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The impact of the 2001 financial crisis and the economic policy responses on the Argentine mortgage market ☆

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Abstract

Following the 2001 financial crisis, the government of Argentina instituted economic policies to soften the adverse impact of the crisis on the economy. In this paper, we use loan-level data to empirically assess the impact of the currency devaluation and the economic response

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policies on prepayment and default patterns of residential mortgages in Argentina. On the one hand, our results reveal a significant higher prepayment rate of borrowers who are relatively wealthy or have a US$-denominated mortgage. On the other hand, we observe a significantly higher default rate of borrowers who are less wealthy or have Peso-denominated mortgage.

JEL Classification: C41; F31; G21; R20

Keywords: Argentine mortgage market; Prepayment and default; Financial crisis; Currency devaluation

1. Introduction

During the 1990's, Argentina experienced an economic boom.[1] Most observers attribute the Argentine success to the currency peg, control of the inflation rate and the broad market-oriented economic reforms (e.g., privatization, economic liberalization, and deregulation). The reforms encouraged the development of credit markets that facilitated the allocation of capital to the private sector. Capital flow into the residential housing market was especially significant—the unprecedented 16.2% average annual growth rate of mortgage credit subsequently led to the creation of a secondary market in 1996.[2] By 1998, the Argentine economy showed early signs of contraction, partly afflicted by the economic turmoil and currency devaluation of neighboring Brazil. By November 2001, the Argentine economic recession evolved into a full-fledged financial crisis.[3] The government defaulted on its debt, repealed the convertibility regime of the Peso and devalued its currency to 1.4 Peso per US$.[4]

To soften the impact of the crisis and to spread its burden between a large spectrum of economic actors, the Argentine government responded in January 2002 with a series of economic policies that significantly affected the financial situation of many households. The government converted US$-denominated bank loans into Argentine Pesos (ARP) at parity. At the same time, in a move designed to limit the loss incurred by savers but that had paradoxical effects, the government converted US$-denominated deposits into Pesos at the official exchange rate of 1.4 Pesos per

[1] The GDP growth rates increasing by over 50% and inflation rates declined from 23,000 to 0% between 1990 and 1997.

[2] Between 1991 and 2000 the market grew from $3.3 billion to $10.8 billion.

[3] De La Torre et al. (2003) document that by November 2001, 47 of the top 50 banks had suffered major withdrawals ($15 billion was withdrawn between July and November 2001, $1.3 billion was withdrawn on November 30, 2001 alone).

[4] Subsequently, inflation surged 46% between 2002 and 2003, house prices in Pesos jumped dramatically, real levels of household income declined by more than 40% between 1999 and 2002, and unemployment peaked at 23% in 2002. The Argentine economy pre- and post-crisis is discussed at length in Section 3.

US$. Furthermore, the government suspended foreclosure proceedings on defaulted mortgage loans. On the other hand, to alleviate the adverse impact of *pesofication* on creditors, the government first (January 2002) indexed all retail loans to the consumer price index and subsequently (November 2002) to the wage-linked index due to the substantial price surge caused by the currency devaluation and high interest rates.[5] Finally, the government had to float the Peso in January 2002.

In this paper, we use a loan-level dataset to study the prepayment and default behavior of the Argentine mortgage borrowers in response to drastic changes in their household portfolio, triggered by the real life economic and financial stress scenario and the subsequent government policy responses. Specifically, we study the prepayment and default decisions of mortgage borrowers in response to the crisis (November 2001), the depreciation of the Peso (beginning January 2002), the indexation of the mortgage loans to the CPI (January 2002–September 2002), and to wage-linked index (November 2002–March 2004).

The data used in our paper is unique in several respects. Our loan-level dataset is made up of individual mortgage loans that were originated between June 1998 and March 2000, with performance observed until March 2004. In addition to the traditional information captured at loan origination, we also observe if the loan was originated in US dollars (US$) or Argentine Pesos (ARP). The dataset also contains a very rich set of demographic variables (income, wealth, age, occupation, marital status, etc.). Using mortgage debt to assess the substitutability between the prepayment and default options is ideal because mortgage debt is much more sensitive to shocks since it has a longer maturity than other consumer debts. Moreover, following the 2001 financial crisis the Argentine mortgage borrowers faced wealth maximization incentives that were beyond the call and put options. The surge in Argentine mortgage prepayments and defaults that occurred during the post-crisis period simply cannot be explained by the factors shaping the traditional prepayment and default model as well as the actual prepayment and default behaviors in the US.

We expect that the impact of the currency devaluation and the economic response policies on the prepayment and default decisions of the US$-denominated mortgage borrowers will differ from those of the Peso-denominated mortgage borrowers. Furthermore, the prepayment and default behaviors of the relatively wealthy/high-income borrowers will likely differ from those of the less-wealthy/low-income borrowers. In particular, the combination of soaring unemployment, declining income and sharp inflation should create a "poverty effect" leading to a surge in mortgage delinquencies/defaults, especially amongst the less wealthy or Peso-denominated mortgage borrowers. On the other hand, the Peso devaluation along with the *pesofication* as well as the indexation of borrowed capital and the appreciation of residential real estate should create a "wealth effect," and thus lead to a surge in mortgage prepayment, especially amongst wealthy borrowers or US$-denominated mortgages.

[5] The economic and financial crisis and the policy response are discussed at length in Section 2.

To preview our findings, once we control for all the traditional risk factors (LTV, interest rates, credit scores, etc.) predicted by the option theory of mortgage prepayment and default, we find that US$-denominated mortgages on average have a significantly higher prepayment rate and lower default rate in comparison to ARP-denominated mortgages. Moreover, the performance patterns tend to be heterogeneous among US$ and ARP mortgage borrowers along wealth and income characteristics. We find a 9.1% lower default rate and 15.7% higher prepayment rate amongst the wealthy borrowers (of both US$- and ARP-denominated mortgage). Similarly, a 10% rise in income lowered default risks by 9.8% and raised prepayment risks by 10.1%.

Focusing on the impact of the financial crisis and the economic policy on the prepayment and default patterns, we find that following the crisis prepayment risks increased 17.8% and default risks rose 8.2% on average. For a 10% depreciation of the Peso, prepayment risks increased 5.2% and default risks increased 14.2%. Subsequent to the crisis, US$-denominated borrowers with wealth and high income were more likely to prepay but less likely to default. In general, the US$ mortgage borrowers' prepayment rate rose 17.2%, while their default rate declined 3.1%.

Next, we find that indexing the mortgage interest rates to the consumer price index (January 2002–October 2002) resulted in a 28.1% rise in the prepayment rate and 20.8% rise in default rate, with a significantly higher prepayment rate amongst those borrowers possessing more wealth. Finally, indexing the mortgage interest rates to the wage-related indices (November 2002–January 2004) resulted in a 14.3% higher prepayment rate and 13.6% higher default rate; these increases are uniform across income groups. These results reveal that subsequent to the wage indexation, the increase in default and prepayment trends have slowdown significantly, which suggests that higher income households may have engaged in rate-differential arbitrage and were able to maximize their wealth by continuing to make mortgage payments since the rise in their wages were higher than the rise in their interest payments. Thus, the mortgage market experienced a slowdown in the prepayment rates. On the other hand, low-income households—with no wealth and no fear of a foreclosure—continued to default on their loans, while those with wealth prepaid their loans. Another possible reason may be that by the late 2003, wages on average started to rise, causing the mortgage rates to climb and affecting borrowers' ability to make monthly payments.

These results highlight the mechanism and the heterogeneity of consumer response to the financial crisis and policy responses. They also raise serious concerns about the adverse impact of economic policy responses on the less-wealthy households. In particular, we find that instead of alleviating the financial burdens of all consumers, the Argentine government's policy responses (pesofication, indexation, etc.) inadvertently discriminated against the relatively lower-income borrowers. On the one hand, the wealthy mortgage borrowers received a positive wealth windfall, which was in turn used to prepay their mortgage debt. On the other hand, the low-income mortgage borrowers, instead of receiving the same positive wealth benefit, endured "poverty effects" and defaulted on their loans. These outcomes reduced the ability and willingness of financial institutions to supply new credit. In turn, the

viability and stability of the newly functioning mortgage-backed securities market in Argentina was weaken, which eventually led to a temporary shutdown of the housing market, with a negative multiplier effect for many economic activities and employment.

