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The SOFOLES: Niche Lending or New Leaders in the Mexican Mortgage Market?

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Abstract

The Mexican mortgage market experienced significant turbulence in the 1990s allowing a newly created financial intermediary, the *Sociedades Financieras de Objeto Limitado* (SOFOLES) to gain entry into the low income mortgage market. The SOFOLES have instituted innovative loan origination and servicing policies and have spurred greater competition and specialization in the financial sector. Due to innovations and government rate subsidization, the SOFOLES' profits have been impressive. However, the question remains as to whether the SOFOLES can survive in a more competitive financial environment.

The SOFOLES are pursuing securitization as the most desirable option for obtaining additional funding to expand their operations. The complexity of pricing SOFOLES mortgages has presented challenges to the securitization of their loans. Until recently the SOFOLES have received a government subsidy (FOVI): funding at a reduced interest rate. This subsidy is passed directly on to their mortgage holders in the form of below market interest rates on their loans. In an effort to expedite securitization, interest rate subsidies were removed and reforms were made to the design of the SOFOLES' mortgage. Switching to a new mortgage design will facilitate securitization by creating an asset that is better understood by the market and is less risky to investors. The analysis here highlights the complexities of pricing the original SOFOLES contracts and provides insight into why reforms were necessary. It also quantifies the interest rate subsidy and allows for its comparison with the new mortgage product that FOVI has begun to promote.

The SOFOLES: Niche Lending or New Leaders in the Mexican Mortgage Market?

by

Natalie Pickering

The Mexican mortgage market experienced significant turbulence in the 1990s. The commercial bank liberalization beginning in 1991 led to wide-scale expansion in mortgage credit until the end of 1994. During this period commercial bank mortgage origination nearly quadrupled, averaging around 130,000 loans a year (Herbert and Pickering 1997). This rapid credit expansion, however, was followed by an even more abrupt halt to mortgage lending following the peso devaluation of December 1994, and commercial banks were left to reorganize their outstanding mortgage (and other) debt. These events allowed a newly created financial intermediary, the *Sociedades Financieras de Objeto Limitado* (SOFOLES), to gain entry in the low-income mortgage market.

The SOFOLES are non-bank financial institutions licensed to lend to particular sectors or for specific types of activities such as housing, consumer and small business lending, or automobile finance. The SOFOLES are not authorized to receive deposits; they must obtain all their funds through investors' equity, national, foreign or development bank loans, or the Mexican capital markets. The majority of the SOFOLES are licensed to lend for housing and real estate development. To date, most of their funds have come from a government trust for lower-income (or so called "social interest") housing, the *Fondo de Operacion y Financiamiento Bancario a la Vivienda* (FOVI).[1] The SOFOLES target the low-income segment of the mortgage market and function essentially as mortgage companies that originate and service loans financed, until recently, at a subsidized interest rate by FOVI.

The SOFOLES are interested in expanding their operations and widening their clientele. The potential for expansion is immense. In the house-price range that the SOFOLES predominantly serve (US$14,000-$22,000), it is estimated that mortgage demand outstrips supply by roughly 55 percent (Campos Spoor 1997). Supply is even more restricted in the lower income brackets in which SOFOLES mortgage credit is more limited. Unmet demand

[1] FOVI's liabilities are funded from the Banco de Mexico (central bank) (93.3%), the World Bank (4%), other sources (2.6%) and its own equity (13%).

among those who can afford housing priced at roughly US$8,000 is 90 percent, and this income bracket contains 65 percent of the total population or about eleven million households. Most of these households are left to meet their shelter needs through the informal sector often constructing their own homes with insufficient materials and few basic services.

Markets are not clearing, in part, because of distortions in the institutional structure of mortgage finance that prevent long-term lending. The SOFOLES, in particular, are constrained by funding; FOVI cannot provide sufficient below-market interest rate loans to meet demand. Thus the SOFOLES want to raise funds by securitizing their mortgages. The formation of a secondary mortgage market and the securitization of mortgages have traditionally been prerogatives of the Mexican government. In the long run, securitization will reduce funding costs and better diversify risks in the market. It will lead to greater standardization of mortgage underwriting and servicing which in turn creates economies of scale that will drive down costs in the market. The Mexican government envisions the secondary mortgage market ultimately providing bond-like assets in which the newly privatized pension funds may invest.

However, several issues have impeded the securitization of mortgages and creation of a secondary mortgage market. First, securitization would mean incurring higher funding costs over the short term because the FOVI interest rate subsidy has to be eliminated or realized up-front before investment grade securities can be issued. In addition, the type of mortgage instrument the SOFOLES initially originated and currently hold on their balance sheets, the dual-index mortgage or DIM, is a complicated asset for investors to price. The contractual provisions that determine monthly payments defer cashflows to the end of the mortgage's life and are difficult for market participants to predict and price. Furthermore, DIMs can accrue excessive negative amortization that increases the risk of borrower default. FOVI has recently initiated a new mortgage product that decreases the interest rate subsidy and eliminates the risks associated with negative amortization. The new mortgage design is a step in the right direction, but it does not solve all the SOFOLES funding issues. The SOFOLES still have over US$1 billion on their balance sheets of the original DIM that they would like to remove. In addition, the new mortgage may create affordability problems for lower income borrowers making it difficult to service.

On the positive side, the SOFOLES have effected several innovations in the market that will make securitization more feasible. For instance, SOFOLES operate as mortgage companies that separate the funding of loans from loan servicing and risk management. The SOFOLES have developed improved payment systems and devised a rudimentary form of risk sharing through community mortgage insurance funds. They have also encouraged greater standardization in loan contracts and servicing systems. The SOFOLES represent evolution toward greater efficiency in mortgage lending. Efficiencies arise as the various services that were once covered by one institution, commercial banks, are broken into functional components. This mirrors the trend in other countries toward greater separation between funding and servicing in mortgage markets.

The purpose of this paper is to review the performance of the SOFOLES authorized to lend with FOVI funds. A second purpose is to discuss problems that these SOFOLES face in trying to expand their operations and funding source beyond the FOVI program. The paper begins by describing the origin and current operations of the SOFOLES. It then examines their lending performance, and how it compares with commercial banks in Mexico as well as similar companies in the United States. The paper concludes with an analysis of the DIM that the SOFOLES originally issued and continue to service. A series of simulations are presented that illustrate the difficulties in pricing the DIM. The simulations also quantify the interest rate subsidy and allow for a comparison of DIM with the type of mortgage that FOVI recently began to promote.

Why Were the SOFOLES Created?

The SOFOLES were created as a result of the North American Free Trade Agreement (NAFTA) and were designed, in part, to allow financial intermediaries like US non-bank financial institutions and Canadian investment societies to begin operating in Mexico. Under Mexican banking laws, any intermediary that grants credit with resources funded by the public through bank deposits or securities issuance is required to obtain a full banking license from the Ministry of Finance. However, credit granting alone does not require this license. Thus, US non-bank financial corporations who wanted to undertake lending operations in Mexico sought authorization for their activities that would not require attaining a full banking license. The SOFOLES were created as an alternative to the licensing of multiple banks.

This option would permit financial corporations to undertake lending for specific activities without undergoing the lengthy and arduous process of obtaining a full banking license.

A second motive for creating the SOFOLES was to spur greater competition and specialization in the financial sector. Financial services in Mexico are highly concentrated with a handful of large commercial banks and financial groups dominating most commercial and consumer lending. By creating the SOFOLES, the Mexican government hoped to increase lending to particular sectors of the economy. The government also viewed the SOFOLES as vehicles to extend credit to parts of the population not served by existing banks; a population that often functions outside formal finance channels.

Mortgage lending was a particular area where these goals were sought. Mortgage finance, like other financial services, has been concentrated among a few large commercial banks that lend primarily to the upper income brackets. Three commercial banks (Bancomer, Banamex, and Serfin) have dominated private lending to housing. As of March 1996, these three banks held more than two-thirds of the outstanding commercial bank portfolio of mortgages (*Comision Nacional Bancaria y de Valores* [CNEV] 1996).

Mortgage credit to the low-income sector of the population has been severely restricted. Most of the loans issued by commercial banks are for residential housing valued in excess of US$30,000 (Herbert and Pickering 1997). Assuming that a household can afford a home worth approximately 3.3 times its annual income and based on official government income surveys, only about 15 percent of all households could afford to purchase such a home.[2]

Following President Lopez Portillo's nationalization of the banking system in 1982,[3] commercial banks were required to maintain a fixed percentage, ranging from 3 to 6 percent, of their outstanding mortgage portfolio in so-called "social interest loans." These loans were partially funded by FOVI, a special government trust fund within the central bank. FOVI acted as a second-tier bank channeling government funding to commercial banks for low-income housing finance (Schaefer 1997). It provided lines of credit and guarantees against default for commercial banks originating these loans. However, when the banks were state-

[2] This housing affordability estimate, reported by the CNBV (1996), is based on World Bank estimates of the average value of a house as a function of household annual income.
[3] Two banks remained under private control: Banco Obrero and Citibank (Fernandez 1998).

owned, social interest loans were funded out of the banks' capital and held on their balance sheets. FOVI set the terms of these loans and augmented funding in some cases. When lending restrictions were lifted in 1989 under the financial liberalization program of the Salinas' administration, commercial banks were no longer required to participate in the FOVI program; however, 100 percent match funding was offered by FOVI to originate social interest loans. Still banks dramatically curtailed lending to the lower-income housing market. Banks had a large number of social-interest loans originated in the late 1980s already in their portfolios, which had not performed well and were unprofitable. The newly privatized banks had little interest in expanding their FOVI portfolio. Instead they rapidly increased lending to the higher income brackets.

FOVI was left to find new means for implementing its directive. The SOFOLES helped to fill the gap by providing a new means for originating and servicing FOVI financed loans. FOVI continued to operate through the commercial banks but on a much more limited scale. After the financial crisis of 1994 when all commercial lending stopped, FOVI began working almost exclusively with the SOFOLES.

Three types of SOFOLES operate in Mexico: 1) those that are independent and predominantly under Mexican ownership; 2) those that are part of a larger Mexican financial group; and 3) those that are affiliated with a foreign corporation (such as Ford or GE Capital). There are approximately 32 SOFOLES currently licensed and operating, 19 are authorized for operating in the mortgage sector. Fourteen SOFOLES are licensed to lend with FOVI funds and these are the only mortgage SOFOLES currently lending on any appreciable scale (see Appendix A for list of SOFOLES).

Regulation of the SOFOLES

The SOFOLES are regulated by the Mexican Credit Institutions Law and fall under the supervision of the Ministry of Finance (*Secretaria de Hacienda y Credito Public* [SHCP]), the Security Exchange Commission (*Comision Nacional Bancaria y de Valores* [CNBV]), and the Central Bank (*Banco de Mexico)*. Regulation of the SOFOLES varies according to whether they are registered as independent domestic corporations, part of a foreign financial group, or affiliates of an external corporation. Until January 2000, foreign investment in SOFOLES was limited to 49 percent of their capital stock. However, under

NAFTA, SOFOLES that are affiliates of foreign financial institutions could have greater foreign equity participation.[4] All SOFOLES are required to register as corporations (*Sociedad Anonima*) and must obtain a license to operate from the SHCP. Each SOFOLES institution must write a basic business plan that describes its internal organization and systems of control, its program for placing debt or equity in the capital markets, and its policy for service provisions, including the geographical area to be served and risk diversification plan.

SOFOLES that are part of a larger financial group must conform to the capital regulations and other portfolio provisions applicable to the parent financial group. Those that are independent pay fixed minimum capital equal to 15 percent of that required for establishing a multiple bank (roughly US$ 2 million). To place debt in the capital markets, these SOFOLES must be in operation a minimum of two years, and the debt must be rated.

Different divisions within the CNBV are responsible for the oversight of each type of SOFOLES. To date, the SOFOLES are subject to few additional regulatory controls other than the standard audits and reports required by the CNBV and SHCP. Most oversight of the mortgage SOFOLES is conducted by FOVI. FOVI has a capital requirement of 4.9 percent of total mortgage assets held by the SOFOLES. In addition, FOVI determines the underwriting and servicing requirements that participants in its mortgage-lending program must meet.

The FOVI Mortgage Lending Program

The FOVI mortgage program dates back to the 1980s when the commercial banks were nationalized. However, the system for allocating FOVI funds was substantially altered in 1989 to make it more competitive. FOVI allocates its mortgage funds to the SOFOLES through auctions in which housing developers bid on the rights to obtain a predetermined number of mortgage credits that will be originated and serviced by a particular SOFOLES institution. The procedure starts when FOVI announces a date when an auction of mortgage credit will be conducted. FOVI specifies the total value of the credit rights that will be auctioned along with the type of mortgage product/house (FOVI A, or B, or PROSAVI, see Appendix B and below) to be issued, underwriting guidelines that the end

[4] NAFTA allowed Mexico to place capital limits on foreign affiliates offering financial services during the transition period (January 1, 1994 to December 31, 1999). The aggregate limit was measured as 3 percent of the sum of the assets of all multiple banking institutions and SOFOLES.

borrowers/homeowners must meet, the geographic area of the country where the projects must be built, and in some cases the minimum and maximum bids acceptable.

