do various individual country guarantees create competitive distortions in the broader EU market as has been suggested by the European Banking Federation?¹¹

Finally, due to the smaller geographical size of the transition countries that have adopted the insurance approach, there may be gains that can be obtained from shedding some portion of this risk across larger geographical areas.¹² How can these smaller markets create a regulatory environment that is both prudent and welcoming of more risk-bearing by more geographically diversified institutions? More generally, given the very recent and often piecemeal emergence of de novo financial sectors in all of the transition countries it is important to achieve a better understanding of how small economies' macroeconomic risks can be most effectively allocated, monitored, and controlled.

In sum, a better understanding of the scale of public sector involvement and government regulation of mortgage credit risk allocation should be of immediate interest to policy-makers in both the transition economies as well as those of the European Union. In both cases a better understanding of the public role in mortgage credit risk allocation would help establish a level playing field across institutions, as well as a regulatory environment which would allow lenders to allocate risks to those with a comparative advantage in such risk-bearing.

¹⁰ Among others, see Foster and Herzog (1981), Pennington-Cross and Yezer (2000), and, according to the European Mortgage Federation (1988), it is the view of German credit institutions.

¹¹ In 1999 the Federation lodged a formal complaint with the European Commission against the system of public guarantees for Landesbanken and savings banks in Germany.

¹² Macro shocks can have significant effects on financial sector stability and public contingent liabilities. For example, as shown by Caprio and Klingebiel (1996), in the past fifteen years the banking sectors of more than 58 countries became technically insolvent often with large public costs. Mortgage credit risk is a particularly important aspect of risk distribution in geographically small countries because in such countries there are not as many distinct housing markets so that these risks cannot as easily be hedged across markets. For example, as discussed further in the text, Quigley and Van Order (1991), show that variations in regional mortgage default rates in the U.S. are both considerable—they vary by a factor of five across regions—and are negatively correlated, indicating strong geographical diversification possibilities

The plan of the paper is as follows. In the next section we discuss how a version of Merton's (1973) options model pricing of deposit insurance guarantees can be applied to mortgage credit insurance and mortgage credit risk regulations. Then, in section III we apply the model to the terms and conditions of 12 forms of insurance now in use in 9 countries and discuss the relative risks of the various programs. Section IV considers some of the complications that arise in exercising the underlying options that affect the pricing of these institutional guarantees. It presents empirical results from the U.S. to demonstrate how these complications can affect both the default behavior of individuals and the estimates of the guarantee fees needed for financial soundness. Based on these results, in section V, we review a number of policy questions. A final section provides a summary and conclusions

II. Guarantees of Financial Institutions as Options.

Based on Merton's application of the Black-Scholes option pricing model, a financial institution with asset value V uses debt financing in the form of a zero-coupon bond issue. At the maturity date of the bond, T , the firm owes B dollars to the bondholders, and in the event of default the firm must forfeit its assets. We recognize the implicit option with the following observation: at maturity T , if the value of the firm's assets, V , is greater than the value of the bond, the firm will pay the bondholders B and net $V-B$; alternatively, if the value of the firm's assets is less than the value of the bond, the firm will default. In this case, the bondholders will claim V , and the firm's equity will have zero value.

If the firm purchases a third-party guarantee, directly analogous to the deposit insurance modeled by Merton, ensuring that the value of the debt remains constant at B , we can use option-pricing theory to value the guarantee. If the value of the firm is less than the face value of the bond, the firm will act as before, paying bondholders B and netting $V-B$. In this case the guarantee has value zero. However, in the event of default, the guarantor will pay the difference between the value of the debt and firm equity ($B-V$) to the bondholder. Thus, the guarantee has value $\min(0, B-V)$, a non-negative value. This valuation of a bond guarantee is identical to that of a put option with stock price " V " and exercise price " B " and absent the guarantee it can be thought of as the discount on the firm's zero-coupon bonds due to credit risk.

From the firm's perspective the debt guarantee is a put option that gives it the right to sell its assets " V " at price " B " at an exercise date identical to the maturity date of the bond. The value of the option is governed by the volatility of the value of the firm's assets. Thus, the traditional Black-Scholes pricing equation can be used to evaluate the implied assumptions about how risky the environment is seen by the firm or the firm's regulators, i.e. what is implied volatility of the firm's asset value. This is given by

$$G(T) = Be^{-rT} \Phi(x_2) - V\Phi(x_1)$$

where :

$$\begin{aligned} x_1 &\equiv \left\{ \log(B/V) - \left(r + \frac{\sigma^2}{2}\right)T \right\} / \sigma\sqrt{T} \\ x_2 &\equiv x_1 + \sigma\sqrt{T} \end{aligned} \quad (1)$$

where V is the current value of the assets of the firm, T the maturity date, σ^2 the variance rate per unit of time for logarithmic changes in the value of assets and $\Phi(x)$ the cumulative normal distribution.¹³

The same concept can approximately be applied to mortgage guarantees both on an institutional and individual basis. First consider the institutional guarantee.

In the case of a publicly-owned or sponsored mortgage insurance company, the government guarantees availability of additional resources to cover any shortage in the insurance company's capital. In the case of a mortgage insurance company it has liabilities ("B") to mortgage lenders in the event of a borrowers' default and it has assets ("V") in the form of capital. Because the capital is more or less fixed as a set ratio to the insurance in force, the government, as a guarantor of the insurance company, is concerned with the volatility of claims from the mortgage lenders to the insurance company.