The remainder of the paper is structured as follows. Section 2 provides a discussion of the Argentine financial crisis and the economic policy response. Section 3 discusses the performance of the Argentine mortgage market before and after the financial crisis. Section 4 reviews the mortgage prepayment and default literature and the econometric methodology. Section 5 describes the data and presents some descriptive statistics. Section 6 reports the findings for the default and prepayment behavior for US$- and ARP-denominated mortgages. Section 7 discusses the implications of the results on the MBS market in Argentina and the broader economy. Section 8 offers concluding remarks.

2. The Argentine crisis and the economic policy response

In the aftermath of the 1998 Tequila crisis in Latin America and in particular the Brazilian currency devaluation, an economic recession began to unfold in Argentina.[6] Its domestic real GDP fell continuously at a cumulative rate of nearly 25% between 1999 and 2001, and unemployment surged, peaking at 23% in 2002. The economic recession turned into a financial crisis, largely triggered by accumulated fiscal imbalances and a general loss of confidence. First, the Argentine government's creditworthiness deteriorated due to the weakening of the public finance system. Second, the lack of public confidence in the economy, as evidenced by the high dollarization of the Argentine economy put tremendous pressure on the pegged currency. Third, the banking system did not have recourse as a lender of last resort due to the currency board mechanism, causing a sudden surge of borrower delinquencies. The vicious cycle in the loss of public confidence and the weakening of the Peso impeded the government's ability to cover its financing requirements through the markets, which led to a bank deposit run in massive proportions at the end of 2001 and put unsustainable pressures on the Peso.

Following the peak of the crisis in 2001, the government pursued extreme emergency measures.[7] In December of 2001, the Argentine government froze all bank deposits and then announced the country's default on external debt. By early Janu-

[6] Mussa (2002), Eichengreen et al. (2003), and De La Torre et al. (2003) emphasize the failure of the fiscal policy, currency mismatch, and the banking sector being the root cause of the crisis. Dominquez and Tesar (2004) argue that subsequent to the Brazilian currency devaluation, the short-term lending and portfolio equity flows to Argentina fell sharply. Calvo et al. (2003) and Calvo et al. (2004) suggest that the drop in capital flow was a potential trigger for the Argentine economic crisis.

[7] We restrict our attention of government response policies to those directly relevant to consumer credit markets, and in particular, mortgage lending. For a broader prospective, see Dominquez and Tesar (2004).

ary 2002, a National Emergency Law repealed the "convertibility" regime of the Peso and devalued the national currency to 1.4 Peso/US$—this official rate applied to fundamental transactions was quickly replaced by a decreed single floating rate regime in February. As a result, the pesofication was applied asymmetrically at parity for loans to the private sector, but at the official exchange rate—although already out of touch with the market rate- for the other contracts, in particular for deposits. Furthermore, outstanding bonds of public or private Argentinean entities issued under Argentine law were also pesofied.[8]

To alleviate the impact of the pesofication on the financial assets of creditors, indexation was introduced. Initially, the "Coeficiente de Estabilización Financiera" (CER) index used was based on the Consumer Price Index, and in the case of consumer loans (including mortgages) included a 3.5% per annum (in real terms) cap on the interest rate to be applied. This index severely impaired debtors because of the price surge following the devaluation of the Peso. Subsequently, it was replaced in October 2002, for mortgages below $250,000 (at origination), by a wage-linked index, known as the "Coeficiente de Variación Salarial" (CVS), also with a cap on interest rates. A sunset clause was however set for the suspension of the indexation prohibition, which was subsequently reinstated in April 2004.

Another response measure targeting outstanding mortgages was the suspension of foreclosure proceedings. Through legislative intervention, the enforcement of security rights was suspended twice for 3 months in the case of liens on residential properties. This intervention was followed by a stay of foreclosure, a voluntary decision made by the banking industry after consenting with the government that nothing could be done to pursue the defaulting borrowers during most of 2002. In 2003, a new mechanism was designed to facilitate the rescheduling of delinquent mortgages of up to $100,000. The new mechanism consists of transferring past due loans to a trust that would bear the cost of restructuring. In exchange, lenders get government bonds. In reality, many banks, concerned by their already excessive exposure with the government, chose to reschedule mortgages at their own costs.

3. The Argentine mortgage market

3.1. Pre-crisis period [9]

Mortgage lending grew sharply in Argentina during the 1990s. The total loans outstanding tripled from $3.3 billion at the end of 1991 to $10.8 billion by the end of 2000. This development was due to several factors. Macroeconomic conditions were favorable, following the stabilization plan of 1991 that pegged the Peso to

[8] For an excellent timeline of the Argentine economic crisis, see the Appendix in Dominquez and Tesar (2004).

[9] For an anlysis of the development of mortgage lending until the crisis, see Angel (2001) and Cristini and Moya (2004).

the US dollar at par through a currency board mechanism and a subdued inflationary environment, which was desirable after a lengthy historical period of hyperinflation and macroeconomic instability. Structural reforms in the mortgage market took place, especially in early 1995 when a fairly comprehensive and consistent framework of reform was undertaken to enhance the country's housing finance. The efficiency of mortgage rights was strengthened, securitization was established, and the MBS market became the most advanced in Latin America, with the first instance of issues partially sold abroad.[10] Liberalization spurred lending because the privatization of state banks, e.g., Banco Hipotecario, leveled the competitive field and encouraged the supply of mortgage loans. In addition, the "Federal Housing System" was organized to provide resources to moderate-income groups via a combination of a theoretically guaranteed volume of public assistance channels (through the "Fundo Nacional de Vivienda") with (possible) links to market funding through securitization. Furthermore, a credit information system for consumer lending was established.

The benefits of this market expansion and the sustainability of the system, however, were uncertain for several reasons. Despite increased access to the capital market, the maturity of the loans in practice remained relatively short (10–15 years typically) and in turn limited the affordability of borrowing. Most mortgages were denominated in US$, 70% of the overall residential sector (80% including all mortgage loans), a reflection of the dollarization of the lenders' funding bases as well as the high premium charge that borrowers must pay to obtain Peso-denominated loans. The interest rates were about 15% for ARP-denominated debts in the year preceding the crisis and about 13% for USD-denominated debts in 1998–2000. The interest rate spreads were further pushed up by wider intermediation spreads that reflected the asset/liability mismatches of the lenders.

3.2. The effects of the economic and financial crisis

At the macroeconomic level, the drastic devaluation of the Peso, which initially dropped to 4 ARP/US$ in March 2002 before stabilizing at around 3 ARP/US$, generated an inflationary environment. Inflation surged to 46% in 2002 and 2003. In turn, households' purchasing power fell drastically as the real level of median household income in urban areas declined by more than 40% between 1999 and the end of 2002. Moreover, this trend was unequally distributed, hurting those in the lowest income distribution more than those at the top of the income distribution.

The crisis also had a dramatic impact on consumer borrowing behavior. Inflation had a significantly strong effect on the mortgage borrowers whose debt payment appreciated sharply. This impact was aggravated by the successive choices of indexes, with each experiencing a higher increase than the other one during the period when they were applied.[11] Although these periods were relatively short, the consequences were long lasting because of the re-evaluation of the loan balances. Overall,

[10] See Standard and Poor's (2000).

[11] In 2003, the economic situation took a turn for the better and significant wage increases were granted by private and especially public sector companies.

the dual economic and financial-crisis triggered shocks that deeply affected the mortgage borrowers in three ways: the ability to repay, real estate prices, and the net value of financial assets and liabilities. Below we discuss each of the impacts in details.

3.2.1. The surge of delinquencies

With a combination of soaring unemployment, sharp inflation and declining incomes, many borrowers faced loan repayment arrears and insolvency throughout the banking system. In consumer lending, there are no aggregated data for the sub-sector of residential mortgages. However, the percentage of past due loans in the overall portfolios peaked at 26% in December 2002.[12] In the case of mortgages, one can assume a parallel trend. Moreover, it is likely that the suspension of mortgage collateral enforcement did not mitigate the surge in non-performing loans. Finally, it remains unclear what impact the rescheduling on impaired accounts had on both the real phenomenon and its translation in the lenders' account statements.

3.2.2. The surge of real estate prices in Pesos

The real estate sector in Argentina was largely dollarized in the urban areas, especially the middle- and high-income segments of the market. The 2001–2002 devaluation of the Peso led to a new price equilibrium, although not through a simple homothetic translation, but rather through differences in the market segments. As a result, there was an abrupt widening of the real estate wealth distribution. At the upper end of the market, where investors need not borrow or even when they do they are often holders of significant assets abroad, property prices in US$ remained quite stable or at most experienced a slight decline. For all other properties that were traded on a dollar basis, real estate prices in US$ dropped, but far less than prices in Pesos. This is likely a reflection of the "safe haven" status of real estate investment as well as a fall in the owners' willingness to sell. Consequently, prices once converted to Pesos skyrocketed. Typically, they were multiplied by 2.5 in Buenos-Aires between 1999 and 2004, and the price-to-income ratio for average properties jumped from its pre-crisis levels typically at 3.5–4 to more than 12 following the crisis.