FOVI specifies a minimum and maximum bid price to regulate the distribution of credits among construction companies. A maximum bid is established to prevent predatory bidding. It avoids concentrating all credit rights to one large construction company that is speculating on future projects. It precludes, for example, large firms from bidding high to win all the credits, and thus purchasing an option for mortgage take-out financing for projects merely under consideration while shutting out smaller companies from receiving mortgages for projects that are already underway. If the large company later decides to cancel the project and builds no houses, the smaller firms are left without funding for houses already built. With a bid cap, all companies bidding the cap will be distributed some credits. Conversely, a minimum bid is established when FOVI expects there to be high demand and the possibility for companies to collude and lower the price.

FOVI auctions are conducted through sealed bids. A developer submits a bid that states the total value of mortgage credits requested and the percentage of the total that the bidder is willing to pay FOVI for the rights to obtain the mortgage credits. For instance, a developer might bid 5 percent for $10,000,000 total in credit to build 1,000 homes at $10,000 each. If this is a winning bid, the developer would then cover $500 of each mortgage issued at the time the final buyer receives their mortgage from the SOFOLES and takes possession of the home. Along with the bid, the developer submits documentation verifying that the proposed housing project meets FOVI's building requirements, a letter of intention from the SOFOLES stating that they will originate and service the loan according to FOVI's underwriting criteria, and proof of ownership, or impending ownership, of the land on which the project will be developed.

The relationship between developers and the SOFOLES is an interdependent one as securing mortgage financing is essential for housing developers. As a result some developers have started SOFOLES in order to obtain financing from FOVI for the purchasers of their homes. Other developers have equity interest in SOFOLES or have merely established a working affiliation with one. Once a developer wins the right to attain mortgage funds from FOVI, the developer can also apply for FOVI construction financing. FOVI will finance construction loans for up to 65 percent of the finished home sale value. The SOFOLES

originate and service these loans as well. Housing developers will take out a construction loan with a SOFOLES institution to gain the so-called "moral commitment" to originate and service the take-out mortgages at the time construction is completed. Until recently no interest rate spread was permitted on FOVI mortgage loans; however, the SOFOLES can charge any opening fee and interest rate spread on construction loans.

FOVI controls the type of mortgage products that the SOFOLES can originate. FOVI's mortgage products are divided into three categories by borrower income and house price: the traditional FOVI A and B mortgages, and a newer product, PROSAVI (*Programa Especial de Credito y Subsidios a la Vivienda*) for very low-income borrowers. Appendix B summarizes the difference between these three original FOVI mortgage products. FOVI A mortgages are for lower middle-income borrowers with monthly incomes ranging from 4.5 to 7.0 times the minimum wage (US$5,400 to US$8,000 annually) and purchasing homes worth up to US$14,000. The servicing fees are reduced for FOVI A mortgages to 50 centavos a month per 1000 pesos in loan balance in order to make them more affordable. FOVI B mortgages are made to households whose monthly income ranges from 6.5 to 8.0 times the minimum wage (US$7,800 to US$18,000 annually) and who are purchasing houses worth up to US$20,000. The servicing fees for these mortgages are 3 pesos a month per 1000 peso loan balance. The PROSAVI mortgage program was started in 1997 and was designed for the very lowest income borrowers, those whose annual income is between 2 and 5 times the minimum wage (US$2,400 and US$6,000). PROSAVI has a front-end direct subsidy in the form of a down payment provided by the government of roughly 20 percent of the value of the house. House values average US$9,000 in the PROSAVI program. Servicing fees are the same as the FOVI A program.

Interest rates, payment rates, origination, and servicing fees have historically all been set by FOVI. Recently, in August 1999, FOVI began to allow the SOFOLES to establish their own servicing fees, but they still must follow the basic FOVI guidelines. The SOFOLES are constrained to originate only the three types of products described above with FOVI funds. They cannot tailor lending to individual borrower needs or characteristics; however, they can use equity or other funding to originate other mortgages.

Under the FOVI program, when construction is completed, the developer locates buyers and assists them in applying for mortgages from the SOFOLES. At the time a home is

purchased and the borrower signs the mortgage contract, the SOFOLES receive a loan from FOVI equivalent to the purchase price of the home plus closing costs minus the down payment (usually 10 percent). This is directly passed on to the developer for purchase of the home. (See Appendix C diagram.)

The funds that the SOFOLES receive from FOVI are held as on-balance sheet liabilities that exactly match their mortgage assets. In other words, FOVI assures that the SOFOLES bear no interest rate risk. In addition, FOVI shares the risk of default by guaranteeing a 50 percent pro rata share of the total loan amount plus an equal share of accrued interest and allowable foreclosure costs. Allowable foreclosure costs are subject to an absolute cap which is indexed year-to-year (Blood 1997). The DIM mortgage that FOVI has historically promoted, is an adjustable term mortgage, and any remaining loan balance after 30 years is completely covered by FOVI. The SOFOLES have not had the occasion to exercise these guarantees to date; they have not foreclosed on borrowers and no loans have reached maturity so the end-of-term balance guarantee has not been exercised.

SOFOLES Underwriting and Loan Servicing

The SOFOLES underwriting and loan servicing procedures differ from those of commercial banks and in part account for lower delinquency rates and better overall performance of their mortgage portfolio. The SOFOLES have designed their underwriting and servicing in accordance with the needs of low-income borrowers. They take advantage of the spatial proximity or "client clustering" characteristic of the low-income market. Most SOFOLES lend to residents of new large-scale housing developments (100 homes or more) and strive for on-going direct contact with their borrowers.

Loan underwriting is onerous in Mexico due to the lack of long-standing credit evaluation bureaus. Credit histories on SOFOLES borrowers are difficult and costly to collect. Prior to 1994, credit information was limited to what was administered by the central bank and collected by corporations affiliated with commercial banks. Since 1995 three national credit bureaus have come into operation. However, these bureaus still lack credit histories on most borrowers particularly those in the lower income brackets served by the SOFOLES. Around 50 percent of the SOFOLES' clients have no credit references. Thus, credit checks on potential SOFOLES borrowers typically entail what is called a "socio-

economic investigation." In the socio-economic investigation the SOFOLES check employment, current address and references and, in many cases, sends someone to the borrower's residence and/or place of work to verify the information on the loan application.

The labor intensity of the SOFOLES origination procedures is mirrored in loan servicing. Inadequate national mail service is largely to blame. Typically borrowers in Mexico do not make loan payments through the mail but instead must visit a bank branch office in person to make a payment. Most SOFOLES clients, as many as 80 percent, make their mortgage payments in cash. Low-income households encounter difficulties making loan payments at banks because banks are not always conveniently located near the borrower's place of work. In addition, regular banking hours coincide with normal business hours requiring borrowers to take leave from work in order to make a payment. Also, loan payment periods (monthly) and wage payment periods (daily, weekly, or fortnightly) may differ causing payment problems.

In response to these payment problems, SOFOLES services loans via branch offices or kiosks located in the housing developments. For large housing projects, the SOFOLES often require the developer to place a payment collection office in the development that the SOFOLES can staff and operate. This improves loan servicing by making payment more convenient for borrowers. When a SOFOLES kiosk is placed in the housing development it can operate during hours that are more convenient for borrowers. It also encourages borrowers to make partial payments throughout the month that better conform to household income flows.

Some SOFOLES have negotiated agreements with the commercial banks to accept payments by their borrowers. When a SOFOLES borrower makes payment at a commercial bank, the payment is placed in the SOFOLES account and recorded on behalf of the borrower. The SOFOLES can access information on their accounts via modem, so they will know at the end of each business day which borrowers have made payments.

Performance to Date of the SOFOLES

The delinquency rates for SOFOLES loans have been significantly lower than that of most FOVI loans held by commercial banks over the same period. Appendix D reports the number of loans delinquent for the FOVI-affiliated SOFOLES as of December 1999.

Commercial bank delinquencies on FOVI loans have been estimated to run as high as 40 percent while the SOFOLES have reported delinquencies on the order of 1 percent. In large part, this is because the loans were originated in a later period. SOFOLES loans were originated after the financial crisis of 1994. In contrast, the commercial banks' FOVI loans were pre-existing, many from the late 1980s, and suffered large increases in loan-to-value ratios as a result of high inflation after the crisis. This has led to more defaults and delinquencies in commercial bank mortgages.

Yet the SOFOLES' low delinquency rates are unusual given the state of the Mexican economy over the period and noteworthy for several reasons. First, roughly 15 percent of the total number of delinquencies is over six months**.** After six months of delinquency, loans are eligible for foreclosure under FOVI's program. Delinquencies well in excess of six months exist revealing both the SOFOLES' preference for re-negotiating debt rather than repossessing the house and the length of the foreclosure process. Precisely because foreclosing on delinquent borrowers is costly and time consuming — it can require up to five years — the SOFOLES have opted to restructure payment plans when borrower payment delinquency persists.

Second, the SOFOLES have created a specific insurance mechanism against delinquency in the early years of the mortgage. Most loans are delinquent through the third month, and then "cure" such that delinquency drops significantly in the fourth month. This is because many SOFOLES require the creation of a special trust account (*fidecomiscos*) as a type of delinquency insurance. The size of the accounts range from 3 to 6 monthly mortgage payments depending on the assessed risk of the borrower. The accounts are either individual and established by the borrower, or common and created by the project developer on behalf of a specific group of borrowers in a housing development. Both types of accounts are established at the time of loan closure and are retained by the SOFOLES until the loan is repaid. An individual earns interest on their account and can use the balance to make the final mortgage payments. Developers' accounts are retained for five years and any loan payments withdrawn due to delinquency or default by borrowers are forfeited. Thus, the developer continues to bear some credit risk of the new homeowners after completion of the project.

The use of such insurance funds creates a discrepancy in the official delinquency rates reported to FOVI. The delinquency rates reported to FOVI reflect the point at which

payments withdrawn from the trust fund cease, not when borrowers stop making payments to the SOFOLES. When a borrower fails to make a payment, the payment is withdrawn from the trust account and the SOFOLES begins collection procedures to replace the payment withdrawn from the account. The borrower's loan is reported as current as long as the remaining resources in the account will cover the loan. Thus, if a borrower who was required to make a three-month insurance deposit at the time of the loan's origination is delinquent 5 months, only 2 months of delinquency will be reported. The SOFOLES collection procedures also become more aggressive after exhaustion of the insurance fund. The drastic decline in delinquency between months 3 and 6 reflects this increase in effort.

The SOFOLES' collection procedures entail more face-to face contact with borrowers than is typical of the rest of the market. Borrowers' frequently cannot be reached by phone and, in fact, may not have a phone either at the residence or place of work. Collections require contacting the borrower personally through visiting their residence or place of work. As described above, such face-to-face collection strategies are a natural extension of the equally direct contact required in underwriting and servicing. Mechanisms have also been designed to place community pressure on delinquent borrowers. For instance, by the second delinquent payment, notification of a borrower's failure to make payment may be sent out to other residents of his or her housing development. This is often the case when a borrower covered by a joint insurance fund against delinquency fails to make payments.

The SOFOLES' delinquency rates have also remained low as a result of government intervention in the market. In the aftermath of the currency devaluation and banking crisis, a special government program was created to encourage borrowers to remain current on their mortgages. This program was originally designed for mortgage debtors of commercial banks (individuals who had taken out loans before the crisis) but was later extended to SOFOLES borrowers.[5] The "Accord for Debtor Assistance" (*Acuerdo de Apoyo a los Deudores* [ADE]) program offers payment discounts until the year 2000 for borrowers who received their loans before April 1997 and who are current in their payments. Table 1 shows the schedule of discounts by year for FOVI loans. For example, a borrower who took out a loan in January

[5] The SOFOLES lobbied to have the ADE program extended to their clients arguing that they service lower income borrowers. Giving commercial bank borrowers a subsidy and not SOFOLES borrowers was regressive and gave commercial banks an unfair advantage. The subsidy, however, remains regressive as it gives commercial bank borrowers a larger discount.

1997, who is current on his or her loan, and who has monthly payments in the first year of 700 pesos, would pay 532 pesos a month. The government subsidy would cover the remaining 168 pesos for the first year (1997). The next year the monthly loan payment due would increase to 806 pesos of which the borrower would pay 661 pesos and the government 145 pesos. The ADE discount is slightly higher for commercial bank loans, due to their higher delinquency rates, and extends through the year 2005.

Table 1: ADE Program Discounts

Year	*Discount as Percentage of Payment*
1996	30%
1997	24%
1998	18%
1999	12%
2000	6%

Source: Softec 1996.

The performance of the SOFOLES in terms of delinquency rates has been quite favorable. This performance is largely due to the innovations in "delinquency insurance" and collections instituted by the SOFOLES. The ADE program has also helped lower delinquency rates. Overall, the delinquency rates for SOFOLES loans are significantly better than those of the commercial banks.

The Sustainability of the SOFOLES

Harmony between the interests of market participants and public policy led to the creation of the SOFOLES, and the economic crisis and overall weakness of the financial services sector have nurtured their growth. Their competition, commercial banks, has been unable to actively participate in the mortgage sector due to the large losses suffered from the devaluation. In place of new lending, commercial banks have been forced to direct their attention to restructuring their existing portfolio of mortgages. The SOFOLES filled part of the void left by banks. The SOFOLES have funded their operations at FOVI's subsidized cost of capital. The pertinent question is whether the SOFOLES can survive in a more competitive financial environment and with decreased support from FOVI.

