CHARACTERISATION OF CONDITIONAL FORECLOSURE LIKELIHOOD: SIGNIFICANCE OF EQUITY, FIRM, NUMBER OF CO-BORROWERS AND SIZE TO ARM FORECLOSURE

NEO POH HAR, ONG SEOW ENG & HO KIM HIN
National University of Singapore

ABSTRACT

This paper establishes the prognostic variables influencing foreclosures for Singapore residential properties through the building of three probit models – one for all property types, the second for high-rise properties and the third for low-rise properties. A total of four variables are found to be statistically significant in all three analyses. Equity and the size of the property are found to have a positive influence on the likelihood of foreclosure. A negative relationship is found with firm as a type of purchaser and the number of co-borrowers with respect to the foreclosure likelihood. In general, it has been found that the foreclosure likelihood does not change significantly with changes in the economic environment.

Keywords: Foreclosure, default option value, probit model, repeat sales, holding duration

INTRODUCTION

Foreclosure risk has seldom been an issue in Singapore prior to mid 1996, as the private residential property market experienced strong growth. However, since then, a sizeable decline in property price has led to a rising number of foreclosure sales, with 1999 having the higher number of 261 private residential properties being foreclosed, as compared to 5 foreclosures in 1996 (refer to Exhibit 1). The glut in the property market was mainly due to the anti-speculation curb implemented by the local government in May 1996 which was aggravated further by the Asian financial crisis and global economic uncertainties. It is most essential for banks and financial institutions to understand the foreclosure risk given the rising foreclosure sales in recent years.

Exhibit 1: Number of foreclosures

Year	Apartment / Condominium	Detached	Semi-Detached	Terrace	Total
1992	4	3	1	-	8
1993	41	3	5	5	54
1994	30	5	5	5	45
1995	7	-	2	2	11
1996	3	-	-	2	5
1997	13	3	4	7	27
1998	36	17	31	28	112
1999	128	27	60	46	261
2000	96	30	17	26	169

Source: Singapore Institute of Surveyors and Valuers Database

Furthermore, the understanding of foreclosure risk is also useful for the development of real estate securitization, especially in Singapore where there has been a change in regulation recently. With effect from September 2002, banks and financial institutions are rank ahead of the Central Provident Fund (CPF) Board, a statutory board in charge of compulsory savings for a retirement fund in Singapore, in the event of any borrower's default. With this change, there is a greater likelihood of the development of mortgage-backed securities. Thus a deeper examination of the foreclosure risk will further enhance and fasten the pace of such development.

Default and foreclosure risk is well documented in the United States and the studies focus mainly on fixed rate mortgages. However, the adjustable rate mortgage (ARM) is found to be a more prevalent mortgage instrument in Singapore (Khor and Ong, 1998), but there are only a few papers that have dealt with ARM. Thus this paper seeks to provide a timely study on foreclosure risk, given the magnitude of such risk in Singapore and the likelihood of development of real estate securitization. For more details about the Singapore mortgage market, see Ong et al (2002).

In addition, Singapore has a unique policy that allows the use of CPF in property purchase. The CPF, in the form of both accumulated and future monthly contributions, can be used to finance the monthly repayments of the mortgage loan. With this unique policy, the foreclosure risk in Singapore might be different from all other studies. Thus this paper attempts to examine the characterisation of the foreclosure likelihood under four broad groups systematically – mortgage loan characteristics, property characteristics, borrower characteristics and environmental characteristics.

In Singapore, foreclosure research is limited, largely because of the relatively small number of properties undergoing foreclosures to date. Another reason is the lack of available time interval data pertaining to the number of foreclosures, the period of time leading to a foreclosure following default and a corresponding set of explanatory variables. Thus this paper seeks to provide a better understanding of foreclosure risk.

The rest of the paper is organised in the following manner. The literature review on foreclosure and the effects of explanatory variables is provided in the next section. A subsequent section frames the appropriate model specification, followed by the section that discusses the sample data. The last two sections provide the model estimates and findings as well as a conclusion to the study.

LITERATURE REVIEW

A large and well-developed literature in the US prior to 1993 assumes that default is synonymous with foreclosure. The distinction between default and foreclosure was developed by Vandell (1993) and later in the work by Ambrose, Buttimer and Capone (1997) and Ambrose and Capone (1998). There were only a few papers that dealt with the foreclosure process itself (Clauretie, 1987; Mulherin and Muller, 1988; Springer and Waller, 1993).

In many studies, however, the focus has been made on the information available at the time of origination of the mortgage loan to help determine the foreclosure probabilities. Much research in this regard has been confined to the fixed rate mortgages (FRM), relative to the fewer research works on the adjustable rate mortgages (ARM). Basically, the decision to default and ultimately to foreclose can be studied from a variety of variables that include mortgage loan, borrower, property and environmental characteristics which are discussed in more depth below.

Mortgage loan characteristics

Several studies recognize that the dominant factor in explaining the likelihood of foreclosure is the equity position of the borrower. They use the initial loan-to-value ratio to measure equity (Kau *et al,* 1994). The current loan-to-value ratio is used in the studies by Cunningham and Capone (1990), Vandell et al (1993) and Capozza et al (1997). Waller (1989) finds that although there is a strong correlation between the initial and current loan-to-value ratio, the current loan-to-value ratio dominated in the foreclosure decision. Most studies also find that the higher the mortgage rate, the greater the probability of foreclosure (Foster, 1984; Schwartz and Torous, 1993).

Mortgage age has been found to be an important variable in explaining the probability of foreclosure. US studies of fixed rate mortgages (FRM) point to a

peaked non-linear relationship between the mortgage term and the likelihood of foreclosure that would occur some 3 to 5 years after origination (Furstenberg, 1970; Campbell and Dietrich, 1983; Waller, 1989). For the adjustable rate mortgage (ARM), Vandell (1978) finds that foreclosure would occur some 2 to 5 years after origination.

Property characteristics

Property price appreciation is an important variable in affecting foreclosure. Jones (1993) finds that in a period of sizeable house price declines, the incidence of foreclosure increases by two to three times. Case and Shiller (1996) find that the negative difference between the current property price and the purchase price is significant in relation to foreclosure probability.

House price variability is found to be significant in explaining the foreclosure rate (Foster and Van Order, 1984; Gabriel and Rosenthal, 1991; and Kau et al, 1994). House price variability has a negative relationship with respect to foreclosure in which the greater the house price appreciation, the less the likelihood of foreclosure.

Neighborhood quality is a significant predictor of foreclosure rate (Vandell and Thibodeau, 1985; Canner et al, 1991). Gabriel and Rosenthal (1991) find that a central city location, often associated with urban disamenities, is prone to lower price appreciation and may well be subject to greater default risk. This leads to greater difficulty in obtaining conventional loans with stricter underwriting standards normally imposed.