Subsequently, housing became unaffordable for most of the urban households. This effect was aggravated by the soaring construction costs, which were sensitive to the 46% rise in external prices in 2002–2003. In turn, homeowners suddenly became richer in Pesos, a wealth effect that perhaps eased the rise in defaults in the second half of the crisis (2001–2003). On the opposite end, aspiring homeowners were unable to afford the high prices—and unable to borrow for that purpose.

3.2.3. The appreciation of net financial worth

The pesofication of most mortgages at parity (while deposits were converted at the official value of 1.4 ARP/US$) and the market value of the Peso dropping far below

[12] The ratio declined to 15.3% in March 2004. Source: Banco Central de la Republica Argentina.

the parity level had a direct impact on mortgage portfolios of banks, as well as a large redistributive effect. Of more significance is the relatively rare phenomenon of individuals having a windfall gain between their US$-denominated financial assets and their US$-denominated mortgage debt—a 40% appreciation in net worth overnight. The windfall was much more substantial in the more frequent case of mortgagers holding hard currency assets that were not subject to Argentine law. The US$-denominated asset value was multiplied by three, while the Peso-denominated liabilities remained unchanged in Peso.

The introduction of indexing consumer loans based on Consumer Price Index and wage-related indices severely impaired debtors because of the price surge following the devaluation of the Peso. During the CPI indexation regime, Argentina experienced a 46% inflation and declining wages, so a high income or wealthy borrower should prepay the mortgage, while a low-income borrower should default on the mortgage. During the wage indexation regime that is based on a median wage, if a borrower's wage is above the median wage, then the borrower can maximize his/her wealth by *not* prepaying the mortgage. However, if a borrower's wage is below the median wage and he/she holds wealth, then the borrower can maximize his/her wealth by prepaying the mortgage. On the other hand, if a borrower's wage is below the median and he/she does not hold wealth, then the borrower should default.

The wealth effect, amplified by the fear of the future consequences of the newly decreed indexation of borrowed capital, induced borrowers to massively materialize the large capital gains by prepaying their depreciated debt. Lending institutions, in trying to restore their liquidity situation, sometimes encouraged mortgage borrowers to prepay. This largely explains the reduction in total residential mortgage loans outstanding from Peso 10.8 billion at the end of 2000 to 5.5 billion at the end of 2003.[13]

4. Methodology

Despite the differences in the global mortgage markets,[14] the theoretical literature on mortgage prepayment and default is based on the option theory first used by Dunn and McConnell (1981), Findley and Capozza (1977), and Buser and Hendershott (1984).[15] The standard approach in empirical mortgage modeling research rec-

[13] This fall also includes the impact of contractual repayment and the quasi disappearance of new lending.

[14] Just to name a few: (i) the underwriting guidelines; (ii) legal framework for default and foreclosure, in particular the existence of deficiency payment or not; (iii) social and cultural attitude towards debt; and (iv) the expectations at one given moment on the real estate price evolution.

[15] According to the option theory, a rational borrower should maximize her welfare by prepaying her mortgage when the call option is *in the money* (i.e., the prevailing market rate is below the existing mortgage coupon rate) in the absence of transaction costs. Similarly, a borrower should default on her mortgage if the put option is *in the money* (i.e., the current market value of the house, serving as collateral, drops below the current market value of the remaining mortgage balance). For a detailed review of the option value literature, see Hendershott and Van Order (1987) and Kau and Keenan (1995).

ognizes the ability of the borrower to terminate the mortgage through either prepayment or default in a competing risks hazard framework.[16] In general, there is agreement amongst the empirical studies that the market values of the call and put options have a statistically significant and positive impact on mortgage termination by refinance or default. However, many empirical studies also find that borrowers are not solely and completely sensitive to financial incentives—borrower characteristics such as low borrower credit scores, age, income, education, employment and personal wealth are also important in explaining borrower default or prepayment behaviors (see, e.g., Archer et al., 1997; Archer and Ling, 1993; Deng et al., 2004a; Green and LaCour-Little, 1997; Quigley, 1987; Stanton, 1995).[17]

Moreover, the surge in mortgage prepayments and defaults in Argentina following the 2001 currency crisis and the subsequent economic policy responses simply cannot be explained by the factors shaping the traditional prepayment and default model as well as the actual prepayment and default behaviors in the US. Following the 2001 financial crisis, the Argentine mortgage borrowers faced wealth maximization incentives that were beyond the call and put options. On the prepayment side, the Argentine mortgage borrowers were given an unexpected, temporary incentive to repatriate US$ holdings from abroad or from under the mattress and pay off their mortgage at 66% discount, regardless of whether borrowers have a US$- or ARP-denominated mortgage. On the default side, the 46% rise in the consumer price index, 40% decline in the household income, and 23% rise in unemployment hampered the Argentine mortgage borrowers' ability to pay the mortgage debt.[18] Moreover, Carbacho et al. (2003) find that households in the lower income deciles faced a 41% decline in their income, while those in the higher income deciles faced only a 23% decline in their income. Therefore, we expect a disproportionate rise in default for the lower income borrowers.

[16] Competing risks models are well developed in the labor economics literature (Mealli and Pudney, 1996; Burdett et al., 1985; Narendranathan and Steward, 1993; and Flinn and Heckman, 1982). These models are based on techniques of survival analysis, which was originated in biological studies of mortality and have found frequent application in industrial engineering failure-time studies as well as economic studies related to employment and labor issues. Kalbfleisch and Prentice (1980), and Cox and Oakes (1985) provide a classic statistical discussion of the topic; Kiefer (1988) provides a review of the economic literature on duration modeling.

[17] Other empirical studies also suggest that borrowers sub-optimally refinance and prepay despite the fact that the call option is "out-of-money". Stanton (1995) raises consumption smoothing as a possible reason for this pattern. Hurst (1999) and Hurst and Stafford (2003) argue that households, particularly those who are credit or liquidity-constrained, refinance because they want to withdraw equity from their home to fund current and future consumption. Agarwal et al. (2004c) consider households that are neither credit or liquidity-constrained and argue that consumers can also be distracted due to a binding time-budget constraint.

[18] Sullivan et al. (2000) analyze a survey of 1991 US bankruptcy filings and find that 67.5% of filers attribute loss of job as the main cause of bankruptcy filings. Additionally, Agarwal and Liu (2003) using data from US provide empirical evidence that for every 1% point rise in unemployment there is a 32% rise in consumer delinquency.

In this study, we follow Agarwal et al. (2004a) to estimate a Cox proportional hazard model of prepayment and default of Argentine mortgage borrowers.[19] The model begins with a baseline time profile of the average probability of default or prepayment conditional on the loan surviving to time t, $h_0(t)$. The baseline hazard can be shifted up or down by a factor depending on the impact of the time-varying covariates, Z_{it}. For mortgage i at time t, the probability of mortgage termination can be written as follows:

$$H(t|Z_{it}) = h_0(t)\exp(Z_{it}\beta). \tag{1}$$

Eq. (1) can be generalized to a joint survival function for prepayment (p) and default (d). Below is the joint survival function, conditional on Z_{it}.

$$S(t_p, t_d|Z, \theta) = \exp\left(-\eta_p \sum_{k=1}^{tp} \exp(\gamma_{pk} + \beta_p' Z) - \eta_d \sum_{k=1}^{td} \exp(\gamma_{dk} + \beta_d' Z)\right), \tag{2}$$

where Z is a vector of covariates that affect the borrowers' prepayment and default behavior. Z includes both loan and borrower characteristics such as prepayment option, loan term, LTV, quarterly updated credit scores, age, income, proxies for wealth, US$-denominated mortgage dummy, and regional dummies. In addition, Z also includes the variables of interest—the crisis dummy, exchange rate variations, both the CPI and wage indexation dummies, and their interaction with the financial and demographic variables. θ is a vector of parameters of the hazard function. γ_{jk} are the parameters of the baseline hazard function, where k indexes discrete periods in the time dimension since loan origination.