Lenders' claims, on the other hand, are determined by the default of the insured borrowers. The risk of this default, however is determined largely by the households exercise of their individual default option. Hence, in effect, the government guarantee is an option (the insurance company's put) on a borrower's option (the homeowner's put) and rigorous evaluation of the risks would require the pricing of an option on an option, a quite complicated mathematical model.

But, the complications are not only computational. For example, non-quantifiable differences in legal recourse also matter in determining how ruthlessly or even whether the household exercises its default option.¹⁴ In addition, borrowers are also affected by the constraints on their ability to exercise another option embedded in the mortgage—the prepayment option, and these constraints on the prepayment option are quite different. In some countries, such as Germany, prepayment is effectively not an option, in most other countries is in an option that can in some cases be explicitly purchased while in others various forms of this option are embedded in the loan terms. Finally, as we discuss further in section IV, the borrowers' default option is also characterized by asymmetric information in which individuals know how much value they place on the indirect costs of exercising the option and the insurer does not.¹⁵ In a word, then, it is not at all clear that such modeling is worth the candle. Nevertheless, with a number of simplifying assumptions we can make direct and conservative estimates of the value of the government's guarantee for specific economic environments, or alternatively, for given guarantee terms, we can infer just how volatile an environment is assumed by regulators.

¹³ This methodology can be extended to more complicated options, for instance options that extend over several periods. However, for the purposes of this paper use of only one period was found to be sufficient. It is well known that the solution to models, such as equation (1) have the intuitively pleasing property that the value of the option is the risk-adjusted expected present value of the costs of the option. This result allows for practical solutions to complicated options via simulation techniques, such as "Monte Carlo" models.

¹⁴ See Jones (1993) for analysis of the significant effects that legal differences with regard to recourse in two Canadian provinces have on default behavior.

¹⁵ See Jaffee and Stiglitz (1990) for a review of this literature.

Our first simplifying assumption is to ignore the cohort effects that can arise over time. In other words, for simplicity, and following the approach taken in Case and Shiller (1996), we assume that the insurer's portfolio is represented by an average loan-to-value ratio for loans which all have the same down payment, were originated at one point in time, have the same amortization schedules, and whose prices move together. This approach prohibits the higher than average earnings (as well as losses) from past cohorts to fund new insurance, see Capone (2000) for a discussion of these effects. It could also affect the relative rankings in the table depending upon both the volatility of a country's growth trend and the degree of international diversification of its financial system. We nevertheless made it because of the computational difficulties in inferring how much inter-temporal and international diversification a country might have. We note, however, that this assumption will tend to make our estimates more conservative.

We also assume that the amount of negative equity realized by firms when a default occurs differs for firms providing insurance for 100 percent of loan balance and those providing first coverage insurance for less than the full loan amount. For insurers providing less than 100 percent insurance, i.e., those co-insuring risks, we assume that the losses realized will be equal to the full amount of the insurance in force, that is 20 to 30 percent of the insured amount. For firms providing 100 percent coverage we assume that the loss will be about 50 percent of the insurance in force. This assumption is made to take into account lenders being more likely to select against an insurer, and particularly a public one, which provides 100 percent coverage, as has been observed in the U.S. by Pennington-Cross and Yinger (2000).

Finally, we assume that there are no legal differences with respect to loan recourse in the event of default and the ability to prepaid loans are identical across countries. With these assumptions, we can formalize how the price charged can affect government transfers. In terms of the Black-Scholes formula, public transfers arise when the value of the mortgaged housing and the insurance company's capital is less than the value of outstanding loans. The probability of exercising this option by the insurance company would be almost non-existent if it had sufficient equity, i.e. if capital and insurance fees were such that the *ex ante* price of the institutional guarantee is approximately zero.¹⁶ In this case there is no subsidy since the expected losses are close or equal to the insurance company's capital. In contrast, a positive option price indicates the premium that the government should charge the mortgage insurance company for its backing.

The above also implies that the present value of insurance fee and capital ("G") for the insurance company should equal the expected present value of losses. More generally, because of the expected present value interpretation of the option pricing model G must be such that:

$$\sum_{t=1}^N \frac{G}{(1+r)^t} UPB_t = \sum_{t=1}^N \frac{E(L_t)}{(1+r)^t} UPB_t \quad (2)$$

where UPB_t is the unpaid balance on the pool, r is the appropriate risk-adjusted discount rate, N is the term of the mortgages in the pool and $E(L_t)$ is the expected loss per dollar of UPB at time t .

¹⁶ It is straightforward to show that, given V , the value of G in equation (1) goes to zero as B goes to zero.

Under these circumstances, the government backing of the mortgage insurance program would involve no direct costs to the government because fees and capital would be sufficient to cover the expected losses.

III. The Implied Risks of the Mortgage Insurance.

Using the methodology described above, we use the specific terms of 12 mortgage insurance programs in 9 countries to estimate the assumed volatility or riskiness of each program. The results are presented in Table 1. Under this approach the government—either as a guarantor or a cost-minimizing regulator—sets the regulations so that the costs of risks are covered by the fees generated.

In our calculations we use an American put option with a term of one year, although changing the term to 5 or 10 years does not affect the relative rankings. We also aggregated the up-front fee and the annual fee into an annual income measure, and assume that these “dividends,” in their entirety, along with reserves, would be used to pay off loan losses. Finally, because we are focusing on one specific instrument in each country rather than a range of, for example, different down payment requirements, the likelihood of the insurer realizing losses is most fundamentally affected by the maximum insurance-in-force to capital ratio that is allowed.

