

Introducing Real Estate Assets and the Risk of Default in a Stock-Flow Consistent Framework

by

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Abstract

Chapter 1: Real Estate Assets in a Stock-Flow Consistent Framework

This chapter presents a five-sector stock-flow consistency growth model where the portfolio decision of the households includes their choice of how much real estate they are interested in holding. The primary aim of this chapter is to model the housing market using the stock-flow consistent approach to explain the current global financial problem triggered by the housing market. The model can then be simulated to predict the behaviour of various variables and propose appropriate solutions to the financial problem in the hope of returning the economy to a suitable equilibrium. The model presented here follows the stock-flow consistent framework developed by Godley and Lavoie. Households' portfolio consists of money deposits, bills, bank equities and real estate. The other sectors that interact with the household sector are the production firms, the banks, the central bank and the government. Aside from the household sector, the banking sector ends up holding some real estate equivalent to the amount of mortgages defaulted by the households. The banks sell off this real estate to the households in the following period. The supply of real estate from the production sector is therefore augmented by the additional ones offloaded by the banks. The households use their real estate holdings as collateral for the mortgage loans they acquire from the banks. Hence the banks take a lien on these properties when households default on their mortgage repayment obligations.

Chapter 2: Implementation of Real Estate Assets in a Stock-Flow Consistent Model

This chapter presents the implementation of the stock-flow consistency model outlined in the first chapter. The purpose of this chapter is to run a simulation of the model and experiment with shocks to determine the path of the economic variables of the model. Another objective in performing the experiments is to find policies for mitigating the housing crisis. The model consists of household, firm, commercial bank, central bank and government sectors. The households make portfolio choices consisting of real estate, government bills, bank deposits and high-powered money. The model is executed using the Eviews computer modeling software until a stationary steady state is achieved. Various shocks are applied to the baseline stationary state. The results of the monetary

policy and other interest rates shocks show that the mortgage rate shock is more effective in influencing the growth rate of the economy as well as controlling the real estate market. In addition, the results support the notion where central banks spread the monetary policy rates increment (or decrement) in several periods. Government fiscal policy is also effective in regulating the housing market. A one-period temporary fiscal policy shock is even capable of generating permanent long run growth effects. Household expectations in future housing price increases or future high rates of housing returns have the effect of heating the real estate market without comparable increases in economic growth. Policy makers must keep these expectations in check.

Chapter 3: Mortgages Repayment Determinants in the Real Estate Market

This chapter analyzes the determinants of mortgage repayment options in Canada. With the freedom that comes with being debt-free and owning a home one will assume that households pay off their mortgages as soon as possible. This peace of mind is priceless to households and therefore many opt for an early mortgage payoff. However, there are factors that inhibit households from carrying out these payoffs and choosing other repayment options. This study uses Canadian micro-level data to examine factors that drive households to default, prepay or continue to make regular mortgage payments. The research methodology uses multinomial (polytomous) logistic regression analyzes. The empirical results establish that the traditional mortgage related predictor variables for repayment are statistically significant with the expected signs. The results relating to the provinces are not significantly different from each other. It is worth noting the role of GDP per capita in relation to the repayment equations. The results did not however provide any significance in relation to mortgage rates and the number of children in the household.

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General Introduction

The world financial crisis that began in 2007 is considered by some economists as the worst financial crisis since the Great Depression in the 1930s. The root of the crisis is the bust in the US housing market bubble. The speculation in real estate in addition to the relaxing of the regular checks and balances of the banking sector greatly contributed to the financial crisis. This doctoral dissertation models a stock-flow consistency model with emphasis on the household sector and its participation in the real estate market. The model is implemented and various simulations are performed on the model. The first chapter presents the model in details while the second chapter presents the simulation and results. The third chapter examines another interesting aspect of the real estate market — notably it examines the economic factors that induce households to default on their mortgages. The first two chapters are dedicated to the modeling and implementation of a stock-flow consistent framework that incorporates real estate as an asset in the portfolio of the household. The third chapter investigates a different aspect of the real estate market which is completely different from the first two chapters. It investigates the main determinants of mortgage repayment of Canadian households.