The SOFOLES function essentially as mortgage corporations that originate and service loans in accordance with FOVI underwriting criteria; they do not rely on interest rate spreads or financial product innovation for their profitability. The SOFOLES' profit margin depends wholly on the difference between their marginal costs of operation and the origination and servicing fees they collect, as do US mortgage corporations. In this regard, the SOFOLES represent evolution in the mortgage market as the different functions of financial intermediation become disaggregated institutionally.

Two factors are critical to the future sustainability of the SOFOLES. First, can the SOFOLES significantly expand operations while keeping marginal costs down? And second, can the SOFOLES fund their operation through market mechanisms at prevailing interest rates?

FOVI recently (August 1999) redesigned their mortgage contracts to reduce the interest rate subsidies, deregulate SOFOLES servicing fees, and create a mortgage asset that positively amortizes from inception. These loans have just begun to be originated and still comprise a small fraction of the SOFOLES portfolio. Nonetheless, such reforms will facilitate the SOFOLES evolution toward reduced dependency on FOVI. The Banco de Mexico and World Bank, in large measure, promoted the switch to a new mortgage instrument because of difficulties that the old instrument presented for securitization. The remaining analysis focuses on these problems associated with securitization. It examines the original SOFOLES mortgage instrument, the dual-indexed mortgage, to reveal the challenges

faced in securitizing these loans. The SOFOLES hold over US$1 billion in DIM mortgages on their balance sheets. The SOFOLES are now originating the new mortgage products that should prove easier to securitize, however, the SOFOLES also hope to remove the existing DIMS from their balance sheets through securitization. The challenges this presents are addressed below. But before turning to the discussion of securitization, it is worth making a few observations about the SOFOLES profits and servicing costs.

The SOFOLES' profits have been impressive. The seven largest lenders averaged a 38 percent return on equity in 1998. The SOFOLES charge servicing fees comparable to the US market. They receive five basis points for servicing FOVI Type A and PROSAVI loans and 25 basis points for FOVI Type B loans. While these rates sound low relative to US servicing fees (Fannie Mae or Freddie Mac servicers charge on average 33 basis points for fixed rate loans and 37-38 for adjustable rate loans), the rates are not directly comparable. SOFOLES servicing fees are taken as a percentage of the original loan balance and are indexed to the minimum wage. Their fees stay fairly constant (depending on how closely the minimum wage tracks inflation) in real terms over the life of the loan. US servicing fees are a percentage of current principal and therefore decline both due to the declining loan balance and inflation.[6]

Simulation of loan performance demonstrates the revenue potential of FOVI loans. Simulating the performance of a FOVI loan of N $100,000 (US$11,700) originated in 1997, suggests that the FOVI A and PROSAVI loan servicing fees generate a present value of roughly NP$5,350 **(**US$630) per loan. The FOVI B loans earn substantially more, around NP$26,500 (US$3,100).[7] This does not include the origination fee, which adds NP$3,000 (US$350) per-loan. As a point of comparison, a US$100,000, 7 percent fixed interest rate loan generates present value revenues of US$3,700 over a 30-year period on servicing fees or an average annual revenue in real terms of roughly US$225. Using a typical SOFOLES portfolio that is 40 percent FOVI A/PROSAVI and 60 percent FOVI B loans, the expected present value revenue is NP$21,040 (US$2,475) per loan or an annualized real income of

[6] Several types of servicing fees exist in the United States depending upon the type of loan (fixed or adjustable rate), the market segment (conforming, jumbo, low-income), its age, and perceived risk. Servicers may also charge a flat yearly fee (usually on the order of US$65 per year) that is renegotiated every 3 to 5 years.
[7] Based on NP$8.5/US$1 exchange rate.

NP$1,800 (US$210) over 30 years.[8] The SOFOLES total revenues for loan origination and servicing are not that different from US loans of much higher average balance.

Under the new program, FOVI has set a minimum servicing fee, but the SOFOLES are allowed to adjust these fees upward as the market permits. The minimum servicing fees are comprised of a flat 65 UDIS a month and a spread on the interest rate of about 2 percent. Servicing fees are roughly the same for all the loan products. With these fees the SOFOLES annual servicing revenues will increase to about US$300 per loan.

The SOFOLES revenue stream is fairly straightforward to estimate. On the cost side, estimates are more difficult to attain. The balance sheet and income statements of the SOFOLES from 1997-99 provide a snapshot of the variable cost per loan of their operations. These suggest that average annual administrative cost per loan ranged between NP$16 and 24 (US$2-3), which is extremely low. However, administrative expenses alone do not represent total average costs of servicing. The fixed costs of establishing computerized information systems as well as branch servicing centers account for a substantial portion of average servicing costs. These fixed costs cannot be estimated adequately from the existing balance sheets and income statements. US companies direct servicing costs per loan have ranged between US$47 and US$109 (Oliver, McDonald, and Kennedy 1996).

The optimal operating capacity of the SOFOLES is unclear, however most evidence suggests that long-run average costs are falling in the overall mortgage market. Improvements in credit reporting and information technology, in part, are driving costs down as are legal reforms that reduce administrative fees associated with closing and property registration.

Nonetheless, as the above description of the SOFOLES lending program suggests, SOFOLES incur higher costs originating and servicing low-income mortgages than Mexican commercial banks in the conventional residential market (Campos Spoor 1997).[9] The SOFOLES' servicing procedures are labor-intensive. They rely on more face-to-face contact with the borrower and less on telephone or mail correspondence. Growth requires greater geographical dispersion that in turn increases fixed costs for facilities as well as management.

[8] Campos Spoor (1997) estimates an average annual yield of US$180 per loan. This assumes that a SOFOLES portfolio is divided 50-50 between FOVI A and FOVI B loans. In reality portfolios have been anywhere from 55 to 65 percent FOVI B loans. The real interest rate for the FOVI loans is assumed to be 7.5 percent and for the US case 4.5 percent.

[9] Notwithstanding current losses due to the high levels of default in the medium and residential market.

To expand business the SOFOLES must establish branch offices or kiosks in new housing developments as well as hire and manage additional personnel to collect delinquent loans. Some cost savings are derived from the economies of density in mass originating mortgages to residents of large low-income housing developments. But even in the US market, where marginal costs of servicing are lower, it was found that the mortgage portfolio's characteristics, more than its shear size, lead to greater profitability. While US mortgage companies derive benefit from economies of scale that accompany portfolio growth, they also become encumbered by extra layers of management and less accountability in sensitive areas such as default management (Oliver, McDonald, and Kennedy 1996). This will hold true for the SOFOLES as well. A key to their on-going success will be maintaining their currently low delinquency rates. This in turn depends on how borrowers who hold DIM mortgages behave under various macroeconomic scenarios. Better understanding of the DIM will help clarify this issue.

Securitization and the Dual Index Mortgage

The most significant cost increase the SOFOLES face in expanding business is securing additional funding at market interest rates. FOVI has until recently provided the SOFOLES funds at a below market rate: 5 percent real. FOVI provides about a 300 basis point interest rate subsidy to the SOFOLES on the liability side of their balance sheet. SOFOLES hold the FOVI mortgages on their balance sheet, but FOVI bears the cost of the interest rate subsidy.

To expand business the SOFOLES will have to obtain funds through collecting deposits, issuing general obligation bonds, or creating mortgage-backed securities.[10] The SOFOLES are currently pursuing securitization as the most desirable option, but choosing any of these modes of finance will result in increased funding costs. Exactly how much funding costs will increase is uncertain. However, a contextual estimate can be made for the cost of bond issuance: inflation-indexed five-year government bonds have a coupon of seven and one-half percent and a recent small debt issuance of one SOFOLES institution offered an

[10] The laws currently governing SOFOLES would have to be changed to permit acceptance of deposits.

eight percent real coupon for ten-year bonds.[11] In an effort to reduce their subsidy and push the SOFOLES forward toward market-based operations, FOVI has begun to provide funding at higher rates, 7.7 to 8 percent. The income on the original FOVI mortgages is 5 percent. The cost of issuing securities based on the older vintage mortgage is high, as the SOFOLES or government would have to absorb the difference between this and what the market demands as a return. Consequently, securitization is seen as an attractive option for obtaining additional funding in the future only if interest rates were raised on the underlying mortgages.

Securitization

Securitization has several advantages over other methods for financing SOFOLES mortgages. It would allow wider diversification of risks, create a highly liquid secondary market and encourage specialization and cost reduction in mortgage servicing.[12] Both the SOFOLES and the government have focused on the possibility of raising funds through issuing mortgage-backed securities (MBS). One possibility is that FOVI acts as a conduit purchasing SOFOLES mortgages and issuing mortgage-backed securities. This would follow the model of Fannie Mae in the United States. FOVI is the natural choice for an issuing vehicle. It is an independent trust backed by the government and currently provides the subsidy, both in the form of lower interest rates and forgiveness of any remaining balance at the end of the loan terms, to borrowers holding SOFOLES DIMs. The World Bank provides liquidity to FOVI and has supported its transformation into a secondary mortgage market facility (Bernstein 1998).

The Mexican government, however, has resisted following the US model in which government guarantees, explicated or implicated, are provided in the market. Instead the government is currently pursuing a different model in which the SOFOLES, or other mortgage banking institutions, issue pass-through securities directly into the market without government guarantees. FOVI would continue to provide funding to the primary market (with the interest rate subsidy being phased out over time) and the SOFOLES would recycle funds in the secondary market. Securities issued would be tranched into a senior investment-

[11] Inflation indexed (UDIS) government bonds have recently (June 1999) traded at an effective yield of 7.99 percent.

[12] See Leae and Chiquier for a good overview of different types of secondary mortgage markets and their pros and cons.

grade bond for sale to the public and a subordinate tranche that the issuer would retain. In addition, FOVI would purchase (with match funding from the government) a principal-only strip that would cancel out any imbedded subsidy. Proceeds from the issue would be used to pay off the FOVI loan that exists on the balance sheet of the issuing agency.

Mortgage Securities Pricing

A predominant concern given the DIM loan contracts is how such mortgage securities would be priced in the market and the extent of the FOVI subsidy. In fact, the predominant reason for changing the FOVI mortgage contract was that little experience existed in designing and pricing DIM mortgages for secondary market transactions. In principal, the cashflows of any asset can be securitized. Concert ticket proceeds are a recent example of one of the more exotic assets whose cashflows were turned into securities. However, for deep liquid markets to form a security, investors need to understand the assets' long-term performance and market value. This will be particularly true of more complicated assets like DIM mortgages.

A great deal of research has been done in the area of mortgage pricing. McConnell and Muller (1988) provide an overview of mortgage pricing techniques used in industry, Hendershott and Van Order (1987) survey the development of the option-pricing approach to mortgage valuation and Kau and Keenan (1995) provide a later review of the academic literature. It is important to point out, however, that practically all theoretical and empirical research on mortgage design and pricing has been conducted on the fixed and adjustable rate mortgages used in the United States. These models are based on US borrower prepayment and default behavior as well as interest rate processes that reflect the US economy.

Yet despite the lack of fundamental research on the Mexican mortgage market, the DIM can be priced. The market value of any mortgage depends on the contractual provisions of the loan, the macroeconomic environment, borrower behavior, and any government programs that may affect cashflows. Contractual features of the DIM, as well as particular aspects of the Mexican macroeconomic environment (interest rates), make pricing the SOFOLES/FOVI mortgage different and more complicated than most common mortgages.

The Dual-Index Mortgage

The DIM is a variation on a mortgage instrument called the Inflation-Proof Mortgage (IPM) and was designed in 1975 by a team of researchers under the guidance of Franco Modigliani at the Massachusettes Institute of Technology (MIT) (Modigliani and Lessard 1975 and Modigliani 1989). The mortgage has also been called the dual-rate mortgage (DRM) and the dual-rate VRM (Variable Rate Mortgage) (Fabozzi and Modigliani 1992). The novel feature of this mortgage is that the monthly payment is not determined by the "effective" or "debiting" rate but instead by a separately calculated "payment" rate. The debiting rate determines the interest accrued on the outstanding debt at any time and is the agreed-upon interest owed by the borrower over the life of the loan. It may be a fixed interest rate, or adjusted periodically to reflect the short-term Treasury Bill rate, or another reference interest rate. The payment rate, on the other hand, specifies the amount paid by the borrower in any given month. It is adjusted periodically, usually at longer intervals than the debit rate, and determines the rate of amortization of the loan at any given time. The payment rate may be set such that the loan negatively amortizes over some periods but ultimately permits complete payment of the mortgage.

In 1984 the Banco de Mexico and the then-nationalized commercial bank, Banamex, designed a similar mortgage that would buffer borrowers against payment shocks but remain profitable to lenders in a high inflation environment. They created a mortgage based on the original IPM with two modifications. First, the Mexican DIM indexes payments to the minimum wage thereby assuring that borrowers payment burden would remain relatively constant over the life of the loan. Second, the DIM contract allows the maturity of the loan to increase due to negative amortization. In months when the payment does not cover the full nominal interest accrued, the loan negatively amortizes. This is called "interest refinancing" in Mexico. Thus, the Mexican DIM is a variable maturity mortgage.

The DIM has been used in various forms by most Mexican mortgage lenders since 1985. Some modifications have been made to the original design, in particular, to the payment index. A few commercial banks switched from the minimum wage index to inflation index right before the 1994-currency crisis. This caused severe payment shock when inflation spiked in 1995, which in turn led to widespread default. Bernstein (1997) and Bernstein, Lee, and Renaud (1997) have covered the problems associated with the currency crisis and the Mexican DIM.