The Table 1 presents the results and basic characteristics of the different programs. In the market economies, the loans discussed are 30 year, 5 percent down-payment fully amortizing mortgage loans and in the Baltic countries and Kazakhstan the loans are 15 year serial loans with 10 percent down payments.¹⁷

Columns 2 through 6 describe the programs’ basic terms. The penultimate column of the table shows the results of solving equation (1) for the implied volatility. The last column presents a relative ranking of the perceived riskiness of the policies with (1) being the safest, and (12) being the riskiest. As can be seen from the table both capital requirements and premiums differ considerably across the countries, and correspondingly, so do the implied volatilities.

Before reviewing our results, it is perhaps useful to once again clarify some of the caveats that limit the inferences that can be drawn. It is, for example, not possible to control for all the differences in the terms of insured loans, legal and judicial infrastructure. In addition, the estimates of volatility are for a portfolio of loans rather than an individual loan. The point of the exercise is to give a relative ranking. Therefore, rather than trying to determine whether the riskiness of the program is under- or over-estimated, we use the results to pose questions: For example, given some perspective on how risky is a country’s economic environment, how safe does a program appear to be?

¹⁷ While it is possible to borrow for maturities of up to 30 years in all of the transition countries in practice most loans are of much shorter term. See the annex for a fuller discussion of the sources of information and details on the program structures. We did not evaluate a Slovenian program that insures loans provided by a publicly-owned insurer for indexed loans. There is some question whether these loans are legally mortgages, reducing the underlying collateral strength for the insurance. See Buckley and Gilbertson (1999). However, when these features are combined with the loans very slow amortization, due to the indexed repayments, it is likely that this is among the riskiest of the programs. Nor did we evaluate a Finnish program operating since 1996 for reasons described in footnote 18.

Table 1. Mortgage Insurance Terms and Implied Risk.

	Insurance in force-to-capital ratio	Premium as an upfront fee	Premium as annual interest payment	Claim coverage	Maximum loan to value ratio	Implied volatility	Rank
1	2	3	4	5	6	7	8
Canada	57	3.75%	0%	100%	95%	2.3%	9
Estonia	10	3 – 3.5%	0%	24%	90%	4%	3
France	28	2%	0.15%	100%	100%>	3.4%	6
Kazakhstan	20	4%	0%	20%	85%	2.6%	8
Latvia	2	0%	1%	22%	90%	18.8%	1
Lithuania (old program)	12	7.78%	0%	100%	95%	5.8%	2
The Netherlands	227	0.3%	0%	100%	100%>	1.4%	11
Sweden (old stock)	∞	0%	0.5%	30%	100%>	0%	12
Sweden (new stock)	62.5	0%	0.5%	30%	100%>	1.66%	10
USA Financial Institutions	33	0%	0.07%	100%	80%	3.1%	7
USA Private Insurance	11.2	0%	0.5%	20%-30%	95%	3.8%	4
USA Public Insurance, FHA	25	1.5%	0.5%	100%	97%	3.5%	5

(The implied risk-free annual interest rate used in the calculations is 6 percent. See description of insurance companies and data sources in Annex 1)

In particular, how do the program terms in one country compare with those in other countries? Does it seem likely that a program is providing implicit subsidies or contingent liabilities for the government and/or households? And if it provides subsidies, are they accounted for in the budget?

It may also be appropriate to consider whether the rankings in Table 1 are intuitively plausible. Perhaps the simplest way to answer this question is to look at the pre-1997 Swedish program which is ranked as the riskiest of all the programs analyzed. It is also the only program analyzed that has realized losses after operating for more than a decade. Hence, while risk exposure is also affected by factors other than just the regulations governing risk exposure, e.g., the scale of the shocks experienced, the poor performance of Sweden is at least consistent with

the results of our analysis.¹⁸ That is, all other things being equal, it would be the program that the model would predict to be the one with the highest probability of losses. Given the apparent strength of the Swedish insurer's legal recourse we cannot say how these risks will ultimately be shared between government and households, but based on past experience, it is clear that under the current program the government is by no means insulated from risk exposure.

Another perspective on whether the estimates are plausible is provided by comparing the implied volatilities with experience. The estimates for the U.S. in column 7 suggest that with a standard deviation of the average house price of approximately 3.5 percent the programs would be financially sound, as independent analyses of the soundness of FHA, by Capone (2000) and of private insurers, cited in Capone, indicate they are. Certainly, the standard deviation of individual house values in the U.S. has been considerably higher; in fact, according to Case, Shiller, and Weiss (1993), it has been closer to 10 percent, suggesting that the estimated volatility is much too conservative.

However, recall that the volatility estimate is for the entire portfolio, and the U.S. has the geographically largest and most diverse mortgage market. Consequently, it would not be surprising if the portfolio's standard deviation was much lower. In fact, data on U.S. house prices collected by Freddie Mac, a U.S. secondary market institution, over the 1975 to 2001 period indicate that the standard deviation of the average national house prices has been 3.3 percent. Thus, again, the estimates are broadly consistent with the empirical evidence.

Now consider the three riskiest programs depicted in the table, i.e., Sweden's pre-1997 program, its current one, and the Dutch program. In the Swedish cases the insurance in force is backed by a 100 percent government-owned company so that even if the company formally held no capital the guarantees would still be a public obligation.