The age of the house can be significant with respect to foreclosure rate. Older houses are normally associated with good neighborhood quality in established districts. Such houses offer better opportunities for price appreciation and reduce the likelihood of foreclosure (Campbell and Dietrich, 1983; Canner et al, 1991; Hakim and Haddad, 1999).

Borrower characteristics

Ability to pay affects the likelihood of foreclosure through the contemporaneous payment-to-income ratio (Jackson and Kaserman, 1980). Borrowers with higher payment-to-income ratio are likely to experience higher foreclosure probability. Therefore, the payment-to-income ratio is closely observed at underwriting for households suspected of relatively high default risk, compared to those with ample wealth to deal with an adverse payment burden.

Age of the borrower is found to have a negative relationship with respect to the likelihood of foreclosure. This is because older borrowers are perceived to have steadier and higher income streams before their retirement; while first time buyers are perceived to be riskier as they are much younger in age, and yet to establish a

stable career (Furstenberg, 1969; Anderson and Vanderhoff, 1999 and Canner et al, 1991).

Certain occupations experience greater income variability, such as the sales occupation whose income is based on sales commission. This increases the probability of foreclosure. Vandell and Thibodeau (1985) find that borrowers who are self employed and those in the sales occupation are more prone to foreclosure. Job tenure of the borrower affects income stability and thus the probability of foreclosure. A longer job tenure would reduce the likelihood of foreclosure (Vandell and Thibodeau, 1985; Cunningham and Capone, 1990).

The income and wealth of a borrower may also explain the decision to foreclose. The higher the borrower's income and wealth, the lower the probability of foreclosure (Furstenberg, 1969; Vandell, 1978 and Bervokec et al, 1994). Household income is found to have a negative relationship with respect to the likelihood of foreclosure (Canner et al, 1991; Lambrecht et al, 1997).

Owner-occupation of the property versus renting out is likely to affect foreclosure probability. It may well be that owner occupiers possess less foreclosure risk relative to the investors, as the investors' monthly loan repayments would come from rents that are prone to changes in vacancy levels and rental demand conditions (Cunningham and Capone, 1990; Hakim and Haddad, 1999). Dependents may have an influence on the probability of foreclosure. As expected, the greater the number of dependents a borrower has, the greater the likelihood of foreclosure (Anderson and VandeHoff, 1999; Berkovec et al, 1994; Hakim and Haddad, 1999).

Environmental characteristics

Trigger events denote a sudden event that happens without any expectation, e.g. retrenchment and divorce. Trigger events can frequently include unemployment and divorce in explaining foreclosure rate. In a study by Capozza et al (1997), both the divorce and unemployment rates are positively related to the foreclosure rate, although these triggers only play a minor role in the foreclosure decision. Quigley et al (1994) find that only the divorce rate signifies a positive relationship with foreclosure.

Campbell and Dietrich (1983), Case and Shiller (1996) and Capozza et al (1997) find that the regional unemployment rate is significant and positively related to foreclosure. Gabriel and Rosenthal (1991) find that the unemployment rate is positively related to the likelihood of foreclosure.

On the whole, the literature abounds with FRM studies in the US that point to significance of house price in relation to the likelihood of foreclosure, as opposed to mortgage value and homeowner characteristics e.g. homeowner's liquidity

position (Vandell, 1978; Jackson and Kaserman, 1980; Foster, 1984; Waller, 1988; Cunningham and Capone, 1990; Kau et al, 1994). In addition, Quigley et al (1994) have shown that the probability of the negative equity ratio is the main time varying covariate, influencing the mortgage holders' foreclosure decision.

Limited research on ARM foreclosure rates largely originates from Canada, with Zorn and Lea (1989) finding that the foreclosure decision is primarily affected by the equity level, debt coverage ratio, mortgage rate and the current property price. Similar results can be found in Cunningham and Capone (1990). The corresponding elasticities of ARM variables are found to be relatively low, indicating that the ARM foreclosure would not significantly vary with changes in the economic environment.

MODEL SPECIFICATION

To examine the prognostic variables (i.e. the determinants) of foreclosure, this paper posits that the dependent binary variable y_i, which can be either 0 (non-foreclosed properties) or 1 (foreclosed properties), depends on a vector of independent variables, denoted as x_i. A general specification is that the probability of observing 1 for y_i is:

$$\Pr(y_i = 1) = F(\beta', x_i), \tag{1}$$

for   i = 1, 2, …, N
     F is an appropriate distribution function.
     x is a vector of covariate values and
     β is a vector of model parameters.

Two specifications for *F*, viz-a-viz the probit model by specifying $F = \Phi$ and $F = \Lambda$, respectively, where:

$$\Phi(x) \quad = \quad \int_{-\infty}^{\beta'x} (2\pi)^{-\frac{1}{2}} \exp\left(-\frac{1}{2}t^2\right) dt \text{,} \tag{2}$$

and

$$\Lambda(x) \quad = \quad \frac{\exp(\beta'x)}{1 + \exp(\beta'x)} \tag{3}$$

It is well accepted that the probit model can be estimated by maximizing the likelihood function:

$$L = \prod_{i=1}^{N} \left[F\left(\beta' x_i\right) \right]^{y_i} \left[1 - F\left(\beta' x_i\right) \right]^{1 - y_i} \qquad (4)$$

Since there is a highly non-linear relationship in many of the variables, consideration is given to the functional form (Capozza et al, 1998).

Exhibit 2 provides a summary of the details that define the variables to be included in the vector x_i, with the expected signs associated with each variable. The variables are broadly grouped under mortgage-loan, property, borrower and environmental characteristics.

Mortgage loan characteristics

Current loan-to-value (LTV) ratio is measured by the outstanding loan balance and property value at the date of foreclosure (sale). The outstanding loan is estimated on the basis of the loan term at the maximum period of 30 years; a minimum requirement of a down payment of 10% prior to the May 1996 anti-speculation measures or a down payment of 20% thereafter. As ARMs are prevalent in Singapore, the mortgage rate is adjusted in the light of the historical mortgage rates set by the local finance companies. For the initial LTV, the 90% loan limit is imposed on properties, purchased prior to the anti-speculation measures, and an 80% loan limit on properties purchased thereafter. A positive relationship is expected between foreclosure and the inferred equity level from the LTV ratios.

As the purchase of a private residential property depends heavily on local borrowing, the likelihood of foreclosure is to be positively affected by changes in the mortgage rate. Higher mortgage rates point to higher debt servicing and the implication of lower affordability, resulting in higher foreclosure likelihood. The percentage change in the current mortgage rate relative to the initial mortgage rate is measured to determine the impact of mortgage rate changes on foreclosure probabilities.

Older mortgages are expected to have a lower likelihood of foreclosure since the borrower has repaid more of the principal. This would increase the corresponding equity level relative to the outstanding loan balance. As a result, these variables may well define a log-linear functional form for mortgage age, between the purchase and sale dates (Campbell and Dietrich, 1983).