The SOFOLES DIM

The DIM used by the SOFOLES takes yet a slightly different form, combining some features of the original Mexican DIM and some features of inflation indexed mortgages known as Price Level Adjusted Mortgage (PLAM). It is most similar to an instrument analyzed by Scott, Houston, and Quang Do (1993) called the hybrid PLAM. The SOFOLES DIM's debit rate is a fixed real rate. Each month the inflation rate from the previous month is added as a spread over the real rate. The payment rate is the same as the original DIM; it is set at an initial level and adjusted periodically to reflect increases in the minimum wage. The difference between the monthly debit amount and the monthly payment is added to the loan principal. As a result, only the inflation rate for the previous month is needed as a spread over the real rate to maintain a constant real return. The SOFOLES DIM is like a hybrid PLAM; the interest accrued on the loan is a fixed real rate, and the payment is calculated separately and related to inflation. It differs from the hybrid PLAM both because the payment rate is indexed to the minimum wage, which is determined by government policy and varies in the degree it follows inflation and because it is an adjustable maturity loan.

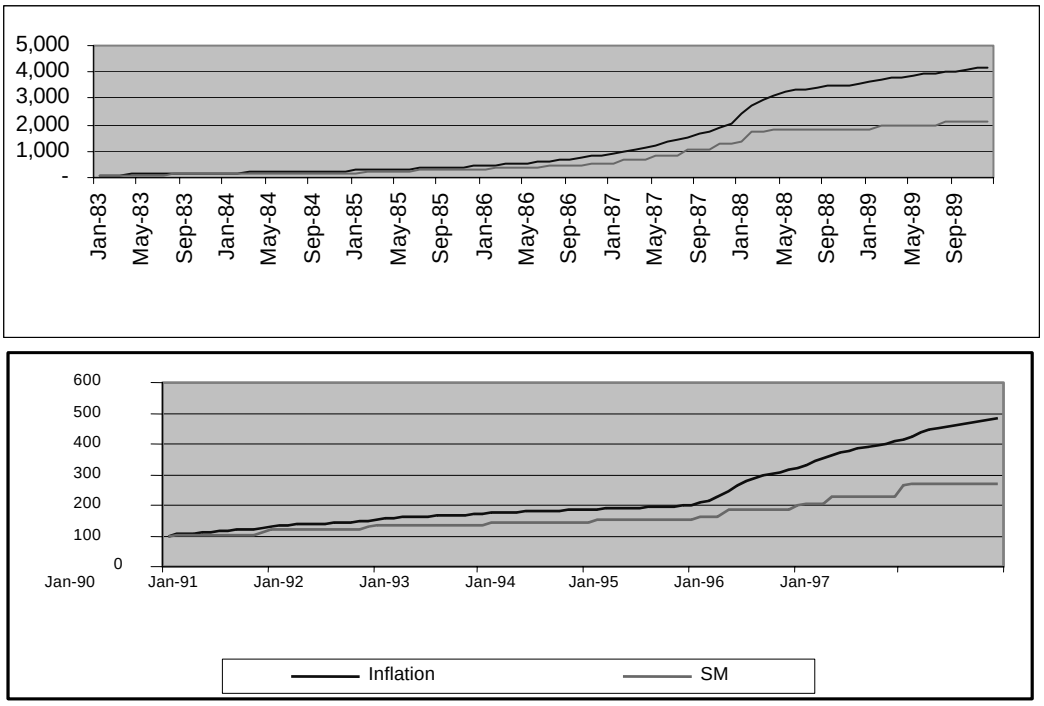
Typically, initial payment rates on SOFOLES DIMs are set low to permit greater affordability. SOFOLES DIMs are set at an initial monthly payment rate of NP$7.0 per NP$1000 of the original loan balance. (Payment rates are quoted as pesos/thousand/month. A New Pesos 7.0 payment per month per NP$1000 original balance is equivalent to 8.4 percent initial annual payment rate. The rate usually increases each six months with the minimum wage.) The loan's annual debit rate is 5 percent real plus the previous months realized inflation rate. The inflation rate since 1995 has implied an annual nominal debit rate ranging from 10 to 95 percent. Thus, loan balances have grown in nominal terms. However, as long as the monthly payment covers the real interest accrued, then the balance decreases in real terms. Bernstein (1997) and Agudo Roldan and Campos Spoor (1992) provide a more thorough discussion of the interest refinancing aspects of the DIM. They show that refinancing the remaining nominal interest into the balance of the loan has the same effect as indexing the loan balance to inflation. However, if the payment rate is set too low or if inflation creates excessive negative amortization at the beginning, it is possible that the loan

will not fully amortize over a reasonable period. For this reason FOVI forgives any balance remaining on loans past thirty years.

The SOFOLES DIM separates the loans' payment rate and accrual rate (nominal interest rates), and this lowers the interest rate elasticity of borrowers' demand. Castaneda (1995) has shown that the observed interest rate inelasticity of demand for mortgage credit in Mexico between 1989 and 1993 can be explained by the fact that the DIM provides borrowers with greater flexibility in making their inter-temporal consumption choices. Borrowers face the lower payment rate rather than the debit rate as the price of mortgage credit. This can have important implications for credit rationing in an environment such as Mexico where the demand for housing is high, rental units are limited, and access to credit is restricted. Borrowers may obtain credit at a lower initial procurement price.

The SOFOLES DIM creates greater affordability and flexibility for the borrower by indexing payments to wages, but it also increases risks for the lender because cashflows are hard to predict and in general deferred or "back-ended." Wage increases affect cashflow timing in two ways: directly through setting the payment rate and indirectly by influencing borrower prepayment and default decisions. The SOFOLES DIM cashflows are hard to predict because changes in the minimum wage index cannot be projected accurately. A special commission comprised of government and labor union representatives determines the minimum wage. The commission adjusts the minimum wage in accordance with inflation and other economic and political considerations. The minimum wage has, at times, been set to deliberately lag inflation as a part of government policies to fight price growth. During the high inflation period of the 1980s the Economic Solidarity Agreement (*Pacto*) included a pact between the government and labor unions to hold wages fixed. Between 1983 and 1989 the cumulative increase in the minimum wage lagged inflation consistently by over 25 percent as a result of this agreement and diverged drastically in 1988 when inflation spiked because of the debt crisis. The minimum wage has also fallen behind inflation in the 1990s, though less severely, until the currency crisis of 1995, which again led it to a wide divergence. Figure 1 shows the trajectory of inflation and the minimum wage over both the 1983-89 and the 1990-98 periods.

Figure 1: Inflation vs. Minimum Wage



Banco de Mexico 2000.

Note that wage growth always lags increases in nominal interest rates due to inflation. This is because expected inflation is reflected monthly in the nominal interest rate whereas wages are adjusted to account for realized inflation after the fact and at longer intervals (about once or twice a year). The difference between the expected inflation rate and the indexed payment rate creates an unattractive risk for lenders.

The wage index also has an indirect effect on SOFOLES DIM pricing. The SOFOLES DIM keeps initial payment rates low by deferring inflation and principal payments until later thereby generating negative amortization. Negative amortization increases the likelihood that the outstanding loan balance is greater than the market price of the home or, in other words, that a borrower has negative home equity.[13] This heightens the probability of default. Nearly two decades of research on borrower behavior in the United States has shown that negative home equity is the leading cause of default. Income and payment shocks can also lead to

[13] The option to default is "in the money" when the outstanding loan balance is greater than the home price and thus exercising the option increases borrower wealth.

borrower delinquency and default. The SOFOLES DIM buffers borrowers from these types of shocks, but it allows the principal balance to increase and potentially leaves borrowers in a negative equity position.

The structure of the SOFOLES DIM has offered advantages to borrowers in terms of lowering their initial payment rates and preventing payments from growing too rapidly even in an inflationary environment. However, the discrepancy between the accrued interest rate and the payment rate has also created challenges for securitization. Discretionary government policy, which determines the timing and magnitude of wage adjustments, in conjunction with negative amortization's impact on borrower default, can make DIMs riskier than conventional mortgages if not designed and managed properly. It also makes financing DIMs more difficult particularly for lenders funding their mortgages through short-term nominal rate liabilities.

Simulating the Performance of the DIM

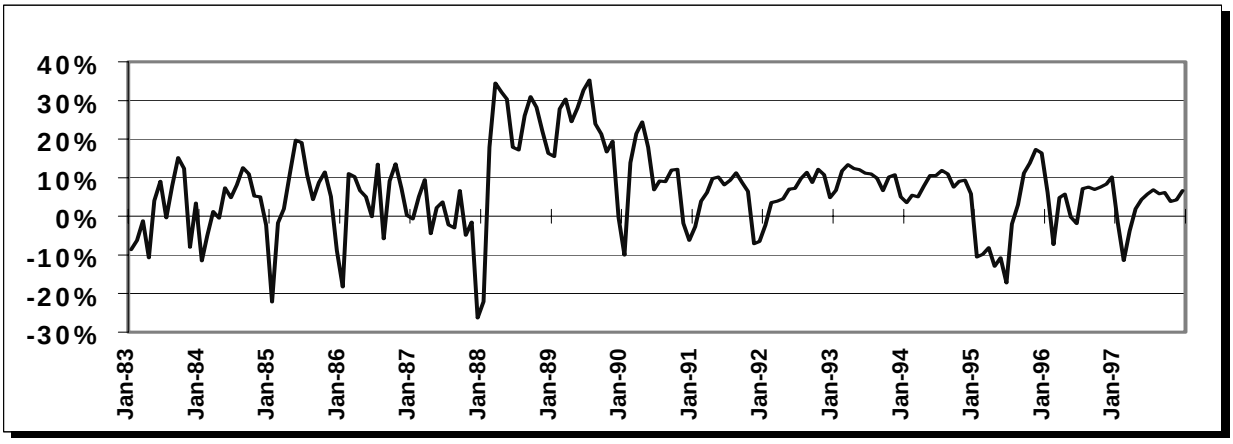
To illustrate how to approach pricing DIM mortgages and to provide rough estimates of the value of the FOVI subsidy for the loans that currently exist on SOFOLES balance sheets, a series of simulations were run under various macroeconomic and borrower default scenarios. The simulations were based upon a simple pricing model. The model generates a cashflow for the loan by simulating the inflation rate and house price movements. The inflation rate coupled with a user-inputted government policy rule for minimum wages changes determines borrower payments.[14] House price movements and the outstanding balance on the loan yield a loan-to-value ratio that drives the default function. Default is calculated as a percent reduction in the remaining cashflow. Once the monthly cashflows are specified, they are discounted by the forecasted short-term nominal interest rate to obtain the net present value (NPV) of the loan, servicing fees, and government subsidies. The model also reports the spread over funding costs for the loan. A full description of the model is found in Appendix E.

[14] A policy rule is set at the beginning of the simulation to determine the progressive change in the minimum wage index. A policy rule is a predetermined schedule that the government would apply to all wage changes over the course of the mortgage's life. For example, the schedule could be that the minimum wage will be changed every 6 months to reflect 100 percent of the accumulated inflation, or it could be allowed to lag inflation by 10 percent but adjusted each quarter (three months). Again, no such consistent policy rule exists for the minimum wage rate; it is determined politically through negotiations between the government and the trade unions.

The results reported here (loan terms, absolute spreads over funding costs, and FOVI subsidies) are sensitive to the input parameters specified for interest rates, inflation, and the minimum wage. These parameters were set based on historic values; however, it is important to point out that the following results aim to provide a stylized view of how the DIM performs as well as ballpark figures for its price and current subsidies. These results are not an accurate prediction of the returns investors could expect. Accurate predictions require refined forecasts of future interest rate environments. The forecasts used here are reasonable but inadequate for actual pricing. They allow one to demonstrate the effects of changes in contract terms as well as the problems associated with funding assets, which offer a real return, with liabilities at nominal interest rates.

SOFOLES DIMs are inflation-indexed assets; securities based on them would protect investors from inflation risk. The real return on the mortgage (absent default) is the contractual real interest rate (currently 5 percent), which is indexed to inflation. The lender is guaranteed a fixed real return of 5 percent over the entire (variable) term of the loan and is fully compensated for inflation. Nonetheless, fluctuations in the short-term real interest rate affect the value of the asset. The Mexican real interest rate (derived from the nominal interest rate less inflation) has fluctuated significantly over the last 5 years and has been negative in many periods (see Figure 2). As should be evident, forecasting the long-term real interest rate is extremely difficult. But as suggested previously, the current contractual 5 percent is clearly a subsidized rate. The current model discounts cashflows at a nominal funding rate, which on average yields a real rate of 8.0 percent.

Figure 2: Mexican Real Interest Rate



Source: Banco de Mexico

Technically the discount rate should be lower than the risk free nominal rate as the lender will be compensated for realized inflation. The appropriate cost of funds is the interest rate on inflation-indexed deposits or bonds. Inflation indexed deposits have recently been offered in Mexico, but to date most funds are still captured in nominal pesos terms. [15] The real rate derived from the Fisher identity (real = nominal – inflation) will differ from the real rate reflected in inflation-indexed assets by expectations and inflation risk premium. To see this, note that the loan debit rate specified above is derived from a constant real rate plus actual (realized) inflation, whereas the discount rate is a nominal rate reflecting a variable real rate, expected inflation, and an inflation risk premium:

Debit Rate = Real Rate + Actual (realized) Inflation

(Nominal) Discount Rate = Real Rate + Expected Inflation + Inflation Risk Premium

If the sum of expected inflation and the inflation risk premium are greater than actual inflation, then the nominal interest rate will be upwardly biased and the NPV reported will be downwardly biased. In other words, the return on the loan contract (their price reported as NPV) will reflect the divergence between capturing funds at a nominal, variable short-term interest rates and receiving income at a fixed long-term real interest rate. This represents an added cost in funding mortgages, one currently faced by most banks whose deposits remain in pesos. The model also reports an NPV based on real cashflows discounted at the contractual rate to eliminate this problem.