The Swedish regulators did not see their pre-1997 program as being subsidized, although it is doubtful that they thought that the program was a sound financial policy either, as the program ultimately realized losses of over \$700 million.¹⁹ Nevertheless, in many ways what is more important than whether regulators got the prices right is whether they were at all prepared for possibly getting the prices wrong. In the pre-1997 program it appears that they were not. Before the losses were incurred, the program was not budgeted as a subsidy program. Hence, what appears as one of the riskiest programs, as well as one that incurred significant government costs, was seen as neither subsidy nor strictly as finance.

¹⁸ In some ways it is possible to look at the pre-1977 Swedish program as a switch from a *bauspar*-like subsidized second mortgage to an insured larger first loan. So, even with subsidies, it may still have been more cost effective than its predecessor as a way to address mortgage rationing.

¹⁹ Sweden's losses in the 1990s are the result of the interaction of a number of factors besides the program's structure, as detailed in Hendershott and Turner (1994). In the Swedish case no capital was held. The contrast of the Swedish and Finnish programs is also interesting. The Finnish program charges an up-front fee of 2.5 percent, and instead of holding reserves against insurance in force, places an annual figure in the budget to cover losses. No losses have realized beyond fees collected as of yet. Finland's program is not evaluated in the table because of the variations in the annually budgeted liability structure. However, the framework developed here could be used to evaluate the adequacy of the budgeted funds.

Of more prospective concern, however, is what the rankings in Table 1 suggest about the Dutch and the current, restructured Swedish programs. The Table indicates that they both have much lower prices and a relatively risky reserve structure, one which could eventually be costly for either their governments or those who have purchased the insurance. The former program has operated in its current form only since 1995 (see Mersmann (2001)), and, as a result, has not yet been in operation during an economic downturn. Nevertheless, it already has 40.9 billion euros of insurance in force, an amount equal to 4.7 percent of GDP. Consequently, given its pricing and capital structure, it appears to represent a significant contingent liability for either the Dutch government or those insured.²⁰

For example, the model indicates that for the programs in both countries to be operating without subsidy, they can tolerate a volatility in house prices, column 7, that is less than half of that of the U.S. For such a result to be realized, however, either the implied volatility of asset prices must indeed be less than half that of the more geographically diversified U.S. market, which it is not, or the insurer must have greater recourse to the borrower's non-housing assets and income, as they do in both countries.²¹ Thus, to the extent that stronger insurer recourse complicates direct comparisons between the U.S. and these countries as to the likelihood of default, the difficulty arises largely because the insurers' relatively stronger financial position in the European countries occurs by increasing borrowers' risk exposure. Thus, to the extent that the Dutch and Swedish insurers' exposures are not considerably higher than is the case in the U.S., it is so not because of program design but rather because households are more exposed themselves to macroeconomic shocks. So, ultimately, the model still points to concerns about the optimality of government policy with respect to the allocation of risk.

It also suggests that these programs do not really provide default insurance. Rather, as long as the insurer has full recourse to the borrower's future income, then the insurance provided is more like a guarantee of timely payments from households to financial institutions rather than default insurance. With full recourse, it is the household rather than the insurer who at least nominally bears the full risk. In this case the guarantee offered is similar to the guarantees provided by Ginnie Mae in the U.S., except in Ginnie Mae's case, recourse is against other financial institutions rather than under-diversified households.

The second insight yielded by the comparison of prices and capital is that the Baltic countries follow a more conservative, and in case of Latvia, much more conservative policy, than do the other countries. In fact, according to the estimates in Table 1, the Latvian guarantee can withstand more than five times the volatility of the French program, and more than thirteen times

²⁰ The Dutch insurer permits the ratio of insurance in force to reserves to be more than nine times larger than that of the U.S. public insurer, FHA. At the same time it charges insurance fees that are a fraction of those charged by insurers elsewhere. It should be noted, however, that unlike the FHA program, the Dutch insurance amortizes over 20 years. That is, over time, an element of co-insurance is built into the program.

²¹ In the next section we discuss the effects that indirect costs can have on the likelihood of default. For instance, Hendershott and Turner (1994) discuss the important effects that the laws regarding recourse can have on potential defaulters' costs and decisions in Sweden and the U. S. In the U.S. insurers rarely seek recourse against future household income, and in some states, such as California, cannot do so, using only the house value as collateral. In many European countries, such as Sweden and the Netherlands, lenders, as a matter of course, seek recourse against borrowers' future earnings. However, as mentioned above, under the old Swedish program, it does not appear that the insurer sought or was able to realize full recourse.

that assumed by the Dutch company. Of course, due to the combination of the size and openness of the latter economies and their small geographical size, the risk exposures of the Baltic countries should be considerably more pronounced than those of France and the Netherlands.²² So, at least at first glance, their conservatism is appropriate.

Disaggregating Freddie Mac's data to look at performance across U.S. states can also provide some perspective on the reasonableness of the pricing for smaller countries with less geographical diversification. The standard deviation of state house prices in the U.S. was double the nationwide level, i.e., 6.6 percent. If we assume that smaller countries have similar experiences as U.S. states, which have populations ranging from about half a million to over 30 million and a median size of slightly less than 5 million, then at this level of volatility only the French program and the proposed Latvian plan would be financially viable. Indeed, if U.S. state level volatility experience is used as a crude estimate of how risky the environment might be in a country like the Netherlands, then the model indicates that price of the option there would be on the order of 84 basis points per year rather than the one time 30 basis point up front fee; a more than 15 fold increase in price is needed to become actuarially sound so that they do not encourage Dutch households to perhaps unwittingly expose their future earnings to house price risks.