5. Data

Our dataset consists of 4867 owner-occupied, fixed rate, first mortgage loans originated by a large financial institution between June 1998 and March 2000, with performance window from loan origination to March 2004. In our dataset, there are 4459 (92%) US$-denominated and 408 (8%) ARP-denominated mortgages. One main reason for such an overwhelming percentage of US$-denominated mortgages reflects the fact that mortgage-backed security buyers, mainly foreign entities who recognized the exchange rate risk, did not want to hold Peso-denominated mortgages. In other words, the difference mostly reflects the lack of confidence in the ARP (even pegged to the US$) and therefore should be seen as a currency risk premium required by investors on a macro level (Cristini et al., 2001). Despite assurances from the government that "a peso was as good as a dollar," consumers continue to hold US$-denominated debts (Edwards, 2002).

[19] We also estimated a proportional hazard model with unobserved heterogeneity, but the mass coefficients are statistically insignificant. A potential explanation is the fact that our dataset is fairly rich and includes several previously unobserved borrower characteristics. We also control for geographically correlated mortgages as discussed in Deng et al. (2004a).

In our dataset, about one-third of both US$- and ARP-denominated loans were originated in 1998, half originated in 1999, and the rest in 2000 (see Table 1). It is interesting that about 13.1% of US$-denominated mortgages, compared to only 2.2% of ARP-denominated mortgages, are 20-year term mortgages. On the other hand, only about 6.8% of US$-denominated, compared to the 8.9% of ARP-denominated mortgages, are 5-year term mortgages. To analyze their performance over time, we create a monthly record of each loan denoting whether the mortgage prepaid, defaulted, or is still current as of March 2004 for both US$- and ARP-denominated mortgages. We define default as 90-days delinquent, while prepayment is the actual payoff of the loan before contract term. During the performance period, about 18.9% of US$-denominated and 24.5% of ARP-denominated mortgages defaulted, while about 24.6% of US$-denominated and 12.2% of ARP-denominated mortgages prepaid (see Table 2).

The dataset contains usual loan level characteristics, such as the original loan amount, the loan-to-value ratio at origination, appraised house values at origination, and the contract interest rate. We also observe many detailed borrower characteristics such as the borrower credit score (Veraz score similar to a FICO score) at origination as well as the quarterly updated score over the sample period. Other borrower characteristics include: income, second income, age, years on the job, debt to income ratio,[20] second house ownership (a wealth indicator), car ownership (another wealth indicator), car value (wealth measure), female ownership, marriage status, employment type[21] and finally whether the homeowner has a checking account relationship with the bank.

In addition, we also know the branch where the loan was originated. In total, there are 137 branches. The branches serve as proxy for the geographical location of the mortgage loans. Since there are differences in the cost and enforceability of bankruptcy and foreclosure laws by geography, the branch indicators will also help control for such differences.[22] Moreover, since we do not have updated house prices, branch dummies will also serve as a proxy for the house price appreciation (housing neighborhoods are likely to stratify by bank branches).

Table 3 provides detailed summary statistics both for the loan and borrower characteristics of the US$- and ARP-denominated mortgages. With respect to the loan characteristics, we learn that US$-denominated mortgages have on average longer loan term than do the ARP mortgages (132 months vs. 109 months). Furthermore, US$-denominated mortgages have on average lower contract rate (12.15 vs. 15.91%)[23] and higher original LTV (62 vs. 52%) than do ARP-denominated mortgages.

[20] Unlike the US, DTI is defined as the monthly mortgage payment as a percentage of monthly income net of taxes. This calculation does not include other debt, such as auto or credit cards.

[21] There are four possible employment categories: self-employed, professional employment, non-professional employment, and merchants.

[22] Though the Argentine legislature protects the rights of the creditor, the enforceability of such rights varies by region. Cristini et al. (2001) note that enforcement of the laws across the 24 provinces in Argentina has resulted in the disparity in credit availability and banks' non-performing loans are higher. Furthermore, they show that the cost of recovery on a bad mortgage loan can vary between 8 and 13 percent across the 24 provinces.

[23] Soon after the financial crisis, the mortgage contract rates jumped up 5 percentage points.

Table 1
Distribution of loan term

	US$ denominated mortgages		ARP denominated mortgages	
	Frequency	Percent (%)	Frequency	Percent (%)
Loan term				
5 Years	301	6.75	69	16.91
10 Years	2357	52.86	222	54.41
15 Years	1216	27.27	108	26.47
20 Years	585	13.12	9	2.21
Loan origination years				
1998	1449	32.5	141	34.7
1999	2310	51.8	201	49.2
2000	700	15.7	66	16.1

Notes: The table reports the loan term and loan origination year distributions (frequency and percentages) for US$- and ARP-denominated mortgages.

Table 2
Distribution of default and prepayments

Default/prepay	All loans	US$	ARP
Defaults	945	845	100
Prepays	1150	1100	50
All loans	4867	4459	408

Notes: The table reports the prepayment and default distribution for US$- and ARP-denominated mortgages.

Moreover, we learn that borrowers of US$-denominated mortgages are on average slightly younger and have relatively lower credit quality (682 vs. 725 credit score[24]) and higher debt-to-income ratio (23 vs. 21%). Many of the other borrower characteristics (such as income level, wealth indicators, demographics, and employment) do not appear to differ significantly between the two types of mortgage borrowers. On average, about 15% of the mortgage borrowers own a second home and 75% own a car (average value of $6025). Furthermore, about 32% of the borrowers are female, 73% are married, 20% have a second income and 16% are married with two incomes. Finally, 15% are self-employed, 53% are professionals, 17% are non-professionals, and 14% are merchants.

These descriptive statistics indicate that both loan and borrower characteristics of ARP-denominated mortgages are on average *less* risky than those of US$-denominated mortgages. Hence, we should expect a priori a lower average default rate and a higher average prepayment rate for ARP-denominated mortgages relative to US$-denominated mortgages. Moreover, it is noteworthy that despite the less risky borrower characteristics of ARP-denominated mortgagers relative to US$-denominated mortgagers, there is 375 basis points higher in the price of ARP-denominated

[24] The scores are provided by a local credit bureau that collects financial and non-financial information to determine the scores. The score range is between 400 (worst) to 800 (best).

Table 3
Descriptive statistics at account origination

Variable name	US$ denominated mortgages		ARP denominated mortgages		*T* stats
	Mean	SD	Mean	SD	
Loan characteristics					
Loan term	132	43	109	32	10.47*
APR	12.15%	1.40%	15.91%	2.14%	−49.38*
Loan amount	$45,594	$27,303	$35,065	$21,899	7.57*
Appraised house value	$78,509	$52,372	$79,316	$64,361	−0.29
Origination LTV	62.04%	16.01%	51.65%	19.21%	12.33*
Borrower characteristics					
Origination credit score	682	255	725	233	−3.25*
Owner Age	40	10	45	10	−9.41*
Income	$2616	$2,079	$2,706	$2,342	−0.83
Debt to income	22.98%	11.93%	21.30%	13.98%	2.68*
Years on the job	9.33	7.93	10.56	8.77	−2.97*
Second house	14.35%	15.07%	15.61%	16.41%	−1.60
Car	73.18%	44.31%	76.70%	41.68%	−1.54
Car Value	$5627	$24,683	$6,070	$13,765	−0.36
Female	30.77%	46.16%	33.09%	47.11%	−0.97
Married	71.00%	45.38%	74.75%	43.50%	−1.60
Second income	20.50%	40.37%	19.85%	39.94%	0.31
Married w/two income	16.73%	37.33%	16.91%	37.53%	−0.09
Self employed	15.54%	36.23%	18.38%	38.78%	−1.51
Professional employment	52.59%	49.94%	54.90%	49.82%	−0.90
Non professional employment	17.78%	38.24%	15.20%	35.94%	1.31
Merchant	14.08%	34.79%	11.52%	31.97%	1.43
Bank relationship	9.98%	29.98%	14.95%	35.70%	−3.15*
Number of accounts	4459	92%	408	8%	

Notes: The table reports descriptive statistics (mean and standard deviations) for the loan and borrower characteristics at loan origination for US$- and ARP-denominated mortgages. Additionally, the last column provides the *t* test for difference in means between the US$- and ARP-mortgages. It is evident that both loan and borrower characteristics are statistically different across US$ and ARP mortgage borrowers.
* Significant at the 5% level.

mortgages with 10% lower LTV.[25] The mortgage rate differential, however, can partially be attributed to the general difference in the interest rates in each currency, the ARP-denominated mortgage rate being affected by a higher currency risk premium.[26] In addition, even though ARP-denominated mortgages have a higher

[25] Mortgage underwriters in Argentina told us that generally older consumers who have lived through past devaluations were more likely to choose a shorter duration, lower LTV, peso denominated mortgage despite a higher interest rate.