Results of DIM Simulation

The results of the simulations illustrate the issues investors face in pricing DIMs and how contractual provisions may affect borrower behavior. Effects of loan origination dates and initial payment rates are first discussed. Then the relationship between payment rates, debit rates, and the potential negative amortization is presented. Finally, the minimum wage adjustment, default behavior, and rate subsidies are discussed.

[15] Rates on UDIS bonds and deposits are reported by the Banco de Mexico from January 1997 to present and have ranged from 5.52 to 7.99 percent.

Appendix F shows the summary statistics and sample cashflow for the typical SOFOLES DIM originated in January 1996, assuming no default and no ADE subsidy. The parameters displayed in Appendix E on the model's input screen come from the contract of a typical SOFOLES B loan. The interest rate, housing price, and minimum wage parameters characterize reasonable expectations for the future macroeconomic environment. Under these assumptions the mortgage negatively amortizes in nominal terms through the first ten years reaching over three times the loan's original balance. In real terms, however, thirty percent of the balance has been paid. The balance then levels off, intermittently positively and negatively amortizing over the next ten years, and declines rapidly until the loan is completely paid off in twenty-four years. The Monte Carlo simulations suggest that the loan's average term is 290 months with a standard deviation of 2.83 months. The average spread below funding rates (negative spread) is –176 basis points. The loan fully amortizes within the contractual 30 years so no end-of-term subsidy is provided; however, the low real interest rate on the loan results in a net present value subsidy of roughly NP$12,000 or 12 percent of the loan's face value.[16]

As a point of comparison, a simulation was run on a loan with the same parameters as above but originated in January of 1985. Such a loan would have earned a positive spread over the discount rate (about 210 basis points) but would not have fully amortized in the 30 years specified by the contract and thus left FOVI with an end-of-term balance of NP$25,600 in present value terms. The positive spread over the discount rate results from the fact that real interest rates were often negative in the late 1980s so inflation indexed 5 percent loans earned a real return. The loan would be profitable to lenders in that interest rate environment even though a large balance remained on the loan at the end of its term.

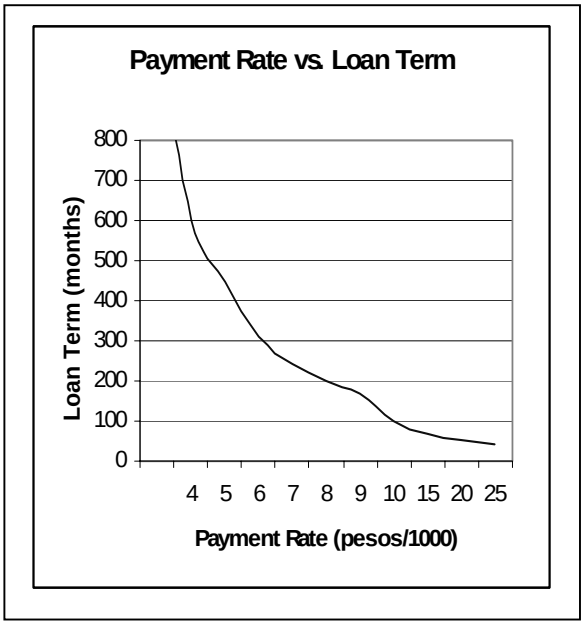
One of the most important parameters of the DIM is the initial payment rate. The SOFOLES loan contracts have begun with a payment of 7 pesos per thousand of original loan balance. This yields an initial effective annual rate of 8.7 percent that increases biannually with the minimum wage. Lowering or raising the initial payment rate has a major impact on the loan's average nominal return and term. Figure 3 illustrates the effects of altering the initial payment rate. As the payment rate decreases, the loan term increases and becomes

[16] The NPV of the loan is on average NP$87,927 (sd. 4,824) when discounted at the nominal interest rate.

infinite below the real rate of interest (equivalent to a monthly rate of 4/1000). [17] If the payment is not covering the real interest rate charged per month then the loan balance grows in real terms and the payment rate cannot increase rapidly enough to ever fully amortize the loan. At lower initial payment rates the loan extends beyond the maximum contract term (30 years). Inversely, at high payment rates the loan amortizes over shorter maturities at positive spreads over the discount rate. This is a result of the volatility of interest rates and the asset-liability mismatch. While the debit rate determines the long-run real return on the asset, increasing or decreasing the payment rate affects the asset's value. This is especially true in a market like Mexico where short-term real rates are high and volatile, and most bank deposits and bonds are floating peso denominated liabilities, increasing or decreasing the payment rate affects the asset's value.

Figure 3: Initial Payment Rate vs. Loan Term (and NPV)

Payment Rate	Mean Loan Term in Months	Basis Point Spread Over Discount Rate
5.0/1000	>480	-270
6.0/1000	413	-157
7.0/1000	291	-134
8.0/1000	228	-113
9.0/1000	188	-74
10.0/1000	160	-47
15.0/1000	93	92



[17] These simulations are based on the parameters specified in the input screen in Appendix E.

20.0/1000	65	243

The amount of negative amortization that a DIM accrues over the initial period of the loan's life is determined by the spread between the initial payment rate and the debit rate. The level that the lender sets the initial payment rate in large measure influences this spread, but so does inflation and the evolution of the minimum wage index. Loans originated immediately following a minimum wage adjustment when inflation is high have longer terms and lower returns. Table 2 illustrates this for the 1996 cohort of loans. Loans originated only one month apart may have several years' difference in term due to divergence between the evolution of inflation and the minimum wage in the early part of the contract. Loan payments are adjusted in the month following the minimum wage increase. The sooner after loan origination that payments are adjusted to reflect inflation the less negative amortization and the shorter the loan term. The extension of term also impacts the loan's return and the interest rate subsidy. The loans with extended terms have a lower return and a higher subsidy.

Table 2: Origination Date Impact on Term and Subsidy

Month of Origination	Inflation	Minimum Wage Increases	Average Loan Term (in months)	Return (Basis Points over cost of capital)	Subsidy (in pesos based on 100,000 loan)
1996					
January	2.67 %	1%	290	-176	$12,073
February	3.89 %		281	-147	$9,931
March	2.73 %		263	-133	$8,005
April	2.32 %	12%	250	-133	$8,080
May	2.47 %		297	-182	$12,801
June	2.46 %		284	-184	$12,521
July	1.72 %		272	-164	$10,489
August	1.55 %		263	-193	$12,507
September	1.40 %		257	-165	$10,136
October	1.35 %		251	-166	$10,182
November	1.51 %		245	-174	$10,570
December	1.27 %	16.5%	239	-187	$11,297

Minimum wage adjustments in Mexico typically occur twice a year in December or January (sometimes both) and in June or July. In the 1980s the minimum wage lagged inflation consistently. In the early 1990s the minimum wage tracked inflation more closely but wage adjustment occurred only once a year. Following the peso devaluation, the minimum wage was again allowed to fall behind inflation.

Simulations of different minimum wage adjustment scenarios show its effect on loan duration, return, and subsidy (Table 3). The evolution of the minimum wage as a percentage of inflation has the largest impact, but frequency of adjustment is significant as well. It is important to differentiate the effect of the payment adjustment speed from the initial level payment rate set on the loan. The initial payment rate has a larger overall impact on the loan's performance; however, it is determined by the lender or in theory could be elected by the borrower. Payment adjustments when tied to the minimum wage are determined

exogenously and are difficult to forecast as they rely on the outcome of government negotiations with trade unions. Some commercial banks in the early 1990s switched the payment index to inflation for their higher income borrowers. The scenario with 100 percent evolution of the minimum wage and 12 adjustments a year is equivalent to an inflation-indexed payment lagged one month. The problem with this contract has been that borrowers are faced with severe payment shocks when inflation rises and incomes adjust more slowly.

Table 3: Minimum Wage Adjustments

Evolution of Minimum Wage (as a percentage of inflation)	Frequency of Adjustment (adjustments / year)	Average Loan Term	Average Spread Basis Points over Cost of Capital	Subsidy (in pesos based on 100,000 loan)
110 percent	12	239	-94	$5,778
	6	242	-101	$6,398
	4	245	-124	$8,188
	2	251	-119	$7,806
	1	263	-105	$6,664
100 percent	12	278	-120	$8,091
	6	281	-139	$8,943
	4	283	-121	$8,048
	2	290	-176	$12,073
	1	305	-154	$10,655
90 percent	12	353	-139	$9,883
	6	358	-138	$9,411
	4	359	-149	$10,590
	2	369	-161	$11,509
	1	395	-147	$10,771

Investors in DIM securities will also need to assess borrower default and prepayment behavior. All the previous simulations were run assuming no default or prepayment. As

mentioned earlier, prepayment is not modeled here. Although prepayment occurs in Mexico, it usually takes the form of partial prepayments rather than complete liquidation of the loan. The market for mortgage credit is so restricted that refinancing is not an option for most low-income households. Furthermore, household mobility is lower than in the United States where a significant portion of prepayments are due to relocation. The factors influencing partial prepayments are not well understood, and without data on prepayment behavior it is difficult to model.

Default, however, has been a major problem for banks in recent years. The SOFOLES have been able to maintain extremely low default levels despite unfavorable economic conditions, but FOVI's subsidized interest rate and end-of-loan balance forgiveness has undoubtedly influenced borrower behavior. The following set of simulations examines various default scenarios for loans of five different vintages (Table 4).[18] Here default is assumed to lead to 100 percent credit loss. This is the extreme loss scenario. For cases in which default leads to judicial foreclosure (currently a small number for the SOFOLES), 100 percent loss is not an unreasonable outcome. Judicial foreclosures in Mexico can require 3 to 5 years and may result in a ruling in favor of the borrower; the lender then suffers a total loss. To avoid such outcomes, the SOFOLES frequently opt to restructure the borrowers loan or even pay the borrower to vacate the property so that it may be resold rather than proceed with judicial foreclosure. Again, assuming a 100 percent loss rate provides a lower bound for the adverse effects of default.

The model predicts default to be the highest in the January 1995 loans as they are the cohort with the greatest negative amortization. The loan-to-value (LTV) of these loans reaches one by the second year in all simulations and climbs to nearly two in many simulations. Thus, when the minimum probability of default is set to 100 percent, all loans terminate at the end of the second year. In contrast, the simulations of the later cohorts shows that in most runs the LTV never exceeds one therefore default does not occur in most iterations consequently bringing down the average.

The impact that default has on the risk adjusted spread reflects not only the average overall level of default but also its timing in the life of the loan. Default decreases the risk-

[18] Simulations use the interest rate and inflation parameters listed in Table 1. The minimum wage is assumed to track inflation 100 percent adjusts two times per year.

adjusted spread of the loan by between 50 and 600 basis points depending on the loan's vintage and the preset default assumptions. If borrowers behave "ruthlessly" and exercise the option to default when it is in the money (assuming perfect information) then borrowers holding loans issued in the unfavorable economic climate of January 1995 would all default. Default would rise significantly even for loans originated in more favorable conditions like those of 1997.

Table 4: Default Scenarios

Loan Origination	Model Default Scenario	Average Default	Term (months)	Risk-Adjusted Spread (Basis Points over Cost of Capital)
January 1995	0 default	0%	464	-16
	10% when LTV>1, grows 100% with LTV	13.2%	464	-180
	100 % default when LTV >1	100%	464	---
July 1995	0 default	0%	321	-139
	10% when LTV>1, grows 100% with LTV	6.15%	321	-187
	100 % default when LTV >1	22.90%	321	-254
January 1996	0 default	0%	290	-176
	10% when LTV>1, grows 100% with LTV	5.22%	290	-234
	100 % default when LTV >1	28.13%	290	-781
July 1996	0 default	0%	273	-146
	10% when LTV>1, grows 100% with LTV	4.51%	271	-247
	100 % default when LTV >1	21.11%	271	-324
January 1997	0 default	0%	310	-187
	10% when LTV>1, grows 100% with LTV	3.02%	310	-191
	100 % default when LTV >1	20.00%	310	-640

Credit constraints make such ruthless default unlikely as does the end-of-term balance forgiveness. However, it is important to highlight the impact negative amortization can have on borrower behavior and thus the performance of the DIM. The DIM has created greater affordability by capitalizing interest payments into the balance of the loan. This presents no

problem as long as the real interest is covered by the monthly payments thereby maintaining a constant real loan balance, and as long as housing prices keep pace with inflation. However, if the loan balance grows excessively or if house prices significantly lag inflation, then the probability of default will rise.