IV. Individual Mortgage Guarantees as Options.

In addition to the literature on viewing government guarantees as options there is also an extensive literature that views the household default decision on a mortgage in much the same spirit, albeit in a more complicated framework (see among others, Campbell and Dietrich (1983), Kau, Keenan, Muller, and Epperson (1990), and Case and Shiller (1996)). The options perspective on default is an attractive concept both because of its disarming simplicity, and because, in the U.S. at least there is empirical evidence that household default decisions are consistent with it.

However, as Deng, Quigley and Van Order (2000) show, there are also obvious concerns with a theory that posits that families behave like financial arbitrageurs. They find more variation in behavior across borrowers than the "ruthless" option model would suggest, and internal research at Freddie Mac has found great predictability from borrower credit history. Indeed, most studies suggest that the household default decision follows a pattern of what might be called "a high transaction cost" option, where the costs of default to households include not only whether their option is in the money, but also such important considerations as the dollar and psychic costs of moving, the value households and the legal code assign to attachable assets, and importantly, their future credit rating.²³

In sum, considering how the individual household decision affects overall portfolio risk exposure shows that more empirical content than just house prices and the value of outstanding

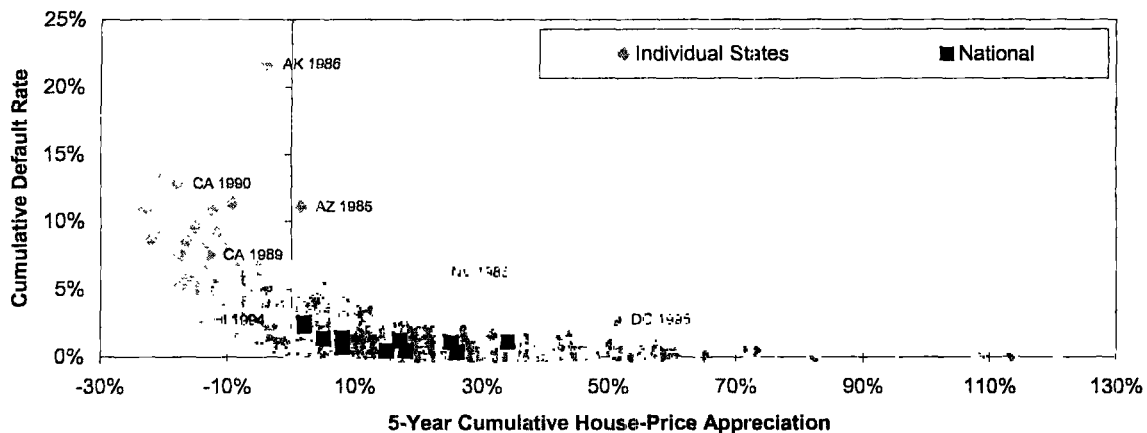
²² While the Netherlands is smaller in size than any of the three Baltic countries, it has more than twice the combined population of the three countries. Hence, it's population is spread over more distinct housing markets.

²³ Cunningham and Hendershott (1984) estimate that in the U.S. these indirect and often intangible costs of exercising the default option may be worth as much as 15 to 30 percent of house value, and these costs are undoubtedly higher in countries where lenders have recourse to borrowers' earnings.

loan balances is needed to make accurate estimates of risk exposure. As shown in Figure 1, the fact that the individual's default decision is so difficult to predict helps explain why lenders ration mortgages in the first place. The figure presents U.S. default data from Freddie Mac for loans originated from 1985 through 1995.

Figure 1

Default Probability vs. House-Price Appreciation
State/Origination Year and National/Origination Year Cohorts (1985-1995)
80% Loan-to-Value, 30-Year Fixed-Rate Home-Purchase Mortgage



Consider the light colored diamond points. Each of these points represents the default experience for 30-year, fixed-rate loans with 79 to 81 percent loan-to-value ratios originated in a particular year in a particular state. The horizontal axis depicts cumulative house price growth in the state for the first five years after loan origination, and the vertical axis shows the percent of the loans that defaulted. For instance, the point labeled “CA 1990” shows that for the loans originated in California in 1990 subsequent house price growth was around minus 15 percent and about 13 percent of the loans defaulted. The scatter looks like what the option model would predict. That is, when a large majority of the states had positive growth, the option was seldom in the money and default rates were quite low.²⁴ But, when house prices fell default accelerated sharply.

The dark squares depict the same thing for the nation as a whole. Thus, the figure shows the difficulty of controlling default risk, especially for lenders in places where house prices are apt to fall or where low down-payments put equity at risk. It shows that the “knuckle” in the default curve—that is, the point after which default rates fall off—implied by the figure is not easy to pin down precisely, adding considerable uncertainty to the income of the lender. Absent good information or the ability to diversify geographically, the incentive is for lenders to try to stay away from the knuckle, by requiring large down-payments. This strategy shifts the effects of a price decline to the right in the figure, so as to remain in the safer, flatter, and easier to price

²⁴ Note that the figure uses only statewide means. Even if the mean is positive some will have declines and some of those declines will be big enough to put the option into the money.

range of the curve. In short, given the complexity of determining how households will behave, lenders have strong incentives to ration by down payment.

V. Using the Options Model to Consider Some Public Policy Issues.

A. The Efficiency of Mortgage Insurance versus Down-payment Subsidies.

Given the difficulties in precisely calculating risk exposure, as suggested by Figure 1, and the evidence that mortgage rationing is common even in well-developed financial systems, there would appear to be a public sector role in bearing such risks. Such insurance could be a relatively efficient way to address the incomplete markets caused by credit rationing. However, for many European countries the relevant question is how does the efficiency of the insurance approach compare with the widespread alternative of providing subsidies for the second mortgages needed to fund the large down payments?