[26] As discussed earlier, the Mortgage Backed Securities market in Argentina has since 1996 provided liquidity to banks (by marketing MBS to international investors in US$) to alleviate concerns of a devaluation risk to the bondholders the MBS were traded in US$. US$-denominated mortgage borrowers who were the bearers of the devaluation risk were provided a subsidy in terms of the interest rate on their mortgages.

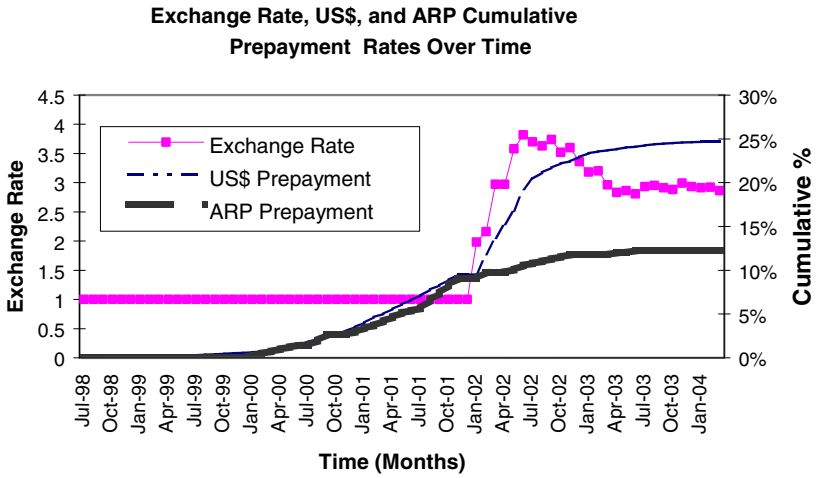

Fig. 1. Exchange rate, US$, and ARP cumulative prepayment rates over time.

percentage of short-term mortgage loans, the average portfolio contract rate (APR) is higher.

Figs. 1 and 2 provide the pre- and post-crisis cumulative prepayment and default pattern, relative to changes in the exchange rate over the 6-year period (07:1998–03:2004). Fig. 1 shows that the prepayment rate for US$- and ARP-denominated mortgages are statistically indifferent before the devaluation of the ARP. Following the devaluation, however, there was a dramatic rise in the prepayment of the US$-denominated mortgages. On the contrary, the prepayment rate of ARP-denominated mortgages slowed down at the onset of the crisis and then rose slowly and steadily thereafter. However, around October 2002, the prepayment rate of both US$- and ARP-denominated mortgage slowed down. The reasons for the slowdown is possibly due to (1) the change in indexation (from using the CPI index to wage index), which resulted in a dramatic drop in the mortgage interest rates; or (2) the stabilization of the ARP/US$ exchange rate. A more formal analysis will help sort the two affects.

Fig. 2 shows the cumulative default pattern of US$- and ARP-denominated mortgages over the same 6-year period. While it is difficult to see in the graph, the average cumulative default rate of US$-denominated mortgages is statistically higher by 1.3% points prior to the devaluation of the Peso. Post devaluation, however, the default rate for ARP-denominated loans extensively out paced that of US$-denominated mortgages. Once again, the default rates started to stabilize after October 2002. It is possible that the change of the indexation increased the borrowers' ability to pay their mortgage loan, thereby lowered the default rate.

We should point out that these figures confound both account seasoning and calendar time events (e.g., the 2001 financial crisis). Thus, while we are interested in the effect of the Peso devaluation and indexation, we might be capturing the effect of account seasoning on prepayment and default. A more formal analysis is warranted before we can make any firm conclusions.

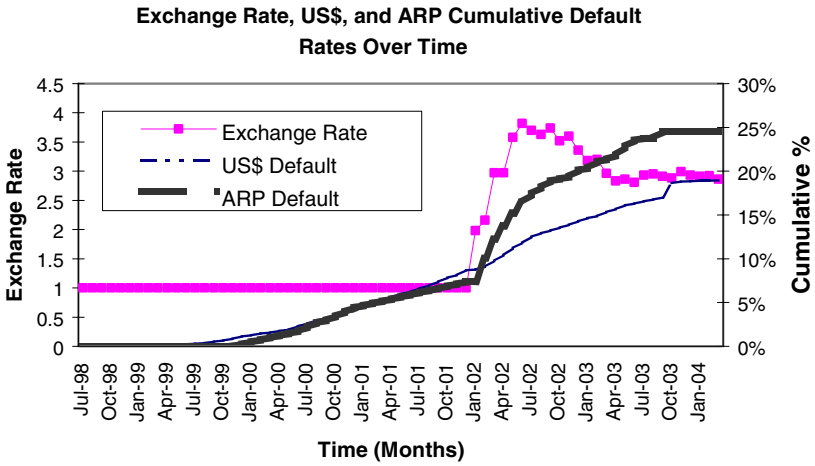

Fig. 2. Exchange rate, US$, and ARP cumulative default rates over time.

5.1. Variables

In modeling the probability of prepayment of US$- and ARP-denominated mortgages, we incorporate a set of explanatory variables that capture financial incentives and consumption smoothing motives to prepay a mortgage debt.[27] To approximate the value of the borrower's prepayment option, we follow the approach outlined in Deng et al. (2000) and estimate the prepayment call option as

$$\text{OPTION}_{i,t} = \frac{V_{i,t} - V^*_{i,t}}{V_{i,t}}, \tag{3}$$

where $V_{i,t}$ is the market value of loan i at time t (i.e., the present value of the remaining mortgage payments at the current market mortgage rate), and $V^*_{i,t}$ is the book-value of loan i at time t (i.e., the present value of the remaining mortgage payments at the contract interest rate).[28] Since consumers are more likely to prepay and refinance following a decline in the prevailing mortgage rate relative to the original coupon rate, a positive value for OPTION indicates that the prepayment option is "in-the-money". To account for any non-linearity in the prepayment option, we also include the square of OPTION.

We do not have access to the current property values, but we do observe the monthly mortgage payment amounts, so we estimate current LTV holding the denominator constant. We expect CLTV to be negatively related to prepayment. We also include the square of CLTV to control for any non-linearity.

[27] This section relies on the variable definitions in Agarwal et al. (2005).

[28] This is the equivalent to the prepayment option value used by Archer et al. (1996) scaled by the mortgage book-value.

In addition, we also capture changes in borrower credit constraints via the time-varying borrower credit score. Borrower credit history is one of the key determinants of mortgage loan approval. Borrowers with good credit history are able to obtain credit with relatively more ease; thus, they are able to take advantage of refinance opportunities. Conversely, borrowers with poor credit scores are credit-constrained since they either face difficulty qualifying for new credit at any price, or if credit is available, the higher interest rate or transaction costs make the new loan prohibitively expensive (see, e.g., Bennet et al., 2000). We include the square of credit score to capture any non-linearity present in borrower credit scores.

The US$/ARP exchange rate for the time period between July 1998 and March 2004 capture the impact of depreciation of the Peso on the prepayment and default behavior of the mortgage loans. We include the square of the exchange rate to capture any non-linearity.

Furthermore, since our dataset contains borrower characteristics, we are able to control for some of the traditionally unobserved variables. We construct dummy variables to denote monthly income for low, medium, high and very high categories. They are evenly divided into four quartiles. We also create a dummy variable for owners with median age above 40 years, as well as continuous variables to control for debt to income and years on the job.[29] In addition, we have dummy variables serving as proxies for wealth, i.e., second home and car. The car value measures the depth of the wealth. Moreover, past studies found variables such as female, married, second income, married with second income, type of profession (merchant, non-professional, professional, and self employed) as predictors of prepayment and default (see e.g., Deng et al., 2004b), we therefore control for these variables as well. Finally, we have an indicator variable for a checking account relationship with the bank. It has been found that relationship banking to be an important determinant of consumer default and prepayment decisions (Agarwal et al., 2004b).

Next, we construct several dummy variables to capture the effect of the crisis and its interaction with mortgage denomination, loan and borrower characteristics. First, we construct a dummy variable for the crisis period (November 2001 onwards). We also construct a dummy variable for US$-denominated loans. We interact these dummies to test whether US$-denominated loans behaved differently during the crisis. Next we construct a set of dummies that interact: (i) the crisis period with LTV, credit scores, prepayment option, income, and wealth; (ii) US$-denominated mortgage with LTV, credit scores, and prepayment option, income, and wealth; and, (iii) crisis period with US$-denominated mortgages with income and wealth. The interaction of LTV, credit scores, and prepayment option with the crisis period dummy and US$-denominated mortgage dummy are aimed to test the sensitivity of the prepayment and default behaviors of US$-denominated mortgages to the traditional option value theory and/or loan characteristics during the pinnacle of the financial crisis. Moreover, the interaction of the income and wealth variable to the crisis dum-

[29] Our results are robust across classification of these variables. Alternative models created discrete variable for debt to income, years on the job and continuous variables for income and age. The results are qualitatively the same.

my and US$-denominated mortgage dummy are aimed to test the effect of the crisis and the subsequent polices on the prepayment and default decisions of the various types of borrowers. As discussed in the previous section, we believe that the crisis and the subsequent policies had an asymmetric impact on households with relatively more wealth, higher income, and US$-denominated mortgages.