Exhibit 2: Summary of variables with expected signs (probit model)

Variable	Code	Expected Signs
Mortgage Loan Characteristics:		
Initial Loan to Value Ratio	InitLVR	+
Current Loan to Value Ratio	CurrLVR	+
Change in Current Mortgage Rate Relative to Initial Mortgage Rate	ChgeMortR	+
Log Mortgage Age	LnMAge	–
Mortgage Rate Volatility	VolMort	+
Maximum Change in Mortgage Rate	MaxChgeMR	+
Property Characteristics:		
Central	Central	+
Tenure where Freehold = 0	F/H=0	+
Low-rise Property – Detached/Semi-Detached/Terrace	Landed	+
Log Age of Property	LnPtyAge	–
Floor / Land Area Floor Area	FlrA / LdA	+
Number of Bedrooms	Bedrm	+
Storeys	Storey	+
Purchase Price	PurPx	+
Property Price Appreciation/Depreciation	PtyPxA/Dp	–
Property Price Index As At Purchase Date	PPIPurD	+
Property Price Index As At Sale Date	PPISaleD	–
Borrower Characteristics:		
Initial Payment to Income Ratio	InitPIR	+
Current Payment to Income Ratio	CurrPIR	+
Change in Current Income Relative to Initial Income	ChgeInc	–
Type of Purchasers	S'POREANS	?
	FOREIGN	+
	FIRMS	+
Developer's Sale	DS	+
Number of Co-owners	Co-Owners	–
Purpose of Purchase: Owner-occupied	OO	–
Environmental Characteristics:		
Property Price Variability	VolPtyPx	–
Unemployment Rate	UNEM	+
Income Variability	VolInc	+

Volatility of the mortgage rate is expected to be an important determinant of foreclosure likelihood in Singapore, owing to the predominance of the ARMs. The average change in the one-month mortgage rate, measured over the entire holding duration, reflects this volatility. A sudden change in the lender's mortgage rate could induce higher foreclosure likelihood. So, the maximum change in the one-month mortgage rate throughout the holding period is to be measured, and a positive relationship between it and the likelihood of foreclosure is expected.

Property characteristics

The location classification serves to determine whether properties located in the Central district are more susceptible to foreclosure. Studies have shown that businessmen suffer from greater income volatility, as they are likely to be adversely affected during an economic downturn, which in turn leads to greater foreclosure likelihood. This is so in the case of Singapore's Central district that is largely occupied by businessmen and professionals. In addition, a central city location has lower price appreciation and would be subjected to greater foreclosure risk relative to other non-central areas (Canner et. al., 1991; Gabriel and Rosenthal, 1991). A dummy variable of 1 is assigned to a property that falls under the central district, and 0 if otherwise.

In Singapore, the tenure of residential properties is categorised as the freehold and the 99-year leasehold. Properties with lease term greater than 999 years are also categorized as freehold tenure. Leasehold properties may well experience a higher likelihood of foreclosure as the corresponding freehold properties, although more expensive to purchase, tend to enjoy stronger price appreciation upon sale and resale than the leasehold properties. Dummy variables are assigned with a value of 0 if the property is a freehold or a 999-year leasehold and a value of 1 otherwise.

The likelihood of foreclosure may differ among the different types of private residential properties. In Singapore, price differentiation is generally in favor of the private detached residential property over the semi-detached property, followed by the terrace and high-rise properties. A primary reason in land scarce Singapore is the substantial land area of the detached properties relative to the rest. It is expected that a low-rise property would have a higher likelihood of foreclosure. To distinguish the high-rise properties from the low-rise properties, a dummy variable with a value of 1 is assigned for the low-rise property and 0 for the high rise property.

Age of the residential property is measured from the date of the temporary occupation permit (TOP) to the date of purchase. It is expected that the newer the property, the higher the foreclosure likelihood, as the majority of new purchases belong to upgraders from public housing – Housing Development Board (HDB) townships. However, not all of these upgraders may be able to meet the initial down payments, through strong enough resale gains from selling their HDB flats

in the secondary market. They would subsequently encounter financial difficulties in their mortgage loan servicing that could ultimately lead to a foreclosure. In contrast, older properties tend to experience high price appreciation, leading to less foreclosure likelihood. These older properties tend to be in more established areas with good amenities and facilities. Similar to the mortgage age, a non-linear age functional form is used.

Floor area is taken to be the built-up area measured in square metres. The implication of larger floor area requirements for the detached and low-rise properties, would be the greater burden of expensive mortgage loan servicing. This could lead to the higher likelihood of foreclosure during a prolonged weakening of wealth and income growth.

In relation to small sized households, it is expected that the likelihood of foreclosure may well vary positively with the number of available bedrooms in the property.

For low-rise properties, it is expected that the likelihood of foreclosure may well vary positively with the number of stories in a property. The number of stories is a proxy for property size in conjunction with a higher provision of available bedrooms.

Absolute purchase price is deemed to be an independent explanatory variable owing to the performance difference between the loans of higher value properties and lower valued properties. Purchase price also measures a property's neighborhood quality. Neighborhoods with good amenities and facilities are likely to fetch higher prices. A positive relationship is thus expected between property price and the likelihood of foreclosure.

It was found in some studies that foreclosure likelihood increases two to three-fold in the period of sizeable house price declines. Property price appreciation becomes relevant and is measured via the difference between the current property price and purchase price. A negative relationship is expected between property price appreciation and the likelihood of foreclosure.

Property price index (PPI) of each region is used to control for a change in market condition. Both the PPI as at the date of purchase is identified and then included as an independent variable. The PPI as at the purchase date is expected to have a positive relationship with foreclosure likelihood. For the PPI as at the date of sale, the reverse relationship is expected, as a higher PPI indicates better market sentiment, and a higher probability of selling at an even higher price. The likelihood of foreclosure would then be lower.

Borrower characteristics

The ability-to-pay concept, like the LTV ratio, is another important factor affecting the foreclosure decision. Both the initial and current payment-to-income ratios can measure the ability-to-pay. The monthly loan repayment is based on the assumption of a threshold purchaser, while per capita income proxies personal income.

For the initial payment-to-income ratio, the monthly loan repayment is taken to be the first repayment upon origination. Income is taken to be the per capita income at the purchase date. For the current payment-to-income ratio, both the loan repayment and income are taken to be the point at the date of sale. A positive relationship is expected in which a higher payment-to-income ratio is likely to experience a higher likelihood of foreclosure.

Income and wealth of a borrower and co-borrowers should have a significant effect on the foreclosure decision. However due to a dearth of data, the per capita personal income is used as a pertinent proxy. Personal income growth is measured based on the per capita personal income at the date of purchase relative to foreclosure date. A negative relationship between the likelihood of foreclosure and income growth is expected.