The simplest answer to this question is which approach is more cost-effective. That is, if the risk can be profitably borne, the insurance approach would have to be more cost-effective than are approaches, such as *bausparkassen* savings subsidy schemes, which require government expenditures to address the same rationing constraint.²⁵ The evidence for the U.S. is that this risk has indeed been borne at prices that have generated a growing and profitable industry. In fact, the prices and capital requirements for U.S. private insurers given in columns 3 and 4 in Table 1 are sufficient to earn an AA or a better credit rating for most mortgage insurers, see Capone (2000). Similarly, a number of other analyses indicate that the fees reported in Table 1 for the U.S. public company, FHA, are also self-sustaining.²⁶

Thus, where this risk is borne at prices sufficient to maintain financial soundness, default insurance is, by definition, a more efficient way to provide financing for the “top up” loans needed by many young families.²⁷ Moreover, even where an insurer conveys subsidies, as the Dutch and Swedish programs appear to, they may still be more efficient than are the interest subsidy programs. Models such as the one presented here allow the size of the subsidy to be inferred and so provide a way to make such relative efficiency comparisons.

²⁵ See Lea and Renaud (1995) for a discussion of the German and French systems and the possible applicability of these subsidized savings systems in transition economies.

²⁶ After experiencing a very turbulent period in the 1980s, FHA undertook a broad review of its programs, which showed that financial soundness required significant price increases. These increases were implemented and over the 1990s performance improved sufficiently so that the price increases were partially rolled back in 2000. See Capone (2000) for a fuller discussion of FHA’s historical experience and the rating of private insurers in the U.S. Private insurers in the U.S. and Canada also experienced difficulties during this time period. For instance, four troubled private companies were bought out by a U.S. company at this time.

²⁷ Greater efficiency would be realized because actuarially priced insurance would entail none of the deadweight losses implied by government subsidies caused by providing in-kind transfers that are valued by the beneficiaries at less than a cash grant of the amount of the subsidy. The transparency and targeting of assistance would also be improved with insurance because, as shown by Diamond (1999), it is difficult to calculate the value of the subsidy provided under many of the savings subsidy schemes. In the case of the guarantee only those who were willing to pay for it would make use of it.

This approach also provides a broader prospective on how a default insurance program fits within a country's broader financial sector strategy. For instance, compare Poland's housing finance assistance strategy with that of some of the countries that have opted for an insurance approach. Poland, with a population of almost 40 million and with more than 90 cities with populations in excess of 50,000, i.e., a country with considerable geographic diversity, has so far chosen to address mortgage credit risk concerns through the provision of subsidies for savings for second loans rather than through the use of guarantees. In contrast, the Baltic countries with a combined population less than one fifth of Poland's, and far fewer separate housing markets, have chosen not only a guarantee approach but guarantees that are geographically concentrated across the limited number of real estate markets within each country. The efficiency of both approaches could be improved, and, as we discuss next, the options model approach can give a sense of how various strategies can affect the efficiency of the approaches used.

B. Diversification of Mortgage Credit Risk: Implications for Small States and the EU.

Figure 1 shows the importance of geographical diversification. It depicts the incidence of default and house price appreciation in the U. S. across states and shows that most of the time for most states defaults are rare, but every once in a while they are huge. Huge enough to generate bankruptcy for institutions with low capital levels. For example, in Case and Shiller's (1996) analysis of the house price crash in the Greater Boston Area, an area with a population of 3 million, similar to that of the Baltic countries, in three of sixty-four locations foreclosure sales alone accounted for 50 percent of sales, even though total foreclosures never exceeded 2 percent of loans.

On the other hand, the dark squares in Figure 1, which depict the U.S.'s national experience, are much more closely bunched within the range of state experience. The national rate has not come close to the worst experience of the states. As mentioned earlier, in the U.S. the standard deviation of house prices nationally has been half that of states, and the range of state standard deviations for the latter has been between 2.3 and 23.7 percent. These differences between national and state level results are not too surprising because since the Great Depression there has not been a period when average house prices in the U.S. nation wide declined, whereas such a decline has occurred periodically in a number of different regions and European economies. In short, the gains from geographical diversification would appear to be large.

Now consider recent policies in the transition countries and the EU in terms of how they affect the ability to exploit these gains.

With the exception of Kazakhstan, all the transition economies analyzed are geographically small, and with populations between 1.4 and 3.7 million.²⁸ The Baltic countries, for instance, are smaller than most of the states depicted in the figure. Hence, they can be expected to have at least as pronounced a "scatter" as is depicted for individual states there. The obvious way to

²⁸ Housing privatization in the transition countries, under close to giveaway terms, has resulted in homeownership rates of 90 percent in Estonia, Kazakhstan, and Lithuania, and more than 85 percent in Slovenia, which privatized early and rapidly, and over 70 percent in Latvia, which is now completing its housing privatization program. They all also have relatively high GDP growth rates and low inflation, and privately-supplied mortgage finance is now growing rapidly

reduce the “scatter” and lower risk exposure and capital requirements for such intermediaries is through geographical diversification, and there are two ways such diversification can be attained: through reinsurance or the bearing of credit risks by internationally-diversified companies.