Next, we construct two dummies for the CPI index (February 2002–October 2002) and the wage index (November 2002–January 2004) regimes. We also interact these dummies with wealth and income variables. Finally, we include a number of variables to control for geography (branch dummies), loan term, quarterly time dummies and account seasoning (AGE of account, AGE-square, and AGE-cube). $AGE_{i,t}$ is the number of months since origination at time t, and as Gross and Souleles (2002) point out, to allow for loan seasoning. That is, *AGE* accounts for changes in the prepayment and default propensity as the loans mature. In addition, Gross and Souleles (2002) note that the age variables allow the competing-risks hazard rates to vary with duration. Our cubic specification of AGE allows the prepayment and default hazards to vary non-parametrically.

6. Results

As a first step in our analysis, we estimate the baseline survival function of the cumulative likelihood of US$- and ARP-denominated mortgages "surviving" (i.e., not prepaying or defaulting) over the sample period. Figs. 3 and 4 present the baseline survival curves for prepayment and default, respectively. Fig. 3 shows the baseline prepayment survival curves. The prepayment rates for ARP- and US$-denominated mortgages are not significantly different. However, it is clear from

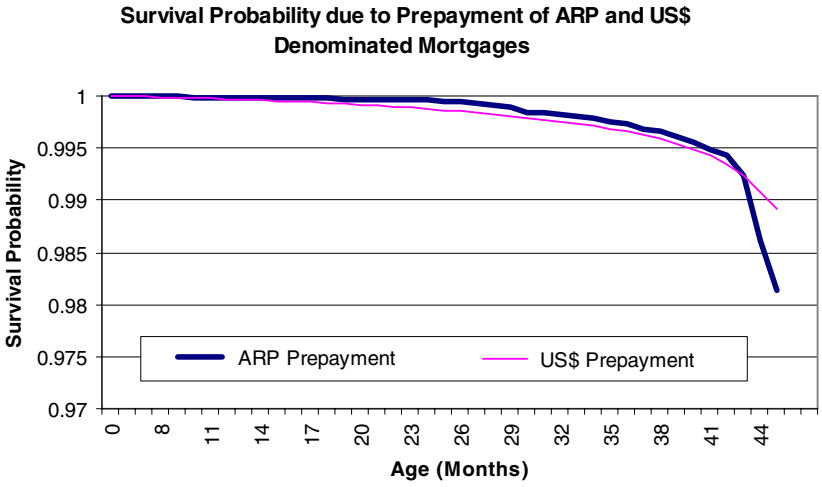

Fig. 3. Survival probability due to prepayment of ARP and US$ denominated mortgages.

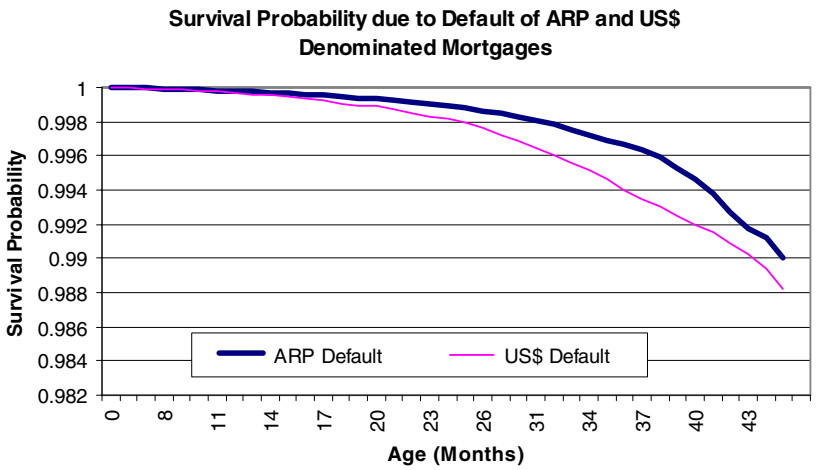

Fig. 4. Survival probability due to default of ARP and US$ denominated mortgages.

Fig. 4 that at any given age, ARP-denominated mortgages have a significantly higher survival (i.e., lower default) rate than do US$-denominated mortgages. As discussed earlier, the overall loan and borrower characteristics of ARP-denominated mortgage borrowers are on average less risky; thus, the lower default rate is expected.

To fully determine the sensitivity of the performance of ARP- and US$-denominated mortgages to the financial crisis, government policies and their interaction with borrower characteristics, Table 4 present the competing risk model parameter estimates. Below we discuss the general results in Section 6.1 and the impact of the financial crisis and the economic policies in Section 6.2.

6.1. General results

Focusing first on the effect of loan characteristics on prepayment and default risks, we find that loan term dummies for 10, 15 and 20 years are positively related to prepayment and default, albeit the 20 years dummies in default are statistically insignificant; these results are consistent with Clapp et al. (2003). Account age is also statistically significant, which is consistent with much of the mortgage literature. Next, we look at the CLTV, lagged six months to avoid endogeniety. The higher the CLTV, the higher the prepayment risk, with no significant differences between the US$- and ARP-denominated mortgages. Surprisingly, we find an insignificant increase in the default risks of loans with higher CLTV. Furthermore, the call option is significantly and positively related to the prepayment and default risks, with higher prepayment and default risks for US$-denominated mortgages. These results are intuitive and consistent with the mortgage literature.

We now turn to look at the impact of borrower characteristics on prepayment and default risks. We find that borrowers with inferior credit quality (credit score lagged six months to avoid endogeniety) are more likely to default but less likely

Table 4
Regression results for default and prepayment for US$ and ARP denominated mortgages

	Default			Prepayment		
	Coeff.	SE	*t* stat	Coeff.	SE	*t* stat
Panel A						
Intercept	5.1068000	2.4776000	2.06	−5.6884000	1.9953000	−2.85
Account age	0.1172000	0.0542000	2.16	0.0327000	0.0148000	2.21
Account age (sq)	−0.0031800	0.0021100	−1.51	−0.0007100	0.0004210	−1.69
Account age (cube)	0.0000280	0.0000250	1.12	0.0000077	0.0000270	0.29
Loan term 10 years	0.0128000	0.0035800	3.58	0.0376000	0.0062800	5.99
Loan term 15 years	0.0000450	0.0000110	4.09	0.0001130	0.0000410	2.76
Loan term 20 years	0.0000310	0.0001000	0.31	0.0389289	0.0187320	2.08
Option	0.5360000	0.1832000	2.93	1.4525000	0.4190000	3.47
Option (sq)	0.0141000	0.0039700	3.55	0.0304000	0.0087900	3.46
CLTV	2.5138000	1.4172000	1.77	4.5261000	1.3709000	3.30
CLTV (sq)	1.6533000	1.1471000	1.44	−5.8324000	1.2067000	−4.83
Credit score	−0.0019300	0.0006640	−2.91	0.0017100	0.0008080	2.12
Credit score (sq)	−0.0000033	0.0000005	−7.25	0.0000018	0.0000005	3.40
Monthly income medium	0.0738000	0.5677000	0.13	−0.0519000	0.5084000	−0.10
Monthly income high	−0.2527000	0.5418000	−0.47	0.3498000	0.4897000	0.71
Monthly income very high	−0.5813000	0.6683000	−0.87	0.3922000	0.1147200	3.42
Age > 40 years	0.0906000	0.0708000	1.28	−0.1442000	0.0834000	−1.73
Debt to income	0.0666000	0.2707000	0.25	−2.9162000	1.2768000	−2.28
Years on the job	−0.0084500	0.0044600	−1.89	−0.0034700	0.0046200	−0.75
Second house	−0.2687000	0.1727000	−1.56	0.0660000	0.1570000	0.42
Car	−0.0578000	0.0918000	−0.63	0.2163000	0.1143000	1.89
Car value	−0.0000006	0.0000001	−3.89	0.0000023	0.0000012	1.99
Female	−0.0135000	0.0693000	−0.19	0.0195000	0.0804000	0.24
Married	−0.0189000	0.0790000	−0.24	−0.2251000	0.0937000	−2.40
Second income	−0.0584000	0.1892000	−0.31	0.9615000	0.1995000	4.82
Married w/two income	−0.0507000	0.2048000	−0.25	0.4511000	0.2158000	2.09
Professional employment	−0.0463000	0.1103000	−0.42	0.2398000	0.1035000	2.32
Non professional employment	−0.0954000	0.0980000	−0.97	0.5093000	0.4011000	1.27