In Singapore, foreigners and foreign-registered companies are allowed to purchase flats in an apartment or condominium of at least 6 storeys high, as stipulated in the Residential Property Act. As high-rise developments make up the bulk of private residential properties in Singapore, the likelihood of foreclosure may well differ among the different nationalities of the foreign residential purchasers. Greater foreclosure risk is expected of these foreign purchasers relative to local purchasers, as the foreign purchasers are perceived to assume more investment risk.

Firms, as opposed to the individual household, are expected to have greater foreclosure risk as the firm is more prone to financial distress, in accordance with the global business and trade cycles. Dummy variables are assigned with a value of 1 for the property purchaser, be it a Singaporean, foreigner or a firm; and 0 otherwise.

Residential property purchased from a developer's sale may well be more risky than the purchases from the resale market. The primary market for new units in Singapore is generally smaller than units offered in the resale market. In the presence of many interested purchasers in a smaller primary market, the chances of obtaining a new choice unit are even lower. As a result, the purchasers could buy a private residential unit on impulse, without much thought on financial planning. A dummy variable of 1 is assigned for the private residential unit purchased directly from a developer, and 0 if otherwise.

In Singapore, the existence of co-borrowers is expected to lower the likelihood of foreclosure, as CPF can be used to finance the monthly loan repayment. The home purchasers may pool their monthly CPF contributions towards the purchase of a property, so that there is not need to make up additional cash from their monthly salary. Furthermore, the additional income from co-borrowers is able to weather possible trigger event(s). Thus, a negative relationship is expected.

Investors are normally driven by profit. Loans taken up by investors, may entail additional risk in relation to owner-occupiers, as investors are more likely to default ruthlessly towards foreclosure when their equity in the residential property values decline substantially. The dummy variable is assigned a value of 1 for investors in private residential properties who are owner-occupiers and 0 if otherwise.

Environmental characteristics

Residential property price variability is envisaged to vary directly with the likelihood of foreclosure. Variability is measured on the average change of the house price index in one quarter over the entire holding duration. A positive relationship is expected in a declining market, like Singapore's prevailing situation, in which greater price variability into the market downturn, leads to a greater likelihood of foreclosure.

Unemployment rate can be used to measure the impact of a trigger event (e.g. loss of income due to retrenchment) and current economic conditions. The measure is defined by the change in unemployment rate at the date of purchase in relation to the date of sale. Since higher unemployment would increase the likelihood of foreclosure, the change in unemployment rate is expected to vary positively with the latter.

Income volatility can be used to measure the impact of the change in per capita personal income on the likelihood of foreclosure. Income volatility is measured on the average change of the per capita personal income in one quarter over the entire holding duration. It is expected that greater income volatility in a declining private residential would increase the likelihood of foreclosure.

SAMPLE DATA

Data for this study is obtained from the sales database of the Singapore Institute of Surveyors and Valuers (SISV), the largest transaction and reliable database of all types of private properties in Singapore. Only private residential properties being foreclosed are identified for the study, focusing on completed foreclosed transactions but excluding properties still undergoing the foreclosure

process[1]. There are a total of 692 foreclosed sales from the period of 1992 to 2000 (refer to Exhibit 1). Selected variables from the database consist of the district, tenure, property type, property price, land area and floor area.

Other relevant variables are obtained from the Department of Statistics, Ministry of Trade & Industry, and Monetary Authority of Singapore. These include the monthly mortgage rate from the finance-company housing loans of 15 years maturity, quarterly average monthly earnings by industries and the quarterly unemployment rate. The URA Property Price Index is obtained from the Urban Redevelopment Authority's Property Market Information Publication. However, variables pertaining to the type of purchaser (Singaporean, foreigner or firm), a developer's sale, as to whether the purchaser is an investor or owner-occupier and the number of co-borrowers, are obtained from the largest private estate agency in Singapore[2].

Types of facilities within the development, number of bedrooms and the temporary occupation permit (TOP) date are recorded from a guide that lists all private residential properties in Singapore. With regard to the types of amenities and negative externalities, measurements are taken from the street directory. Amenities e.g. school, shopping centre, market, Mass Rapid Transit (MRT) and the bus interchange within 300m from the development, are identified. For negative externalities e.g. a nearby expressway, cemetery and industrial properties, within 400m from the development are also recorded (Ong and Koh, 2000).

Equally significant is the identification of only private residential properties with repeat sales to determine the factors affecting the foreclosure decision. The exclusion of properties still under ownership, should help to safeguard the occurrence of future foreclosure likelihood for such properties as the mortgage term in Singapore is deemed to be long, up to a maximum term of 30 years. The selection of repeat sales would offer a more accurate analysis for the study.

---

1. Properties that are still undergoing the foreclosure process are not included since these owners would still have an opportunity to reinstate the property by paying all the outstanding principal and cost to the lenders.
2. The agency is a reliable source that prefers to remain undisclosed.

Exhibit 3: Descriptive statistics on the foreclosure decision

Variables	High Rise		Low Rise	
	Mean	Std Deviation	Mean	Std Deviation
Foreclosure	0.2578	0.4379	0.2189	0.4139
Purchase Yr	1994.5135	1.6647	1993.3898	1.7249
Sale Yr	1998.1289	1.9440	1997.5186	2.0258
Mortgage characteristics:				
InitLVR	0.8830	0.0376	0.8969	0.0174
CurrLVR	0.7971	0.2346	0.7959	0.3309
ChgeMortR	0.0074	0.0960	0.0179	0.1032
Mage	3.5869	1.9181	4.1168	2.4551
VolMort	0.0086	0.0037	0.0072	0.0028
MaxChgeMR	0.0771	0.0400	0.0708	0.0401
Property characteristics:				
Central	0.4096	0.4923	0.0978	0.2973
F/H=0	0.4387	0.4967	0.0140	0.1175
PtyAge	4.0520	5.2197	11.8602	12.1858
FlrA / LandA	142.9813	52.4507	344.7166	302.9292
Bedrm / Storey	2.8420	0.7556	2.0730	0.5949
PurPx	844087.237	503295.953	1539786.82	1362549.84
PtyPxA/Dp	0.1490	0.3828	0.7959	0.3309
PPIPurD	119.8046	29.3976	133.6494	53.6855
PPISaleD	127.6384	17.0549	143.5077	36.1511
Borrower characteristics:				
InitPIR	2.2308	3.0863	4.4462	3.6944
CurrPIR	1.8105	1.2418	3.6088	3.3324
ChgeInc	0.2653	0.2416	0.3312	0.2541
S'poreans	0.7484	0.4344	0.8727	0.3336
Foreign	0.2162	0.4121	0.0280	0.1650
Firms	0.0478	0.2136	0.1304	0.3370
DS	0.5842	0.4934	0.1786	0.3833
Co-Owners	1.7672	0.7070	2.1724	0.9755
OO	0.4179	0.4937	0.2050	0.4040
Environmental characteristics:				
VolPtyPx	0.0539	0.0214	0.0636	0.0328
UNEM	0.3948	0.8086	0.5076	0.6143
VolInc	0.0892	0.0185	0.0872	0.0244
Total number of observations	481		644	
Total number of foreclosure observations	124		141	

Selection of foreclosed properties is based on the availability of market comparables for each foreclosed property. Pertinent market comparables are based on the date of origination of each foreclosed property in which only comparable properties, transacted within $\pm$ six months from the date of origination of each foreclosed sale, are used. Total number of repeat sales for the foreclosed properties, for which market comparables were available, constitute 319 foreclosed properties (comprising 157 apartments and condominium, 70 terrace, 49 semi-detached and 43 detached properties).