For these countries, the model indicates that reinsurance would allow the currently proposed reserves/fees to be reduced, perhaps significantly. For instance, if the expected volatility of an internationally-diversified mortgage insurance portfolio was similar to that of the U.S. national rate, the Baltic companies could significantly lower their reserves or prices.²⁹ Consequently, the results suggest that as markets develop, that in the countries where public insurance companies now operate they should be able to cede part of their risks to large international reinsurance companies at favorable prices. They should, in short, be able to lower their risk exposure as well as borrower costs through reinsurance contracts.³⁰ Thus, in principle, their imminent access to the EU should offer them gains in this direction.

However, in order for the EU countries to be able to offer geographical diversification possibilities to the transition countries, they must first be able to exploit them. At present, this result has not been realized. In particular, the model suggests that for full geographical diversification gains to be realized in EU countries mortgage insurance prices in some countries—such as the Netherlands and Sweden—will probably have to be increased. It also suggests that in the other EU countries which provide subsidies rather than insurance as a way to reduce rationing, such as Germany, France, and Austria, or cross default guarantees by other borrowers, as in Denmark, that it will be difficult for private insurers to compete.³¹ Thus, given the current policies in the EU countries, it is unlikely that private insurers will be willing to exploit the possibilities potentially available through EU-wide geographical diversification. They are, as a result, not likely to be willing to offer geographical diversification possibilities to the small markets of the transition countries.

C. Is Mortgage Credit Risk Insurable: Lessons from the U.S. Great Depression.

If mortgage credit risk is not insurable then the strength of any insights from options models are likely to be exaggerated. In particular, some have argued that the collapse of private insurers in the U.S. and Canada during the Great Depression suggests that options models are not likely to be useful. In this view, the correlated macro risks that can affect the default experience are such that reliable estimates of loss are impossible to make. If so, the risks may not be

²⁹ For example, the Latvian program’s reserves and prices are such that it would be able to withstand the experience of any of the U.S. states except Arkansas, which was particularly hard hit during the savings and loan crisis. In other words, unless there is a financial crisis in Latvia of a similar scale to that of the U.S.’s crisis, then based on this benchmark one can expect the Latvian insurer to have a one in fifty chance of becoming insolvent. However, to achieve this level of safety requires the large reserves now held.

³⁰ However, whether they are able to lower borrower costs depends on the competitiveness of the reinsurance market. Froot (1995), for example, suggests that the pricing in a similar market, that of catastrophic risks, is not competitive. He shows that reinsurance premiums generally run at considerably higher prices than do estimates of actuarially expected losses. In one case the price was more than six times the expected losses.

³¹ The Danish mortgage bond system involves all individual borrowers in the credit risk for all the other mortgages that make up a particular mortgage bond. If one borrower in a bond defaults, the other borrowers who happen to be pooled in the same security are, at the lenders’ discretion, jointly liable for repayment.

insurable. This result, in turn, suggests that considerable caution should be exercised in encouraging a stronger private sector role in the industry.

Based on this view, the public presence in the provision of default insurance in so many countries is easy to understand. However, this view also makes it less easy to understand the development and flourishing of the private mortgage insurance industry in a number of countries, and its complete privatization in Australia. The model helps consider what light can be shed on this question by the Great Depression experience.

When the information provided to the *Moreland Commission* (1934), which analyzed the industry's collapse, is considered within this approach, it shows that reserves and fees charged were well within current industry regulations. For example, in terms of Table 1 the figures for columns (2) through (6) were: a ratio of 14 to 1 for insurance-in-force to reserves, zero charges in up front fees and a 50 basis point on-going charge, insurance covered 20 percent of loan amount, and down payments of 33 percent were required. These figures imply that the companies followed a relatively prudent structure, along the lines of those currently used by U.S. public and private mortgage insurers.

Thus, the collapse of the entire industry would appear to suggest that even prudently structured companies could collapse. The result would seem to confirm the perceptions about the uninsurability of the risk, as well as raise issues as to the credibility of the rating agencies that argue that private U.S. insurers are financially sound. However, the *Moreland Report* also shows that, unlike today's regulations, the reserves were held in mortgages rather than in assets with uncorrelated values, and that reported earnings included premiums from non-performing loans. In addition, the report documents that over-appraisal of property values was endemic, and dividends continued to be paid out as troubles mounted. In short, from the *Moreland Commission Report* one can infer regulatory incompetence rather than uninsurable risk was the cause of the industry's troubles in the Great Depression.

Hence, the experience from the Great Depression, cannot, as has been claimed, be said to provide evidence that mortgage credit risk is not insurable. This result, in turn, implies that mortgage insurance should not be provided only as a ward of the state. The private sector has a legitimate role to play. The result does, however, provide evidence on the importance of prudent regulations, appropriate pricing, a sound legal basis for lending, and the need for the enforcement of those regulations and laws. Default insurance is not a substitute for a strong legal and regulatory environment, and even in the most developed financial systems private insurers need careful regulation as the U.S. and Canadian experiences in the 1980s suggest. In short, it shows why the kinds of risk analyses implied by options models can indeed be helpful to effective decision-making.

VI. Conclusions

To conclude, although the options pricing approach to modeling mortgage credit risks does not yield precise estimates of the prices needed to compensate for various risks, we believe it can, nevertheless, be helpful in a number of respects. For instance, the model predicts that it is hard to price credit risk precisely. But this inability to price precisely is exactly why lenders, and

particularly lenders with geographically-concentrated portfolios, are likely to rely on non-market rationing devices to avoid the risks involved. As a result, the approach provides an explanation for why there is an almost ubiquitous public presence in addressing this particular market imperfection.³² That is, it is not just that young families are politically favored in many countries, although that may be the case, rather it is that without such a public sector intervention younger borrowers would be rationed out of the market.