As previously stated, the original SOFOLES DIM carries an interest rate subsidy. The amount of the subsidy depends upon the course of interest rates, inflation, and the minimum wage. On average, the subsidy ranges from NP$5,000-NP$13,000. To eliminate this subsidy the real interest rate on the loan would have to be raised. A final set of simulations was run to determine the impact of raising the loan's accrual rate to 8 percent real. An 8 percent real interest rate is closer to what investors would demand as a return on SOFOLES mortgages. Raising the debit rate and keeping the payment rate at $7 pesos/1000 of loan balance results in a loan that exceeds the thirty year loan term and an end-of-term present value balance of NP$27,500. This outcome is worse than the former interest rate subsidy and highlights the importance of increasing the payment rate. With an initial payment rate of $9 pesos/1,000 loan balance, the loan yields a positive return of 216 basis points and fully amortizes in 25 and one-half years. This does not account for losses due to default.

It is important to point out that increasing the initial payment rate to $9 pesos/1000 would not create an affordability problem for most borrowers. To see this, note that if even if a borrower is at the current FOVI underwriting guideline limits of 25 percent payment-to-income, increasing their initial payment to $9 pesos per thousand would place them at a payment-to-income ratio of 32 percent. This is well within the underwriting guidelines of most US low-income lenders. Albeit DIM mortgage payments grow, they grow in tandem with wages so should not create a problem for borrowers.

The New FOVI Mortgage Instrument

As the previous simulations reveal, the DIM is a complicated mortgage to price and is more risky than some instruments due to its negative amortization. After the 1994 currency crisis, many commercial bank DIMs built up so much negative amortization due to the resultant high inflation that balances reached two and three times their original level. Default skyrocketed and banks took large losses. The DIM mortgage was blamed for these losses. For these reasons FOVI was under pressure to change the type of mortgage it promoted.

FOVI has elected to switch to a fixed-rate price-level adjusted mortgage in which both the loan balance and payments are fixed in UDIS and the term is fixed to 30 years. FOVI's new program also reduces the interest rate subsidies and, as previously mentioned, allows SOFOLES to set their own financial margin on servicing. Under the new program interest rates have been raised by about 3 percentage points. Under these contracts, mortgage payments remain constant in real terms (UDIS) each month but increase by inflation in nominal terms. The loan balance, which is also UDIS denominated, increases in peso terms with inflation.

The new mortgage design alleviates many of the problems associated with the DIM. In real terms, the new contracts are equivalent to the fixed rate mortgages commonly issued in the United States. The loans positively amortizes from inception so that borrowers build up equity in their homes. This helps reduce default risk. There is no extension risk as the mortgage has a fixed term. And like the DIM, these mortgages offer a real return to investors and completely compensate them for inflation.

The principal disadvantage of the new design is that it creates affordability problems for low-income borrowers. Initial payment rates on the new mortgage are roughly 50 percent higher than the old design and 20 percent over that of a DIM with a 8 percent real interest rate (and 9 pesos/thousand loans balance). In part, this is due to the familiar "tilt" of fixed-payment, fixed-interest rate mortgages in a high inflation environment. The required inflation premium in a fixed-interest rate, fixed-payment mortgage makes initial payments larger than otherwise required because inflation diminishes their real value over time. This tilt effect makes payments higher in real terms in the early years of the mortgage when borrower-earning power is likely to be less and diminishing in the later years when borrowers income is actually higher.[19]

To improve affordability and alleviate the pressure of monthly inflation driven increases in payments, FOVI has created a swap that allows borrowers to switch their payments from monthly inflation adjustments to annual minimum wage adjustments. The swap is administered by a trust of FOVI (the Banco de Mexico). Borrowers can purchase the swap for an 11 percent increase in their monthly payments. While this helps defer payment increases to one-year intervals, it does not lower the overall payment burden. Furthermore,

SOFOLES have commented that they find it difficult to manage the added swap contract.[20] Customers do not understand the contract and question the utility of paying an extra 11 percent each month to insure against monthly inflation increases. A better solution would be to make investors bear some of the inflation risk and to create traded instruments that would allow them to hedge this risk.

Conclusion

The SOFOLES have played an important role in maintaining mortgage lending to low-income households in Mexico through the financial crisis of recent years. They have expanded to fill the void left by the commercial banks in the mortgage sector and have improved efficiency by innovating in many important areas of origination and servicing. However, their lending programs have been wholly dependent on receiving matched funding from FOVI at a subsidized interest rate. This is gradually changing as FOVI has begun to encourage more market-based operations by raising its interest rates to commercial levels and deregulating servicing fees. Nonetheless, SOFOLES' business will be severely curtailed in the future if their operations cannot expand and adapt to the higher costs of attaining capital through market mechanisms.

The SOFOLES have been highly profitable with an average return on equity of 38 percent in the last year. These profit margins will decrease with greater competition and higher costs of funds. The SOFOLES mortgages have carried two forms of borrower subsidies: below market interest rates and forgiveness of the end-of-term balance if sufficient negative amortization leads the loan's term to extend beyond the contracted period. Both of these subsidies affect the profitability of the mortgage, but as the simulations suggest, the subsidized interest rate is most significant under the original contractual provisions. The interest rate that a SOFOLES mortgage must carry to earn a market return is substantially higher, about 300 basis points. Raising the contract interest rate puts greater payment pressure on borrowers; the new PLAM mortgage design exacerbates this due to its associated payment tilt. Still the new mortgage will facilitate securitizing SOFOLES loans in the future.

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[19] The DIM was designed in the 1970s at MIT precisely to overcome the payment tilt problem.
[20] Personal communication Manuel Campos Spoor, December 1999.

SOFOLES servicing fees are already in line with US servicing fees for loans that are of much higher balances and thus are providing the SOFOLES with an adequate revenue stream. The new lending guidelines will only increase these earnings. While cost in servicing and origination are high in Mexico due to several shortcomings of the legal system and postal service, costs are falling. The SOFOLES can weather some reduction in revenues before becoming unprofitable.

FOVI has funded well over US $1 billion in DIM mortgages through the SOFOLES. Removing these assets from the SOFOLES balance sheets through securitization would both increase liquidity, allow for greater risk diversification, and allow FOVI to provide more direct subsidies to the lowest income households through the PROSAVI program. In order for SOFOLES' DIMs to be securitized, investors must have a better understanding of how DIMs perform. The above analysis highlights some of the central problems in pricing these assets. Chief among them is how to estimate cashflows based on the minimum wage index. In addition, much more analysis must be done on borrower behavior in the mortgage market. It is unclear how SOFOLES' borrowers may behave in response to higher interest rates, payment rates, and longer loan maturities (no end-of-term balance forgiveness). Default has been extremely low but is unlikely to remain so in a normal market environment. The wide variety of subsidies and borrower relief programs currently existing make it difficult to predict unconditional borrower behavior. Additional history and data are needed for better understanding and correctly pricing default risk in the Mexican mortgage market.

The SOFOLES reflect some age-old attributes of the Mexican financial sector, namely what is often characterized as the Mexican trinity between government, big business, and banking. The SOFOLES were born out of the interests of government and the construction industry for financing services in the mortgage sector. Yet, they also represent a new direction in the evolution of financial institutions: loan origination and servicing separated from the capture of funds. In a world in which capital markets increasingly intermediate financial flows, specialized loan-servicing companies are important institutional players in the market. The SOFOLES are positioned to become new leaders in the mortgage servicing business. It is important that the barriers to mortgage securitization are overcome to allow for their growth and expansion in the market.

APPENDIX A
List of SOFOLES

	SOFOLES Licensed for Mortgage Lending	Year Began Lending	Number of Loans[1]	Portfolio Value[2] (Millions of Pesos)
	Independent SOFOLES authorized to lend with FOVI funds			
1	Hipotecaria Nacional	1995	27,626	$3,795
2	Hipotecaria Mexicana	1996	20,279	$2,719
3	Hipotecaria Su Casita	1995	18,923	$2,595
4	Crédito Inmobiliario	1996	10,500	$1,904
5	General Hipotecaria	1995	8,388	$1,219
6	Financiamiento Azteca	1995	6,979	$974
7	Patrimonio	1996	5,282	$583
8	Hipotecaria Crédito y Casa	1997	5,160	$1,090
9	Impulsa (formerly Metrofinanciera)	1997	1,928	$231
10	Hipotecaria Mexico	1999	975	$70
11	Financiera Comercial América	1997	871	$187
12	Terras Hipotecaria	1999	699	$82
13	Operaciones Hipotecaria	Newly Authorized	0	0
14	Fincasa	Newly Authorized	0	0
	Independent but Unauthorized to Lend under FOVI Program			
15	Financiera Inmobiliaria, S.A. de C.V.		Unavailable	Unavailable
16	Fomento Hiptecario, S.A. de C.V.		Unavailable	Unavailable
	Affiliated with Foreign Corporations **(Unauthorized to Lend under FOVI program)**	**Affiliate of:**		
17	Hipotecaria Associates, S.A. de C.V.	Associates	Unavailable	Unavailable
18	Credito Familiar, S.A. de C.V.	Bancomer	Unavailable	Unavailable
19	Compañía Hipotecaria de las Américas, S.A. de C.V.	WMC Mortgage Co. Intl.	Unavailable	Unavailable

Source: CNBV 1997, 1998; FOVI 2000.

1. Includes all loans FOVI and non-FOVI, however most SOFOLES hold no more than 10 non-FOVI loans

2. Includes bridge loans

APPENDIX B

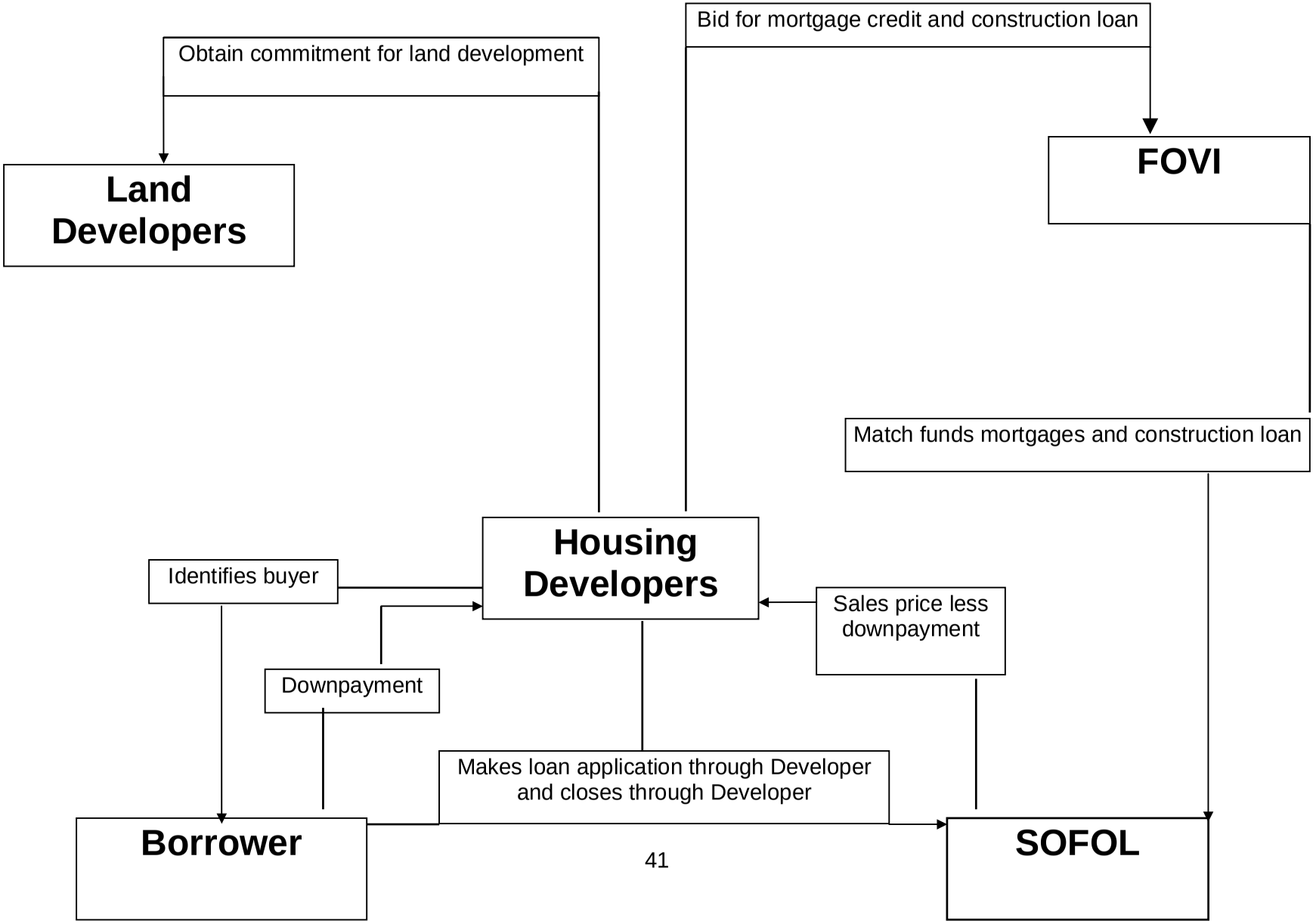
FOVI Underwriting Guidelines and Loan Terms

Terms	FOVI B	FOVI A	PROSAVI
Underwriting Guidelines			
1. Income Group	Middle	Lower Middle	Low
2. Minimum Annual Income Allowable	US$7,800 (6.5 SM)	US$5,400 (4.5 SM)	US$2,400 (2 SM)
3. Maximum Monthly IncomeAllowable	US$18,000 (8 SM)	US$8,400 (7 SM)	US$6,000 (5 SM)
4. Average Value of House	US$20,000	US$14,000	US$8,000
5. Loan-to-Value Ratio	90%	90%	70%
6. Payment-to-Income Ratio	25%	25%	25%
7. Min and Max Age of Borrower	21-54	21-54	21-50
8. Min. Yrs in Current Employment	2	2	Currently employed
9. Min. Yrs at Current Residence	2	2	None
Loan Terms			
10. Lending Instrument	Dual Index Mortgage	Dual Index Mortgage	Dual Index Mortgage
11. Interest Rate	5% real	5% real	5 %
12. Index	Inflation (UDIS)	Inflation (UDIS[1])	Inflation (UDIS)
13. Adjustment Period	Monthly	Monthly	Monthly
14. Payment Rate	$7.00/1000	$7.00/1000	$7.00/1000
15. Payment Index	Minimum Wage	Minimum Wage	Minimum Wage
16. Adjustment Period	6 Months following Wages	6 Months following Wages	6 Months following Wages
17. Loan Terms	360 Months	360 Months	360 Months
18. Direct FOVI Subsidy			US$2,200 (8,000 UDIS or roughly 20% of the house value)
Origination and Servicing Costs			
19. Opening Commission	3.0 %	3.0 %	3.0%
20. SOFOLES Servicing Fee	$2.50/1000	$0.50/1000	$0.50/1000
21. FOVI Servicing Fee	$0.50/1000	0	0
22. Appraisal Fee	0.25%	0.25%	0.25%
Credit Investigation Fee (per loan)	$300.00	0	0

Source: FOVI, Banco de Mexico 1997.