As for the market comparables, there are 2,930 apartment and condominium properties as well as 3,339 low-rise properties, all of which are non-foreclosed properties. Among the comparables for each foreclosed property, three to five of them are drawn based on the criteria of similarity in all aspects except for the nature of sale. Such criteria include the purchase price, the floor and land area. In addition, those properties that are not sold at arms-length are excluded. As a result, the achieved sample size is reduced to 265 foreclosed sales[3] (124 high-rise and 358 low-rise properties), and 854 non-foreclosed sales (357 high-rise and 497 are low-rise properties). The corresponding descriptive statistics for the sample are outlined in Exhibit 3.

Mortgage loans in Singapore are originated on the date of purchase and the holding duration is therefore equivalent to the age of the mortgage. As shown in Exhibit 4, the mortgage age for non-foreclosed properties of all property types is 2.4 years on average; that for foreclosed properties is about 4 years. As the majority of purchases, prior to the government's 1996 anti-speculation measures, tend to be speculative in nature. As a result, holding durations are inclined to be very short, leading to the mortgage age for non-foreclosed properties being relatively lower than that for the foreclosed properties on average. The trend in mortgage age for foreclosed properties is consistent with other studies on fixed rate mortgage by Furstenberg (1969, 1974) and Waller (1989), in which foreclosure rates peak at three to four years after origination.

---

[3] As compared to the total number of foreclosed sales between 1992 and 2000, 265 foreclosure cases represent only 40% of the total foreclosure. One main reason is the lack of availability of comparables as the comparables are selected based on the date of origination and the transaction database consists only of data from 1990 onwards. Hence, foreclosed properties with origination dates prior to 1990 are discarded. Another reason could be the lack of sufficient repeat sales, that is, if we are unable to find at least 3 comparables for each foreclosed observation, that observation is omitted.

Exhibit 4: Average holding duration

Property types	Average holding duration (years)	
	Foreclosure	**Non-foreclosure**
Apartment/condominium	3.8794	3.2840
Detached	3.9748	1.5809
Semi-detached	4.3409	2.2154
Terrace	3.7261	2.5477

Exhibit 5 shows the behaviour of foreclosure rates for all residential property types with respect to the holding duration and that for each property type. A peaked non-linear relationship is observed for the overall foreclosure rate during the term of the mortgage. This trend is in line with several US studies. During the initial period of loan origination from year zero to year two, the foreclosure rate is minimal, as indicated by a gradual rise in its observed gradient ascent. From the second year, the foreclosure rate rises steeply and peaks around year five. These trends are consistent with studies on the adjustable rate mortgage by Vandell (1978) in which foreclosure occurs between the second and fifth years after origination. Thereafter, foreclosure rates fall sharply, reaching a minimal foreclosure rate after the eighth year. These results highlight several studies that there exists little likelihood of foreclosure during the initial period of loan origination. Lenders are likely to scrutinize borrowers during this initial period and after a few years into the loan, a borrower's equity could have risen sufficiently to make foreclosure undesirable (Fursterberg, 1969, 1970 & 1974; Vandell, 1978; Campbell and Dietrich, 1983; Waller, 1989; and Schwartz and Torous, 1993).

Exhibit 5: Foreclosure rates over holding duration
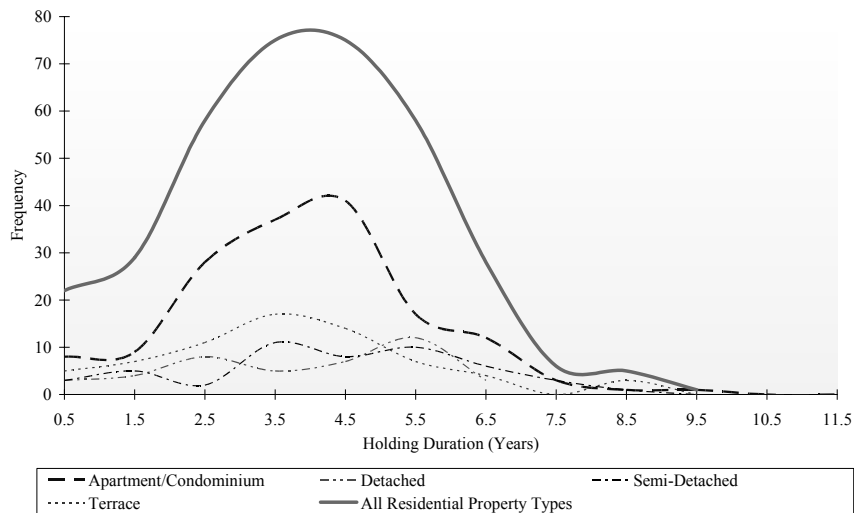
Foreclosure rates for apartments and condominiums peak during the second to fifth year, while those for terrace properties peak between year four to seven; that for the semi-detached properties peak between year three and nine. The peak is between year two and seven for the detached properties. With the exception of detached properties, constrained by sample size, it can be inferred that the higher the property price, then the greater the exposure to foreclosure. In addition, the time period to a peak in the foreclosure rate is deemed to be longer. For high-rise and terrace properties, the peak period is about three years while that for the semi-detached properties is longer at about five years. A contributing reason may well be that such properties have a relatively higher payment-to-income ratio.

MODEL ESTIMATES & FINDINGS

In the analysis of factors affecting foreclosure under the probit model, a full sample of all property segments is used. Further analysis is conducted by separating the sample into the high-rise and low-rise properties, in order to compare the effects of the variables on these properties.[4]

To differentiate between the low-rise and high-rise properties in the full sample analysis, dummy variables with the value of 1 are assigned to the low-rise

---

4. However, due to the limited sample size in each property segment, further regression analysis on each property type is not carried out.

properties. In addition, the variables on storey height, meant only for the low-rise properties, and the bedroom numbers for the high-rise properties, are omitted from the probit model. The probit model deployed in the analysis is subject to some variability in the initial and current loan-to-value ratios as well as the payment-to-income ratio. The results are presented in Exhibit 6, based on the highest log likelihood for the analysis, and the main findings of interest are discussed subsequently.