More concretely, this approach can provide insights, as well as some cautionary perspectives, on the current structure of a number of programs. In particular, we find that in a number of economies default insurance pricing and reserve policies do not appear to be prudently structured. That is, the price structures imply either that regulators often expect these programs to operate in a much safer economic environment than seems likely, or, alternatively, these programs have been conveying either large unbudgeted subsidies or contingent liabilities for either the government or borrowers who may well be unwittingly exposed, as well as under-diversified. Such liabilities have already been realized in Sweden, and the current risk exposure in the Netherlands, and even with the restructured program in Sweden, appears to be large.

The options perspective also helps to show when the provision of mortgage default insurance can be a cost-effective tool for addressing mortgage rationing. When correctly structured, mortgage insurance programs can lead to more complete markets without the use of subsidies. As such, they are, by definition, more efficient than are schemes that rely on subsidies to address market incompleteness. Hence, prudently-structured public default insurance will be more cost effective and efficiency-enhancing than are the frequently used bauparkassen subsidy schemes.

Finally, such models also can provide some perspective on the potential benefits of geographical diversification, as well as the costs of impediments to realizing these gains. This result may be particularly important to the success of mortgage default insurance programs in small economies such as the Baltic States, and could lead to significant savings in required reserves and premiums. It is also, however, of relevance to the EU countries' inability to exploit the full advantages of their now much more geographically diverse single currency market.

³² See footnotes 3 through 6 for a brief discussion and enumeration of countries with various public policy responses to this market imperfection.

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Annex 1

Brief information on the different programs (by country in alphabetical order)

Canada - Canada Mortgage and Housing Corporation (CMHC). (Insurance in force to capital ratio is calculated using data from CHMC Annual Report 2000 and premiums are given by Judy Saunders, Senior Manager of International Housing Finance Department at CHMC)

Estonia - Credit and Export Guarantee Fund (KredEx). KredEx gives guarantees to banks for lending money to the young families or to young specialists under the age 35 to buy homes. Data was provided by Mirja Adler, Manager of Housing Division of KredEx.

France - Guarantee Fund for Social Home Ownership (FGAS). Olivier Hassler, Housing Finance Specialist at the World Bank provided information.

Kazakhstan – The Agency for Mortgage Insurance of Kazakhstan (AMIK). AMIK is being designed to support mortgage loans to moderate income households. Data was provided by David Luchterhand, Chef of Party, the Pragma Corporation and is described in Merrill and Whitely (2002).

Latvia – mortgage insurance scheme is being introduced within the framework of the World Bank Housing project to be administered by the Technical Unit operating under supervision of the Ministry of Finance provided the data. The proposal in Latvia is similar to those offered by private mortgage insurers in Estonia, Kazakhstan, and U.S.–i.e., the insurer pays a specific top portion of the claim.

Lithuania - Housing Loans Insurance Company. The Company insures the loans for construction, purchase or reconstruction of housing granted by the banks or other credit unions registered in the Republic of Lithuania, which have signed co-operation agreements with the Company. Data was provided by Andrejus Trofimovas, Former Vice President of Housing Loans Insurance Company and is available on their web page. Until recently, the guarantee in Lithuania was similar to that of the public insurance companies in the U.S., Netherlands, Sweden and Canada. However, it was reorganized in early 2002 to operate on a co-insurance basis.

The Netherlands - The Foundation Guarantee Fund for Homeownership (FGFH) is a private non profit organization with government's liquidity guarantee. It was established on the basis of the previously operating municipality guarantee program that was also backed by the central government. The municipal program started in 1957 and ended in 1994, when its guarantees were bought by the FGFH. Data was provided by Hans Mersmann, Deputy-Director of the Mortgage Guarantee Fund for Homeownership in the Netherlands.

Slovenia – the Slovene system is complicated, involving indexed loans which make the outstanding loan amount decline slowly during the early years of the loan and then much more steeply during the loan's last few years. This kind of amortization schedule increases by a considerable amount the period during which risk exposure is high so that default is a more likely option. We did not estimate the implied risk of this program, but as the insurer is publicly-

owned and it is not clear that the loans have the legal basis of mortgages it is likely to be among the riskier programs.

Sweden - The National Housing Credit Guarantee Board (BKN), is a national government agency under the Ministry of Finance. BKN administers government credit guarantee programs for housing development. Government credit guarantees can be provided for loans advanced by financial institutions that are operating in Sweden. BKN has at present two main stocks of guarantees, one for guarantees registered before 1997 and another one for guarantees registered 1997 and later. BKN's losses for old stock are covered by Government grants. BKN experienced huge losses on old stock due to recession, tax reform and reduced government subsidies. Guarantees issued after 1997 must be fully financed by income from guarantee fees. We include an "old" and "new" Swedish programs to reflect the programmatic changes introduced in 1997. Data was provided by Hans-Åke Palmgren, Economist at BKN.

USA Financial Institutions- Home Mortgage Lending Institutions. These terms are those used to determine mortgages for risk weightings as described by Quigley and Van Order's (1991) .

USA Private Insurance – Insurance in force-to-capital ratio is the average ratio of mortgage insurance industry. The regulatory ratio is higher, 20 to 1. See Mortgage Insurance Companies of America (2001). The premiums are given by PMI Group, Inc.

USA Public Insurance- The Mutual Mortgage Insurance Fund (MMIF) is Federal Housing Administration's principle insurance fund. See Capone (2000) and Pardo (2001).

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