(*continued on next page*)

Table 4 (*continued*)

	Default			Prepayment		
	Coeff.	SE	*t* stat	Coeff.	SE	*t* stat
Merchant	0.0289000	0.1016000	0.28	0.3857000	0.1053000	3.66
Bank relationship	−0.0204000	0.0076500	−2.67	−0.6184000	0.0942000	−6.56
Panel B						
US$ mortgage dummy	−4.0723000	2.0415000	−1.99	4.0432000	1.3764000	2.94
US$Dummy*Option	0.2623000	0.1176000	2.23	0.8160000	0.2858000	2.86
US$Dummy*Credit score	−0.0006380	0.0005330	−1.20	0.0005900	0.0005160	1.14
US$Dummy*CLTV	0.0715000	0.8398000	0.09	1.0279000	0.7380000	1.39
US$Dummy*Income medium	0.0799000	0.5824000	0.14	−0.3108000	0.5501000	−0.56
US$Dummy*Income high	−0.0414000	0.5527000	−0.07	1.0335000	0.5199000	1.99
US$Dummy*Income very high	−0.6523000	0.5344000	−1.22	1.1872000	0.4421000	2.69
US$DummyWealth	−0.1695000	0.0532400	−3.18	0.4044000	0.2008000	2.01
Panel C						
Crisis dummy	0.7400000	0.2844000	2.60	7.9019000	1.6192000	4.88
Exchange rate	6.8184000	1.1637000	5.86	6.5611000	1.5127000	4.34
Exchange rate (sq)	1.1969000	0.1832000	6.53	1.0256000	0.2422000	4.23
Crisis*US$ dummy	−0.2739000	0.0976800	−2.80	0.5117000	0.1382000	3.70
CrisisDummy*Income medium	0.6139000	0.8397000	0.73	−1.9282000	1.1893000	−1.62
CrisisDummy*Income high	−0.6918000	0.3055000	−2.26	0.0445000	0.0220060	2.02
CrisisDummy*Income very high	−0.2276000	0.0563000	−4.04	0.0347000	0.0159650	2.17
CrisisDummy*Wealth	−0.6407000	0.2751000	−2.33	0.1024000	0.0307900	3.33
Crisis*US$*IncomeMedium	0.5715000	0.8186000	0.70	1.3973000	1.1528000	1.21

Crisis*US$*IncomeHigh	−0.8094000	0.3877000	−2.09	0.4728000	0.1486000	3.18
Crisis*US$*IncomeVeryHigh	−0.2095000	0.0521000	−4.02	0.7735000	0.3749000	2.06
Crisis*US$*Wealth	−1.2884000	0.5360000	−2.40	0.6198000	0.2747000	2.26
CPI Indexation	1.0484000	0.1451000	7.23	0.1781000	0.0202000	8.82
CPI Indexation*Wealth	0.9546560	0.7382900	1.29	0.2578470	0.1283000	2.01
Wage Indexation	0.6158000	0.1714000	3.59	0.3787000	0.1213000	3.12
Wage Indexation* AboveAvgIncome	−0.0159000	0.1794000	−0.09	0.1126000	0.2226000	0.51
Loan origination year dummies	Yes					
Quarterly dummies	Yes					
Bank branch dummies (137 branches)	Yes					
Number and % of default/prepays	945	19%		1150	24%	
Pseudo R^2	0.49					
Number of accts/observations	4867	186,467				

Notes: This table shows results of a proportional hazard model of prepayment and default using monthly date for Argentine mortgage borrowers from June 1998 to March 2004. Prepayment is defined as actual payment of the loan amount prior to contract terms and default is defined as 90 days past due. Since foreclosure was suspended, the lender was treating 90 DPD as effective default of the loan. The independent variables control for bank branch dummies, loan origination year, account age, calendar time, credit risk, current loan-to-value ratio, interest rates, various demographic variables (age, income, wealth, marital status, etc.), dummy variables for the crisis, exchange rate, CPI and wage index dummies, and interaction of the crisis and policy variables with income and wealth. All time varying variables are lagged by six months to avoid any endogeniety. Additionally, credit scores, exchange rates, call option, and LTV are modeled to capture any non-linearity. The competing risks model is estimated as a multinomial logit via maximum likelihood.

to prepay, with no significant differences between US$- and ARP-denominated mortgages. Moreover, we find that both measures of income are insignificant in explaining mortgage default and prepayment behavior of the Argentine mortgage borrowers; however, borrowers of US$-denominated mortgages holding wealth (car and second home) are significantly more likely to prepay their mortgage. With respect to income, we find that borrowers in the medium-, high-, or very-high-income quartiles are *not* significantly more likely to default on their mortgages than borrowers in the low-income bracket, while borrowers in the very-high-income quartiles are significantly more likely to prepay their mortgage. Moreover, US$-denominated mortgage borrowers in the higher income brackets are significantly more likely to prepay than those in the lower income quartiles. As we noted earlier, at the macro level, household income declined by more than 40% between 1999 and 2002. However, as discussed earlier in Section 3.2 and by Carbacho et al. (2003), the crisis had a negatively redistributive impact on the real income decline. Carbacho et. al., find that households in the lower income deciles faced a 41% decline in their income, while those in the higher income deciles faced only a 23% decline in their income. While we only observe income at mortgage origination, the above statistics confirm that low-income households experienced a much higher decline in their real income and thus, a higher risk of defaulting on their mortgage loan.

Other borrower characteristics such as female, home ownership, marriage, second income, married with second income, and employment type do not have statistically significant affect on the likelihood of default, but have significant impact on the likelihood of prepayment. For example, while married borrowers are less likely to prepay their mortgage, borrowers with second income or married borrowers with two incomes are more likely to prepay their mortgage. Borrowers who are employed as merchants are more likely to prepay. Other interesting results include the following. Borrowers who have relatively higher debt to income ratio are not significantly more likely to default but are significantly less likely to prepay. The longer the borrower (of either US$- or ARP-denominated mortgage) has been on her job, the less likely she is to default and prepay. While these results are directionally consistent with Carbacho et al., 2003, who find that households with longer job experience have a higher income, our estimated coefficients are insignificant. Finally, it is interesting to find the households having some relationship with the bank are significantly less likely to default and to prepay their mortgage. This is also consistent with Agarwal et al. (2004b) who show that various measures of bank relationship reduce the likelihood of default and prepayment.

Overall, these results suggest that default and prepayment decisions are not only driven by the value of the options, but borrower characteristics also help explain the heterogeneous prepayment and default patterns.

6.2. Impact of the financial crisis and economic policy responses

We first look at the patterns and sensitiveness of the Argentine mortgage prepayments and defaults following the financial crisis. We find that on average the prepay-

Table 5
Marginal Effects of Prepayment and default for US$ and ARP mortgages at the 24th month

Variables	Default	Prepayment (%)
Traditional option variables		
100 basis points increase in APR	6.8%	12.1
10% drop in LTV	−11.2%	9.1
5% Drop in credit score	7.1%	−3.2
Demographic variables		
US$ mortgage dummy	−4.5%	8.4
Wealth indicator	−9.1	15.7
10% rise in monthly income	−9.8%	10.1
Financial crisis and demographics		
10% rise in the exchange rate	14.2%	5.2
Crisis dummy	8.2%	17.8
Crisis*US$ Dummy	−3.9%	17.2
Crisis*US$*IncomeMedium	4.6%	−2.3
Crisis*US$*IncomeHigh	−7.1%	4.7
Crisis*US$*IncomeVeryHigh	−12.1%	12.5
Crisis*US$*Wealth	−12.3%	16.1
Government policies and demographics		
CPI index dummy	20.9%	28.1
Wage index dummy	13.6%	14.3

Notes: The marginal effects of traditional option, demographic, financial crisis and government policy variables on the prepayment and default behavior of Argentine mortgage borrowers. This table reports the impact of a change in the indicated variable on the probabilities of prepayment and default holding all other variables constant at their sample means.

ment and default risks are significantly higher following the financial currency, with higher prepayment but lower default amongst the US$-denominated mortgages. The marginal effects on Table 5 show an 8.2% rise in default and a 17.8% rise in prepayment following the crisis. Moreover, the Peso-US$ exchange rate has a significantly positive effect on both default and prepayment decisions, indicating that households are more likely to default and prepay their mortgage as the Peso depreciates relative to the US$. In Table 5, our marginal effects results indicate that a 10% rise in the exchange rate (i.e., a 10% depreciation in the Peso) resulted in a 14.2% rise in default and a 5.2% rise prepayment.