Mortgage loan characteristics

Of the mortgage loan characteristics, the most important variable affecting the foreclosure decision, is the loan-to-value ratio (initial or current). The sign, as expected, is positive in all of the three probit-model analyses. This is consistent with many studies that recognize the borrower's equity position to be the dominant factor in accounting for the likelihood of foreclosure.

Mortgage rate effects on the likelihood of foreclosure are measured in three ways: change in current mortgage rate relative to the initial mortgage rate; mortgage rate volatility and the maximum change in mortgage rate during the holding period. For the high-rise properties, there is a positive significant result that is consistent with the expected sign, implying that the higher the change in current mortgage rate, relative to the initial mortgage rate, the higher the foreclosure likelihood. However, a negative sign is observed for the low-rise properties. A possible reason is that professionals and businessmen form the majority of purchasers, would often enjoy high wage increases in comparison to the mortgage rate increase. Thus, the rate increase may not be felt to be adverse.

Volatility of mortgage rate over the holding duration shows a positive relationship with the likelihood of foreclosure. With the exception of the low-rise properties, the results are all significant. Therefore, the greater the volatility in mortgage rate, then the higher the likelihood of foreclosure, as the borrowers are exposed to greater mortgage rate risk. It is also observed that the maximum change in mortgage rate during the holding period does not appear to affect the likelihood of foreclosure.

Mortgage age is found in several studies to be an important variable affecting the foreclosure decision. Results indicate a negative significant result for all property types and the low-rise properties except for the high-rise properties. The negative significant result is consistent with an earlier finding in the study that the likelihood of foreclosure tends to diminish as the mortgage age increases. This is because borrowers accumulate equity that discourages foreclosure.

Exhibit 6: Results from the probit model

Variables	All Property Types		High Rise		Low Rise	
	Estimate	Std Error	Estimate	Std Error	Estimate	Std Error
Mortgage characteristics:						
InitLVR	1.7574***	0.6172	3.6311***	1.2461		
CurrLVR			-0.4435	0.0700	1.2208***	0.4673
ChgeMortR	0.2793	0.5761	0.7246	1.0041	-1.7339**	0.8705
LnMAge	-0.7228***	0.2717	0.6806	0.5273	-1.0032*	0.3886
VolMort	46.1281*	24.1775	68.1435*	33.0881	4.1248	52.5565
MaxChgeMR	0.4804	2.9592	-1.4866	5.6012	5.6586	4.6346
Property characteristics:						
Central	0.0117	0.1275	0.1966	0.1870	0.2030	0.2639
F/H=0	-0.1930	0.1400	-0.1304	0.1595	-0.1172	0.6732
Landed	-0.0850	0.1656				
LnPtyAge	0.0593	0.0608	0.1109	0.0782	-0.0875	0.1797
FlrA / LandA	0.0011**	0.0005	0.0052*	0.0028	0.0013**	0.0006
Bedrm / Storey			-0.0900	0.1362	0.0651	0.1387
PurPx	0.0000	0.0000	0.0001***	0.5050	0.0000**	0.0000
PtyPxA/Dp	-0.3062*	0.1586	-0.5031*	0.2725	0.1474	0.3159
PPIPurD	0.0030	0.0020	-0.0044	0.0045	0.0040	0.0026
PPISaleD	-0.0047*	0.0027	-0.0091	0.0060	-0.1491	0.0035
Borrower characteristics:						
Init PIR	-0.0217	0.0195	-0.0201	0.0236		
Cur PIR			-0.9620***	0.2309	0.1884*	0.1120
ChgeInc	0.1066	0.3307	-0.3701	0.5747	-0.0632	0.4776
S'poreans	-0.0174	0.3614	-1.1470	0.9643	0.2128	0.7688
Foreign	-0.4405	0.3302	-1.4317	0.9625	-0.1373	0.4033
Firms	-1.2590***	0.3955	-2.2544**	1.0392	-1.5556**	0.7789
DS	0.0720	0.2133	0.1199	0.2488	-0.2519	0.6603
Co-Owners	-1.0603***	0.0911	-0.7640***	0.1332	-1.3440***	0.1447
OO	-0.4437*	0.1119	0.1244	0.1498	-1.7040***	0.2927
Environmental characteristics:						
VolPtyPx	0.2761	2.2340	-1.9660	6.2652	0.7361	2.6281
UNEM	0.0867	0.0789	0.2401**	0.1132	0.6630	0.1439
VolInc	-7.3033*	4.2298	-6.3792	7.5594	-5.4220	6.4877
Number of observations	1125		481		644	
Log likelihood function	-449.3092		-215.0600		-183.7444	

Dependent Variable = Foreclose is equal to 1
*Statistically significant at 90%
** Statistically significant at 95%
*** Statistically significant at 99%

Property characteristics

Properties located in the central region have higher foreclosure risk, which is consistent in all three probit-model analysis as indicated by positive relationship, although insignificant. This is attributable to the existence of highly priced properties in the central region relative to other regions. In addition, properties located in the central location may have lower price appreciation, resulting in higher risk of foreclosure (Canner et. al, 1991; Gabriel & Rosenthal, 1991).

Although insignificant, all three analyses indicate an opposite sign on tenure than expected, inferring the possibility of a lower likelihood of foreclosure for leasehold properties in contrast to that for the freehold properties. Results are also insignificant for the age of a property, similar to studies by Vandell and Thibodeau (1985), as well as for the bedrooms and storey factors.

However, results are significant for the area factor, inclusive of the land and floor areas, in all three probit-model analyses, showing a positive relationship with the likelihood of foreclosure. This would imply that the larger the area, then the higher the foreclosure likelihood. Another reason may well be that a larger area tends to be associated with a higher property price that would lead to a higher foreclosure likelihood.

Purchase price is significant and positively related to the foreclosure likelihood in all three analyses except for all property types. In general, it is expected that the greater the property price, the higher the likelihood of foreclosure. Nevertheless, the property price appreciation for the high-rise properties has a negative relationship with the likelihood of foreclosure. Thus, the greater the price appreciation then the lower the foreclosure likelihood.

Borrower characteristics

Both initial and current payment-to-income ratios are found to be insignificant. The exception is the current payment-to-income ratio for high-rise and low-rise properties. In the case of the low-rise properties, a positive relationship occurs between current payment-to-income ratio and the likelihood of foreclosure. As expected, the higher the level of the payment-to-income ratio, then the higher the foreclosure likelihood. However, a negative relationship is observed for the high-rise properties. This is consistent with the work by Vandell and Thibodeau (1985), Cunningham and Capone (1990) and Springer and Waller (1993).

A possible reason may well be that monthly loan repayments for high-rise properties tend to be much lower than those for the low-rise properties (by about half, at least). For high-rise properties with lower monthly loan repayment, the owners may use their CPF to pay the monthly payment in full, and there may be excess amount in the CPF account which could be drawn from should there be an increase in the payment-to-income ratio. However for low rise properties, the

owners may already stretch to their maximum limit as regards to the use of CPF and in some cases, cash payment may be needed to top up the amount that cannot be paid by CPF. Furthermore, there may be a possibility of insufficient surplus wealth following a substantial down payment for the low-rise property purchase. Thus any slight increase in monthly repayment may well lead to default and subsequent foreclosure.