[1] UDIS = *Unidades de Inversion* (Inflation-indexed accounting units)

APPENDIX C : Loan Origination



APPENDIX D

Loan Delinquency: Number of Loans Delinquent by Months Past Due

		Months Delinquent																																				
		3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	Total	Total # of loans originated	% of loans
1	**H. NACIONAL**	37	20	18	10	5	9	8	3	5	1	1	4	2	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	126	27,626	0.46%
2	**H. MEXICANA**	67	43	32	16	9	18	4	4	2	5	5	5	2	1	2	8	4	4	4	1	0	0	0	2	0	0	3	0	0	0	0	0	0	0	241	20,279	1.19%
3	**H. SU CASITA**	53	43	28	24	14	8	9	10	11	16	9	5	4	1	3	0	2	0	1	3	1	0	1	0	0	0	0	1	0	0	0	0	0	0	247	18,923	1.31%
4	**CRED. INMOB.**	55	17	4	3	15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	94	10,500	0.90%
5	**GENERAL HIP.**	23	76	2	15	5	7	16	12	5	4	3	7	0	0	3	2	3	1	2	2	1	2	0	1	1	0	1	0	1	0	0	0	0	1	196	8,388	2.34%
6	**F. AZTECA**	28	0	0	5	7	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	45	6,979	0.64%
7	**PATRIMONIO**	38	13	13	3	2	3	2	2	2	0	1	2	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	82	5,282	1.55%
8	**HIP. CREDITO Y CASA**	66	16	8	5	5	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	104	5,160	2.02%
9	**IMPULSA**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1,928	0.00%
10	**H. MEXICO**	5	2	2	1	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	975	1.23%
11	**F. COM. AMERICA**	5	1	2	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	871	1.15%
12	**TERRAS**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	699	0.00%
13	**OPERACIONES HIP.**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%
14	**FINCASA**	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00%
	T O T A L	142	32	25	14	14	8	5	5	2	0	2	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	253	21,894	1.16%

Source: FOVI, Banco de Mexico, December 1999.

APPENDIX E

The SOFOLES Mortgage Simulation Model

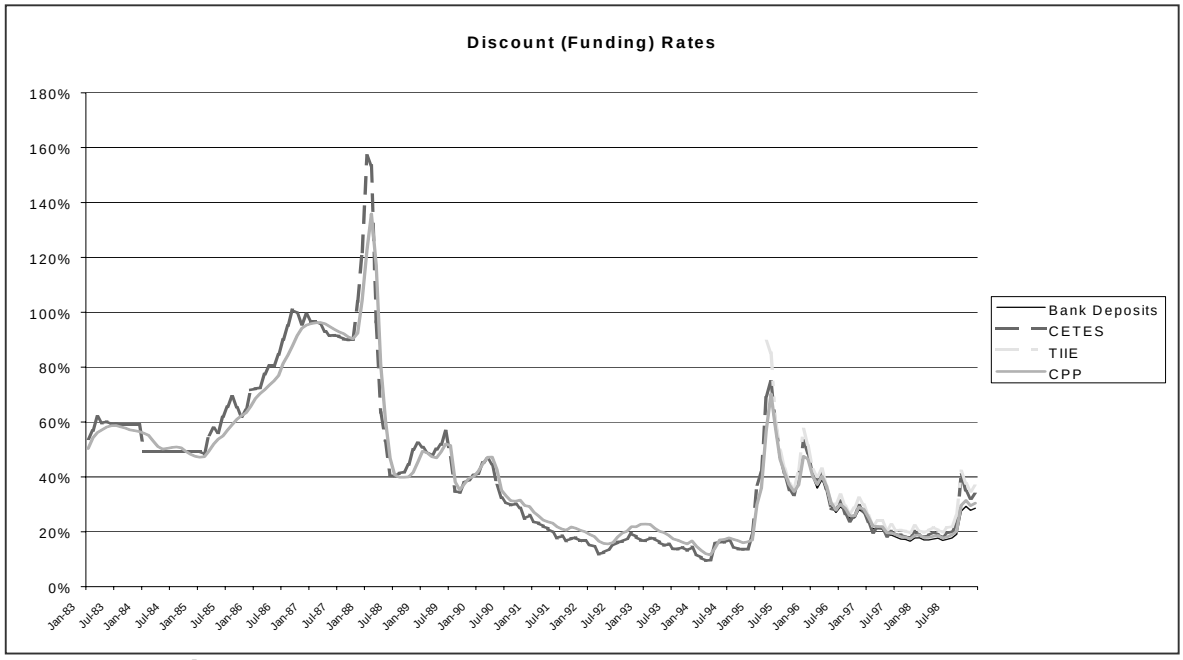
The model developed to simulate the performance of the SOFOLES mortgages requires the user to input the contractual provisions of the loan, some simplified assumptions about borrower payment behavior, government subsidy programs, and minimum wage policy. Figure 1 shows the input screen for the SOFOLES mortgage simulation model. The user must specify the origination date, initial real interest rate, payment rate, the frequency of payment rate adjustments, a maximum and minimum borrower default rate, and whether the mortgage is part of the ADE government subsidy program. The model also allows the user to specify the origination and servicing fees charged by the SOFOLES and FOVI so that estimates can be made of loan servicing profitability under different macroeconomic scenarios (interest rate environments), fee schedules, borrower behavior, and stylized government wage policies.

Figure 1: Simulation Model Input Screen

FOVI Mortgage Model				
	Loan Contract Parameters	**Enters Parameters into Matlab**	**Variable Names in Matlab**	**Run Model & Retrieving Results**
Initial Loan Amount	100,000	0	inloan	***Run Deterministic***
Initial Property Value (LTVof 90)	111,111	0	inpropval	0
Loan Origination Date	01/01/96	0	ordate	***Set Number of Runs***
Real Interest Rate (annual)	5.00%	0	inrate	1000
Payment Rate	**0.70%**	0	inpay	0
Original Loan Term	25	0	loanterm	***Start Runs***
Loan Forgiveness After Year (100= no loan forgiveness)	30	0	loanforg	0
ADE program (yes=1, no=0)	0	0	ade	**Print**
				Full Matrix
SOFOLES origination fee	3.000%	0	soforg	0
SOFOLES servicing charge	0.250%	0	sofserv	0
				Summary
FOVI servicing charge	0.050%	0	fovorg	***Statistics***
				0
Specification for Borrower Default				0
Minimum Percent Default	0%	0	defaultmin	0
Maximum Default (as percent of max LTV)	0%	0	defaultmax	0
				Run
Specification of Macroeconomic Scenario				***Summary***
Evolution of Minimum Wage (as percentage of inflation)	100%	0	smadjust	0
Frequency of Minimum Wage Adjustment (12,6,4, 2 or 1 X per yr)	2	0	smevol	0
Discount rate (Bank Deposits=1, CETES=2, TIIE=3, CPP=4)	1	0	discount	0
Spread Over Discount Rate (can be negative)	0	0	spread	0
				Clear Matlab
Exports Macrodata to MathLab		0	macrodata	0
Parameter of Nominal Interest Rate Process		0	(set all)	
Mean Reversion	0.4500	0	k_int	
Long-run Mean	0.2400	0	o_int	
Diffusion Volatility	0.0200	0	v_int	
Mean of Jump Shock	0.0001	0	m_int	
Variance of Jump Shock	0.0002	0	g_int	
Poisson increment	0.1900	0	q_int	
Correlation with Inflation	**0.95**	**0**	roe	
Parameter of Inflation Process				
Mean Reversion	0.3500	0	k_inf	
Long-run Mean	0.0100	0	o_inf	
Diffusion Volatility	0.0020	0	v_inf	
Mean of Jump Shock	0.0001	0	m_inf	
Variance of Jump Shock	0.0002	0	g_inf	
Poisson increment	0.1600	0	q_inf	
Parameters of Housing Price Process				
Expected Rate of Appreciation in House Prices (inflation=1)	0.1600	0	hapfact	
Volatility of distrubances in House Price Appreciation	0.0050	0	v_hom	
Correlation with nominal interest rate shock	0.8100	0	roe_hom	

The model allows the user to choose between different discount rates reported by the Banco de Mexico. The discount rate should depend on the assumed funding source. Bank deposits are the average cost of short-term commercial bank receipts. The 28-day peso-denominated Mexican treasury bill rate, the *Certificado de la Tesorerí* (CETE), reflects the money market for nominal government debt. The cost of bank term deposits (domestic currency) rate, the *Costo de Captación a Plazo* (CPP), is a weighted-average of actual bank time deposits calculated monthly by the Banco de Mexico. This rate is slightly higher than the short-term deposit rate, but the series reported by the Banco de Mexico only covers two years from January 1996 to December 1998. The short-term deposit rate is used prior to that. Finally, the average inter-bank interest rate, the *Tasa de Interes Interbancaria Promedio* (TIIP), is the average of at least six interest rates quoted by commercial banks to the Banco de Mexico on a hypothetical transaction of a given amount and maturity. The Banco de Mexico retains the right to complete any transaction at the rate quoted, thus this rate is meant to better reflect current market conditions than the 28-day CETES or CPP rate. The TIIP rate only existed from March 1995 onward. Figure 2 shows a graph of these four rates over the 1983-1997 time period.

Figure 2



Source: Banco de Mexico

Interest Rate and Inflation Processes

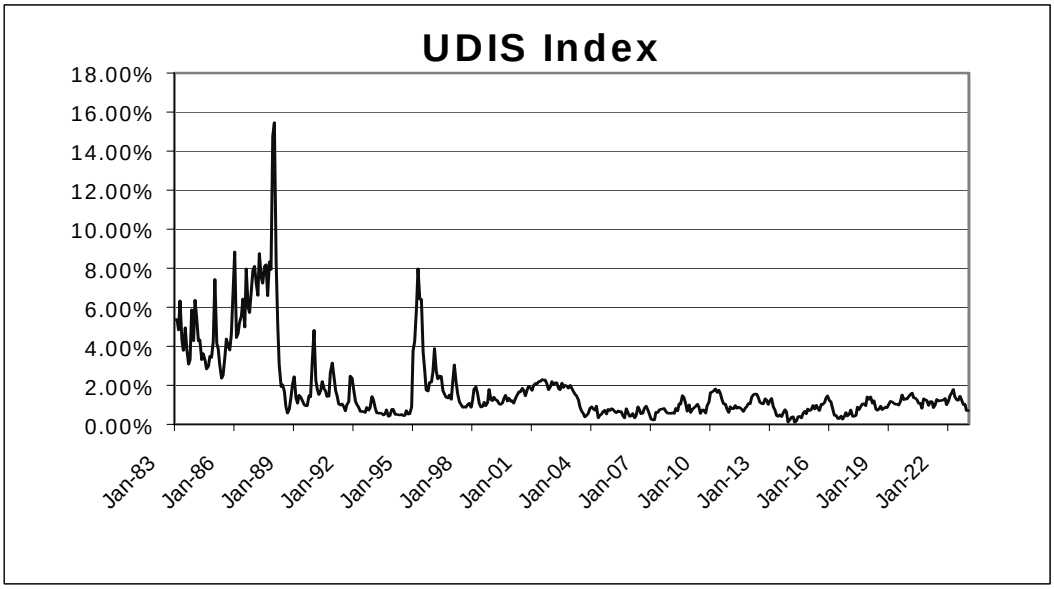
The evolution of the monthly interest rate (discount rate), the Unidad de Inversion (UDIS) inflation index, which is equivalent to the CPI reported on a daily basis, and the minimum wage rate are the three macroeconomic variables affecting DIM cashflows. The SOFOLES DIM accrues interest at a fixed real rate plus inflation. The real interest rate is indexed to the ratio of the value of the UDIS from the last day of the previous month divided by the value of the UDIS on the last day two months prior. The interest accrual rate for month *t* is:

$$\text{Accrual Rate}_t = \text{Real Rate(constant)} + (\text{UDIS}_{t-1}/\text{UDIS}_{t-2} - 1)^1$$

The UDIS reflects the daily increase in consumer prices derived from the bimonthly measurement of the national consumer price index. The UDIS is increased daily at a constant rate for the 15 days (25^{th} of current month to 10^{th} of next month) between CPI measurement but is based on the previous 15-day inflation rate. The UDIS was created in April 1995. Since the model allows the user to simulate the mortgage performance from January 1983 onward, monthly reported CPI data are used for the period prior to the creation of UDIS. Figure 3 shows the constructed UDIS index from January 1983 to 1998 and a simulated path from January 1999 to 2023.