However, we find that the effects are heterogeneous amongst different types of borrowers. Relative to borrowers of an ARP-denominated mortgage, borrowers of a US$-denominated mortgage are less likely to default and more likely to prepay following the crisis. For borrowers of a US$-denominated mortgage, the marginal effects on Table 5 shows that there was on average a 3.9% lower default but a 17.2% higher prepayment following the currency crisis. With respect to default and prepayment patterns of the different income group post financial crisis, our results show that borrowers in the high- to very-high-income quartiles or have more wealth were significantly less likely to default, but were significantly more likely to prepay. Furthermore, we find a significantly higher prepayment rate and lower default rate amongst the US$-denominated mortgage borrowers with more wealth or

in the high- and very-high-income quartiles. Amongst these borrowers of a US$-denominated mortgage, we find a 4.6% higher default for those in the medium-income bracket, but a 7.1% lower default for those in the high-income bracket and a 12.1% lower default for those in the very-high income bracket. On the prepayment side, the opposite is true. There was a 2.3% decline in the prepayment for those US$ mortgage borrowers in the medium-income quartile, but a 4.7% rise in the prepayment of those in the high-income quartile and a 12.5% rise in the prepayment of those in the very-high-income quartile. Finally, there was a 12.3% decline in default but a 16.1% increase in prepayment of those US$ mortgage borrowers holding more wealth.

One potential explanation for the above results is that the higher-income or wealthy borrowers benefited from the capital gains and hurried to materialize it, while the less well-off incurred unemployment and impoverishment. These results provide evidence that the policy responses to the currency devaluation have an asymmetric impact on consumer finance behavior.

Finally, we look at the impact of the CPI and wage indexation regimes and their interaction with income and wealth to determine whether high-income borrowers maximized their wealth by not prepaying their mortgage during the wage indexation regime. The results suggest that prepayment was 28.1% higher on average and default was 20.9% higher during the CPI indexation regime. The interaction of CPI dummy with wealth reveals that wealthy borrowers had a significantly higher propensity to prepay, but not to default. Furthermore, even though we find that during the wage indexation regime default was 13.6% higher and prepayment was 14.3% higher on average—a significant slowdown in both default and prepayment trends compared to the trends during the CPI indexation regime. Moreover, prepayment for high-income borrowers is statistically insignificant. These results imply that high-income borrowers maximized their wealth by continuing to repay the mortgage, while potentially earning higher returns on other investments opportunities.

7. Impact of the crisis on the secondary market and financial institutions

According to a 1998 study by Argentina's Secretariat of Industry, Trade and Mining, the country's mortgage debt grew 92% on a per capita basis from $137 million in 1994 to $264 million in 1998. Furthermore, Argentina's monthly average mortgage loans by all financial institutions in the country rose from $166 million per month in 1997 to $207 million per month in 1998.

Given the rapid growth in the mortgage market during these four years, government officials and market participants felt the need to develop a mortgage-backed securities market in Argentina. They argued that a secondary market would help structure the growing primary market by instituting standards for credit and property underwriting policies, and enabling lenders to hedge against the financial risks. The secondary market would be composed of mortgage-backed securities (MBS), bringing a higher level of long term liquidity to the banking system. They envisioned that the MBS would stimulate the Argentine mortgage market in the same way that Fannie Mae and Freddie Mac did for the US market. This was facilitated with a

US$1.55 billion investment from the International Finance Corporation (IFC) in a central conduit system set up by Banco Hipotecario.

The MBS program included loans ranging from US$10,000 to US$80,000 (with terms ranging from 3 to 20 years and fixed interest rates between 10 and 18%). These mortgage loans were denominated in US$. The mortgage obligation contained provisions requiring that the principal and interest on the mortgage loan be payable in US$. Hence, the exchange rate risk was born entirely by the borrower, accounting for the "discounted" interest rates for mortgages in US$.

With the Argentine government defaulting and devaluating its currency in December 2001 and the subsequent paradoxical economic policy responses ("pesofication" suspension of foreclosures, CPI and wage indexation) designed to cushion the adverse impact of the devaluation on the financial burdens of borrowers and financial institutions, the devastating effects on the mortgage-backed securities market were enormous. First, as discussed earlier, the 66% subsidy on loan repayment, combined with the 46% rise in consumer price index accelerated the prepayment speed of the underlying mortgages. Second and most severely, the pesofication caused the debt payments made to investors to fall below the dollar amount necessary to meet timely payments on the original terms, which then led to a deep depreciation of the investors' holdings. Eventually, because of the forced pesofication at a sharply devalued rate, Argentine MBS were deemed in default and downgraded to a rating of 'D'.[30]

The economic and financial crisis also had dramatic impact on the financial system. Of the 116 financial institutions existing in 1999, only 97 existed in March 2004 (a 19% reduction over a five-year period). Similarly, the loan portfolios of these institutions shrunk from 23.5% (private loans as a percentage of GNP) in 1999 to 8.5% in 2004, a 15% point reduction. It is only in 2004 that few of the banks (Banco Rio, Banco Nacion, etc.) started to once again offer mortgage loans. Most of these loans are short maturity of up to 10 years and targeted to relatively more wealthy individuals.

Effectively, there are three main factors that still impede the reestablishment of the primary and secondary mortgage markets in Argentina. First, the future uncertainty of the macroeconomic stability affects both the borrowers and the investors. Second, the high level of credit risk affects both lenders and investors. Finally, the loss of confidence in the legal system to protect the lender from credit losses has made lenders apprehensive of offering new credit.

8. Conclusions

In December 2001, Argentina defaulted on her external debt and devalued her currency. In the subsequent months, the Argentine government pursued economic polices intended to soften the adverse impact of the Peso devaluation on the finan-

[30] See Fitch Ratings (2002).

cial burdens of consumers and financial institutions. Specifically, the government converted all US dollar (US$) denominated debt into Argentine Pesos (ARP) at the pre-devaluation exchange rate of ARP1.00:US$1.00 and converted all US$ denominated deposits into ARP at the post-devaluation exchange rate of ARP1.40:US$1.00. Finally, the government announced a New Bankruptcy Law protecting debtors' (over creditors') rights - the law suspended the judicial foreclosure on all consumer or commercial loans. To shield the banks, the government indexed the mortgage interest rates, first to the CPI and then to the wage index.

In this paper, we study the impact of both the currency devaluation and the subsequent economic policy responses on the Argentine consumers' decision to prepay or default on their residential mortgage loan. We accomplish this with the help of a loan level dataset of US$- and ARP-denominated residential mortgages (originated between 1998 and 2000). In the absence of economic policies, we expect the default rates for both US$- and ARP-denominated mortgages to rise significantly. However, our empirical results show a sharp jump in the prepayment speed of US$-denominated mortgages and a sharp rise in the default rate for ARP mortgages following the crisis, which cannot be explained by factors shaping the traditional prepayment and default model or the traditional unobserved borrower characteristics. These results can only be explained by drastic changes in the household portfolio, triggered by real life financial and economic policies. The "pesofication" and the CPI indexation policies provided a one-time opportunity to wealthy and/or US$-denominated mortgage borrowers to prepay their loans. The suspension of the foreclosure laws, the 23% rise in unemployment, and a 40% drop in income provided an opportunity to the low income and/or ARP mortgages borrowers to default on their loans. Furthermore, the policies had significant impacts on the availability and price of credit and the functioning of the secondary mortgage market. The price of credit jumped by 5% points, while the availability of credit dropped by 50%. Finally, the secondary mortgage market also collapsed.

The lessons learnt from the financial crisis and the subsequent economic policy decisions by the Argentine government can be summarized as follows. The policy decisions aimed at spreading the cost of the crisis amongst the whole spectrum of stakeholders, with an emphasis on protecting individual debtors, was in general well intentioned. However, in doing so, some fundamental mechanisms on which mortgage lending relied on were deeply affected: trust in the future value of financial instruments, effectiveness of security rights, creditworthiness of the government, intangibility of contracts, etc. Moreover, the policies resulted in disproportionately benefiting the higher income and wealthy individuals, while disadvantaged the lower income and unskilled consumers.

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