Results pertaining to the relationship between the likelihood of foreclosure and change in current income relative to the initial income, are not conclusive. Results are also inconclusive for the kind of purchasers (Singaporean, foreigner or the firm) observed. All three probit-model analyses show an unexpected and insignificant negative relationship between the foreigner kind of purchaser and the likelihood of foreclosure. The same trend is observed for the firm-purchaser. This contradicts the finding by Vandell et al (1993).

A possible reason may well be that the local banks and financial institutions are more aware of the higher investment risk profile associated with both the foreigner and the firm kinds of purchasers. They are scrutinized carefully prior to the granting of loans, thus reducing the likelihood of foreclosure consequently. A higher down payment may even be imposed and upon financial distress, then a sale of the property would be an appropriate option on the basis of a large equity shield accumulated (Waller, 1989). In addition, the firm facing financial distress may choose to sell its property rather than to foreclose, as the decision to foreclose carries high intangible costs in terms of the significant diminution in loan credit worthiness and reputation.

Results are found to be inconclusive involving the likelihood of foreclosure and the issue of whether the property concerned is purchased from the developer or not.

Foreclosure likelihood is found to have a negative relationship with the number of co-borrowers, in contrast to the only finding on the effect of co-borrowers on foreclosure probability by Cunningham and Capone (1990) that co-borrowers have no effect on foreclosure. The negative relationship suggests, as expected, that the greater number of co-borrowers, then the lower the likelihood of foreclosure. In addition to the additional income from co-borrowers to weather any possible trigger event(s), the result may be that the CPF is a source of finance in property purchase. Since the CPF can be used for monthly loan repayments, the purchasers may pool their monthly CPF contributions, so that no additional cash is needed from their monthly salaries. When any unforeseen event should happen such as retrenchment, the monthly additional cash saved can be used to pay for the monthly repayment.

Owner-occupiers show an expected and significant negative relationship with the likelihood of foreclosure, except for the high-rise properties (showing an insignificant positive relationship). This finding is consistent with studies by Cunningham and Capone (1990) and Hakim and Haddad (1999) in which investors are inclined to assume greater risk in both the rental and property markets.

Environmental characteristics

Among the environmental characteristics, the relationship between property price volatility and the likelihood of foreclosure are on the whole insignificant, although the high-rise properties show a negative relationship with the foreclosure likelihood. A possible explanation is that the majority of sales took place during a recovery period, in which the mean sale-year for the high-rise properties was 1998. Thus, the greater the price volatility in a recovery market, then the lower the foreclosure likelihood. This is consistent with work by Clauretie (1987), Canner et al (1991), Gabriel and Rosenthal (1991) and Kau et al (1994) in which a significant negative result is obtained for a rising market.

Change in the unemployment rate is only found to have a significant positive relationship with the likelihood of foreclosure for the high-rise properties. All property types and the low-rise properties show an insignificant positive relationship. These findings are consistent with studies by Capozza et al. (1997) in which the higher the change in the unemployment rate, then the higher the likelihood of foreclosure.

Income volatility is only found to have a significant positive relationship with the likelihood of foreclosure for all property types as expected. The implication is that the higher the income volatility, then the higher the foreclosure likelihood, as the borrowers face more exposure to income changes.

Among the variables concerned, only four variables consistently produce the same significant sign of the relationship in all three probit-model analyses. These variables include: loan-to-value ratio, floor/land area, the firm as a kind of purchaser and the number of co-borrowers.

None of these four variables are related to the group of environmental characteristics, rendering some support to the finding by Cunningham and Capone (1990) that the ARM foreclosure does not change significantly with changes in the economic environment. Instead, the foreclosure is being affected by factors that are controllable by the banks and financial institutions. The banks and financial institutions may grant a lower loan to value ratio to more risky borrowers as evidenced by the finding that by increasing the loan to value ratio, the likelihood of foreclosure will be reduced.

Since the number of co-borrowers has an impact on the likelihood of foreclosure, the banks and financial institutions may restrict their lending to individual borrowers or impose more stringent criteria on the borrowers. In addition, banks and financial institutions should look into the household size in relation to the floor/land area, to determine whether it is within the financial means of the households to purchase large residential property units.

CONCLUSION

The data source for this paper is the Singapore Institute of Surveyors and Valuers (SISV) REALINK database, which provides the most comprehensive data of private property transactions across all property types in Singapore. The study involves an in-depth profiling of the foreclosure likelihood for the private residential properties, through an analysis of the descriptive statistics (inclusive of the mean measures). The foreclosure risk profile is examined and the result shows a peaked non-linear relationship during the mortgage term where foreclosure risk peaks in the second to fifth year from the mortgage origination date. The variables that significantly influence the foreclosure likelihood are then analysed by building three probit models – one for all property types, the second for high-rise properties and the third for low-rise properties.

Among the factors affecting the foreclosure likelihood, a total of four variables are found to be the statistically significant in all three analyses. They include the loan to value ratio, size of the property, the firm as a kind of purchaser and the number of co-borrowers.

Equity that is measured via the loan-to-value ratio as a proxy and the size of the property are found to have a positive influence on the likelihood of foreclosure. For the two variables, namely, the firm-purchaser and the number of co-borrowers, a negative relationship is found with respect to the foreclosure likelihood. In general, it has been found that the foreclosure likelihood does not change significantly with changes in the economic environment, mitigated by the imposition of stringent loan underwriting criteria by the local banks and financial institutions.

Among the four significant variables, the number of co-borrowers is found to be the most significant. This may be associated with the use of CPF in property purchases in Singapore. As CPF can be used for the monthly loan repayment, many potential homebuyers may purchase the property with other co-borrowers, so that little or no additional cash is needed for the monthly loan repayment, as these owners can pool their CPF to purchase the property. Furthermore, the monthly repayment by co-borrowers can still continue even if unforeseen circumstances such as a job loss should happen to any of the borrowers. In addition, the purchase of a property with co-borrowers would lower an

individual's monthly loan repayment and this means that they may not utilize fully their CPF contribution, with those not utilized being accumulated in the CPF account. Thus upon any unforeseen events such as retrenchment where there is no monthly CPF contribution or there is an increase in the monthly loan payment, the owners may draw from the accumulated CPF contributions.

The foreclosure does not change significantly with changes in the economic environment. This again might be associated with the unique policy of allowing CPF towards home purchase in Singapore. In an unforeseen event such as wage cut or retrenchment where there is no more CPF available for home financing, some reservation can be made to draw CPF from the special account (which is intended mainly for medical expenses) for debt payment in the short term.