[1] More precisely the SOFOLES contracts specify that the annual nominal interest rate should be calculated as: $i = \{ (1+r/12) * (UDIS_{t-1}/UDIS_{t-2)} - 1\} * 12$ and that to attain the monthly rate this should be divided by 360 and multiplied by the number of days in the month. This yields a greater annual effective rate.

Figure 3



Source: Banco de Mexico.

The inflation path as well as the path of short-term interest rates is derived from a jump diffusion stochastic process. The simulated rates begin in January 1999.[2] Separate stochastic processes are specified for both nominal interest rates and the UDIS growth rate. The UDIS growth rate and nominal interest rate are highly correlated; between January 1983 and December 1998 the UDIS growth rate and bank deposit rate exhibit an 86 percent correlation. However, one process can not be derived from the other. Movements in the nominal rate reflect changes in the real rate, the inflation risk premium, and expected inflation. Thus, the processes must be estimated separately.

US models used to price residential mortgages commonly assumed that the spot interest rate follows the mean reverting Cox, Ingersoll, and Ross model:

[2] The observed yield curve for government securities was not used to determine the implied forward rates. The longest term nominal peso denominated bond in Mexico is one year, thus only one year of implied monthly future rates could be inferred from the yield curve. UDIS denominated bonds are issued for three to five years.

$$dr = \gamma(\theta - r)dt + \sigma_r \sqrt{r} dz_r$$

where γ is the rate of mean reversion, θ is the long-run mean, and σ_ρ is the instantaneous standard deviation. This diffusion model lends itself to applications for solving optimal decision rules for prepayment and default behavior and provides an adequate process for simulating interest rate movements in the United States. However, as Figures 2 and 3 exhibit, the UDIS and Mexican interest rate series move far more discontinuously than interest rates in the United States.

The stochastic process used to simulate both interest rates and UDIS growth rate is a jump-enhanced diffusion process (Poisson-Gaussian) proposed in recent work by Sanjiv Das (1998). Das has shown that a mean-reverting process can be combined with a random jump specified as:

$$dr = k(\theta - r)dt + \sigma dz + Jd\pi(h)$$

where *k* is the rate of mean reversion, θ is the long run mean, and σ is the standard deviation of the diffusion process. *J* is a random jump. A Poisson process π with arrival frequency parameter *h* governs the jump, which can be constant or drawn from another probability distribution. Das has shown how this model can be estimated using a continuous time transition density function, through the method of moments, or using a discrete-time approximation when the jumps are normally distributed.

In discrete time the process above is expressed as:

$$\Delta r = k(\theta - r)\Delta t + \sigma \Delta z + J(\mu, \gamma^2)\Delta\pi(q)$$

Where σ is the standard deviation of the Gaussian shock, and Δz is a standard normal shock term. $J(\mu,\gamma^2)$ is the jump shock, which is normally distributed with mean μ and variance

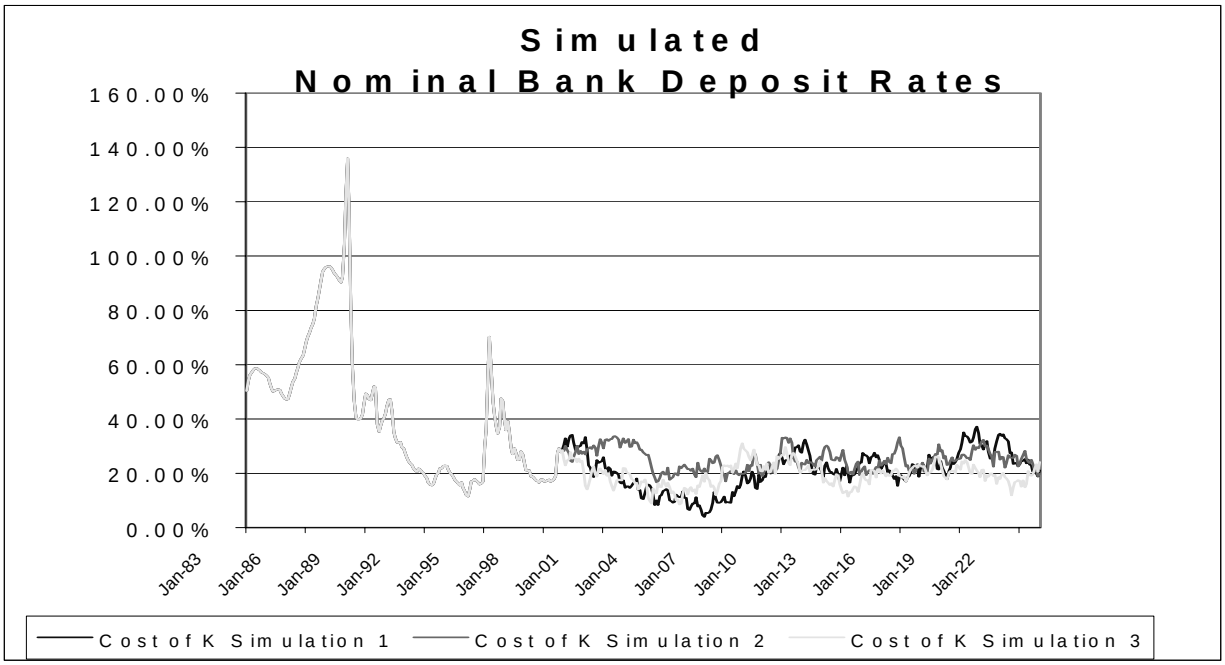
γ^2, and $\Delta\pi(q)$ is the discrete-time Poisson increment approximated by a Bernoulli distribution with parameter q for the probability of a jump in any period. The transition probability for this Poisson-Gaussian process is:

$$f[r_t|r_{t-1}] = q\exp\left[\frac{\left[-r_t - r_{t-1} - k(\theta - r_{t-1})\Delta t - \mu\right]^2}{2(\sigma^2\Delta t + \gamma^2)}\right]\frac{1}{\sqrt{2\pi(\sigma^2\Delta t + \gamma^2)}} +$$

$$(1-q)\exp\left[\frac{\left[-r_t - r_{t-1} - k(\theta - r_{t-1})\Delta t\right]^2}{2(\sigma^2\Delta t)}\right]\frac{1}{\sqrt{2\pi\sigma^2\Delta t}}$$

The transition probability function assumes that only one jump or no jump occurs in each time interval. This is a reasonable assumption for short frequency data; it is less accurate for longer frequency data, such as monthly, but is still an improvement over a pure diffusion model. The transition probability function can be used to estimate the parameters θ, k, σ, μ, γ^2 and q through maximum likelihood estimation. Estimated values are shown in Figure 1. These estimates are based on the short-term average bank deposit rates and the growth in the constructed UDIS series from January 1983 to December 1997. Given the structural changes that the Mexican economy has experienced over these years, estimates from the most recent period based on a shorter time interval would be preferable. Alternative parameters for either of these processes can easily be specified for the model. For instance, a lower long-run mean or higher volatility may be substituted for those estimated from the data. Three simulated paths are shown in Figure 4.

Figure 4



The payment rate and servicing fees are expressed as a number of pesos per 1000 of initial loan balance and are indexed to the growth of the minimum wage index. Because the minimum wage is determined from the policy rule based on the inflation rate, it also becomes a stochastic variable. The algorithm for determining monthly payments divides payments into those made by the borrower and government ADE program and those payments for loan servicing (SOFOLES and FOVI). If the default model is activated and default occurs in a simulation, then the default discount is applied to the borrowers loan payment as well as the government subsidy and servicing fees.

Modeling Default, Prepayment and Housing Price Changes

Rational option-pricing models assume that borrowers' optimally prepay and default when doing so provides a positive payoff, or in other words, when these options "are in the money." Borrowers should default when the value of their home is less than the balance of their mortgage and should prepay when they can refinance the loan for the same remaining term at par for a mortgage rate less then the current loan. These are optimal decision rules for rational agents under complete capital markets, complete information, and no transaction cost.

Research on the US market has shown that while option values are the principal predictors of default and prepayment, actual borrower behavior differs substantially and that, in general, option-based models have overestimated default and prepayment. Borrowers are less ruthless in exercising options than the theory predicts.

In Mexico, where interest rates are more volatile, mortgage refinancing is more restricted, and household mobility is lower and less well understood, option-based models of prepayment and default at best provide a rough approximation of borrower behavior and thereby mortgage prices. The present model assumes zero prepayment and allows the user to specify a minimum and maximum default rate based on the value of the default option (the loan-to-value ratio [LTV]).

A borrower default model was derived from simulating housing prices and determining the LTV over the life of the contract. The National Social Interest House Price Index (*Indice Nacional del Costo de Edificacion de la Vivienda de Interes Social* [INCEVIS]) was used to determine actual house price changes over the period January 1983 to December 1998. The house price was then simulated following Kau, Keenan, and Kim (1993) using a standard log-normal stochastic process:

$$\frac{dH}{H} = (\alpha - s)dt + \sigma_H dz_H$$

Where $(\alpha - \sigma)$ is the expected appreciation in house prices, σ_H is the volatility of house price disturbance term, and dz_H is a Weiner process correlated with interest rate shocks. From the housing price process, month-to-month changes in the house price can be determined and the LTV calculated. When the LTV is greater than one, the default option has a positive value and is thus in the money.

The default model is a simple extrapolation from the option value. Default is treated as a barrier option in which exercise becomes increasingly probable as a function of rising

LTV. [3] In other words, the model assumes that borrowers begin exercising their option to default as the LTV surpasses one and increasingly default in proportional to the value of the option (LTV) as it grows to its maximum. When the maximum LTV is reached, the pool is "seasoned" and default ceases. The user sets the minimum default level (percentage) that occurs if the LTV become greater than one and the percent of the maximum LTV (in excess of 1) that default. Default increases proportionally from the first occurrence of an LTV in excess of 1 to the maximum LTV. For example, assume the user has set the minimum default at 1 percent and the maximum default (as percentage of LTV) at 10 percent. If the LTV ratio reaches 1 in month 50 and grows to its maximum of 1.5 in month 100 then the default level will start at 1 percent in month 50 and rises in proportion to LTV to reach its maximum of 6 percent (1 percent + 0.5 x 10 percent) in month 100. Default is taken as a percent reduction in the remaining cashflow of the loan.

The simple approach taken here to model default allows default to be conceptualized as a barrier option in which borrowers have different strike prices due to inherent heterogeneity, information asymmetries, or because they face different transaction costs. It should be noted that an advantage to using the Poisson-Gaussian process described above for the inflation and interest rate projections is that a conventional option-based pricing method for pricing default can be used if loan termination is fixed. Das (1997) has developed a method for pricing American-type options using discrete data that exhibit Poisson-Gaussian (jump-diffusion) characteristics.

Running Simulations and Reporting Results

The model allows the user to run a series of Monte Carlo simulations based on the input parameters. For each replication random numbers are drawn from the appropriate distributions to project the inflation and interest rate processes and determine the cashflows. Cashflows are discounted at the funding cost prevailing in each month (plus or minus a spread if included). The model reports the mean discounted present value of both nominal and real

[3] Barrier options are options whose payoffs depend on whether the underlying asset price reaches a certain level during a specified period of time. See Hull (1997) for further discussion. Thanks to Alejandro Dias de Leon of the Banco de Mexico for suggesting that default be treated as a barrier option in this context.

cashflows for the term of the loan net of any end-of-term balance. The present value of the end-of-term balance is reported separately. This allows the user to identify both the values of the interest rate subsidy over the life of the loan and the subsidy granted through forgiving the end-of-term balance. The mean present value of the loan, however, includes the government subsidy from the ADE borrower relief program. The discounted present value of the subsidy is calculated and reported separately so that the total present value of the government relief program can be determined. The standard deviation for each of these values is also calculated.

The model also calculates internal rate of return (irr) based on both the nominal and real cashflow and a margin multiple over (or under) funding costs. The margin multiple is calculated as a constant, *m*, in the cumulative discount factor:[4]

$$1/(1+m*i_{t})\,(1+m*i_{t-1})\ldots..(1+m*i_{1})$$

The margin multiple is determined for each individual run and then averaged over all runs in the simulation. It reflects the relative funding costs given an initial price (initial balance) of the loan and a series of funding rates. Absolute basis points spreads over or under the average funding costs are reported. These are determined by multiplying the relative spread, *m*, by the average nominal and real interest rates. For example, if the relative spread is 102% and the average cost of capital *K* is 28 percent then the basis point spread is 28*(1.02)= 28.56-28 = 56 basis points. If the real interest rate is 5 percent then the real interest rate spread is 5*(1.02) = 5.10-5 = 10 basis points.

Finally, the model saves the last monthly amortization, payment, and subsidy schedule for visual or graphical inspection along with the average minimum and maximum default rates.

[4] See Berk and Roll (1988) for a more complete description of the margin multiple.

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