REFERENCES

Ambrose, B., Buttimer, R. and Capone, C. (1997), "Pricing Mortgage Default and Foreclosure Delay", *Journal of Money, Credit and Banking,* 29 (3): 314 – 325.

Ambrose, B. and Capone, C. (1998), "Modelling the Conditional Probability of Foreclosure in the Context of Single-Family Mortgage Default Resolutions", *Real Estate Economics*, 26 (3): 391 – 429.

Anderson, R. and VanderHoff, J. (1999), "Mortgage Defaults and Borrower Race", *Journal of Real Estate Research,* 18 (2): 279 – 289.

Berkovec, J., Canner, G., Gabriel, S. and Hannan, T. (1994), "Race, Redlining and Residential Mortgage Loan Performance", *Journal of Real Estate Finance and Economics,* 9 (3): 263 – 294.

Campbell, T. and Dietrich, J. (1983), "The Determinants of Default on Insured Conventional Residential Mortgage Loans", *The Journal of Finance*, 38 (5): 1569 – 1581.

Canner, G., Gabriel, S. and Woolley, J. (1991), "Race, Default Risk and Mortgage Lending: A Study of the FHA and Conventional Loan Markets", *Southern Economic Journal*, 58 (1): 249 – 262.

Capozza, D., Kazarian, D. and Thomson, T. (1997), "Mortgage Defaults in Local Markets", *Real Estate Economics*, 25 (4): 631 – 655.

Capozza, D., Kazarian, D. and Thomson, T. (1998), "The Conditional Probability of Default", *Real Estate Economics*, 26 (3): 359 – 389.

Case, K. and Shiller, R. (1996), "Mortgage Default Risk and Real Estate Prices: The Use of Index-Based Futures and Options in Real Estate", *Journal of Housing Research,* 7 (2): 243 – 258.

Clauretie, T. (1987), "The Impact of Interstate Foreclosure Cost Differences and the Value of Mortgages on Default Rates", *Journal of The American Real Estate and Urban Economics Association*, 15 (3): 152 – 167.

Cunningham, D. and Capone, C. (1990), "The Relative Termination Experience of Adjustable to Fixed-Rate Mortgages", *The Journal of Finance*, 45 (5): 1687 – 1703.

Foster, C. and Van Order, R. (1984), "An Option-Based Model of Mortgage Default", *Housing Finance Review*, 3 (4): 351 – 372.

Furstenberg, V. (1969), "Default Risk on FHA-Insured Home Mortgages as a Function of the Terms of Financing: A Quantitative Analysis", *The Journal of Finance*, 24 (3): 459 – 477.

Furstenberg, V. (1970), "Interstate Differences in Mortgage Lending Risks: An Analysis of Causes", *Journal of Financial and Quantitative Analysis*, 5: 229 – 242.

Furstenberg, V. (1970), "The Investment Quality of Home Mortgages", *Journal of Risk and Insurance*, 37 (3): 437 – 445.

Furstenberg, V. and Green, J. (1974), "Estimation of Delinquency Risk for Home Mortgage Portfolios", *Journal of The American Real Estate and Urban Economics Association*, 2 (1): 5 – 19.

Furstenberg, V. and Green, J. (1974), "Home Mortgage Delinquencies: A Cohort Analysis", *The Journal of Finance,* 29 (3): 1545 – 1548.

Gabriel, S. and Rosenthal, S. (1991), "Credit Rationing, Race and the Mortgage Market", *Journal of Urban Economics*, 29 (3): 371 – 379.

Hakim, S. and Haddad, M. (1999), "Borrower Attributes and the Risk of Default of Conventional Mortgages", *Atlantic Economic Journal,* 22 (2): 210 – 220.

Jackson, J. and Kaserman, D. (1980), " Default Risk on Home Mortgage Loans: A Test of Competing Hypotheses", *Journal of Risk Insurance*, 47 (4): 678 – 690.

Jones, L. (1993), "Deficiency Judgements and The Exercise of the Default Option in Home Mortgage Loans", *The Journal of Law and Economics,* 36 (1): 115 – 138.

Kau, J., Keenan, D. and Kim, T. (1994), "Default Probabilities for Mortgages", *Journal of Urban Economics,* 35 (3): 278 – 296.

Khor, A. and Ong, S. (1998), "Housing Loans: Finding the Best Fit", *Business Times Property Supplement*, July 15, Page 6.

Lambrecht, B., Perraudin, W. and Satchell, S. (1997), "Time to Default in the UK Mortgage Market", *Economic Modelling,* 14 (4): 485 – 499.

Ong S.E. and Koh Y. (2000), Time On-Market and Price Trade-offs in High-rise Housing Sub-markets, *Urban Studies,* 37 (11): 2057-2071.

Ong, S.E., Thang, D. and Maxam, C. (2002), "Mortgagor Motivations in Prepayments for Adjustable Rate Mortgages", *Review of Urban and Regional Development Studies*, 14(2): 97 - 116.

Quigley, J., Van Order, R. and Deng, Y. (1994), "Household Income, Equity and Mortgage Default Risks", University of California-Berkeley, Working Paper.

Schwartz, E. and Torous, W. (1993), "Mortgage Prepayment and Default Decisions: A Poisson Regression Approach", *Journal of The American Real Estate and Urban Economics Association,* 21 (4): 431 – 449.

Springer, T. and Waller, N. (1993), "Termination of Distressed Residential Mortgages: An Empirical Analysis", *Journal of Real Estate Finance and Economics*, 7 (1): 43 – 54.

Vandell, K. (1978), "Default Risk Under Alternative Mortgage Instruments", *The Journal of Finance*, 33 (5): 1279 – 1296.

Vandell, K. and Thibodeau, T. (1985), "Estimation of Mortgage Defaults Using Disaggregate Loan History Data", *Journal of The American Real Estate and Urban Economics Association*, 13 (3): 292 – 316.

Vandell, K. (1993), "Handling Over the Keys: A Perspective on Mortgage Default Research", *Journal of The American Real Estate and Urban Economics Association*, 21 (3): 211 – 246.

Vandell, K., Barnes, W., Hartzell, D., Kraft, D. and Wendt, W. (1993), "Commercial Mortgage Defaults: Proportional Hazards Estimation Using

Individual Loan Histories", *Journal of The American Real Estate and Urban Economics Association*, 21 (4): 451 – 480.

Waller, N. (1988), "Residential Mortgage Default: A Clarifying Analysis", *Housing Finance Review,* 7: 321 – 333.

Waller, N. (1989), "Residential Default: An Empirical Note on Changes in Property Value and Debt Over Time", *Housing Finance Review*, 8: 155 – 164.

Zorn, P. and Lea, M. (1989), "Mortgage Borrower Repayment Behavior: A Microeconomic Analysis with Canadian Adjustable Rate Mortgage Data", *Journal of The American Real Estate and Urban Economics Association*, 17 (1): 118 – 136.