The first chapter uses the stock-flow consistent framework developed by Godley and Lavoie (2007) together with mortgage debts and mortgage defaults to model the current financial problem triggered by the housing market. The chapter also examines other housing related behaviours of the household. These behaviours include the defaulting of mortgages. The banks take possession of the real estate property once the household defaults on their mortgages.

Real estate is modeled as an asset in the portfolio of the household. Households

therefore allocate a portion of their investible wealth in real estate depending on the expected return on real estate in comparison to the returns of other investible assets in the economy. The other assets in households' portfolio are money deposits, and bills. The banks are assumed to be owned directly by the households. The supply of housing consists of newly constructed homes and homes the banks took over from the households when the households defaulted on their mortgage debts repayment obligation. The supply rate of new houses is positively related to the ratio between the price of real estate and the production cost. The growth rate of mortgages is assumed to be a factor of the government sector growth rate and the rate of inflation. The default rate of the households is a constant proportion of accumulated mortgage debts at the beginning of each period.

The other stock-flow consistency models of the housing market in the literature are those of Zezza (2008) and Eatwell et al. (2008). In Zezza (2008), the household sector consists of capitalists and workers. Zezza investigated the puzzle of the coexistence of a shift in the distribution of income towards the richest 5 percent of the population and the decline in saving relative to disposable income. He found this behaviour, since 1990, to be contrary to the Keynesian models of household behaviour. Zezza (2008) shows that “an increase in the expected market price of houses will generate a price bubble if the supply of new homes lags behind the increase in speculative demand” (p. 379). This leads to a rise in output and the fall in saving rates. Eatwell et al. (2008) investigate the driving forces, including the expansion of sub-prime mortgage lending that led to the recent financial bubble. Their model suggests that the “shadow banking system” rather than the household sector was the cause of the crisis due to the growth of leverage which is now characteristic of financial firms throughout the financial system.

The second chapter implements the model presented in the first chapter. There are several types of experiments that can be undertaken using this model. The chapter

presents some of the most relevant experiments related to the housing market. The Eviews modeling software is the tool used in performing the simulations of the model. The experiments only consider cases where the shock parameter increases from the baseline value as opposed to decreasing it.

The paths of some chosen variables are traced in the various scenarios during the experiment. The paths typically analyze growth and real estate parameters. The growth parameters mostly analyzed are consumption and income. The real estate parameters include the demand, supply and price of real estate, and the demand for mortgage loans. Both the one-time permanent shock and the one-period temporary shock regimes are involved in the experiments.

The simulations covered in chapter two consist of firstly, monetary policy and other interest rate changes where the interest rates of bills, deposits and mortgages are increased above the baseline scenario. The second consists of changes in the expected rate of return on real estate. The rate of return on real estate is the major determining factor households consider when allocating their limited investible wealth to real estate. Thirdly, the changes in the mortgage defaulting rate are simulated. The default rate directly affects the supply of real estate and indirectly affects the willingness of the banks to issue mortgage loans to households. The fourth simulation consists of the government fiscal policy. The government fiscal policy is one of the most effective shock parameters in the model. In the experiment the growth of government expenditure is increased to a new level over the baseline scenario. In the next simulation, the expectation about housing prices is examined. Price rise expectations in the real estate market can potentially lead to price bubbles. Finally, the default rate is made a determining factor for mortgage rates. This experiment endogenizes the mortgage rate markup over the deposit rate. This experiment brings to light the black box nature of the interest rate markups.

The third chapter explores the factors that lead households to default on their mort-

gage repayment obligations. Home ownership is a long-term goal of most households but some of these households do not honour their mortgage repayment agreements with the banks. Default is costly to banks, the home insurance companies and as well as the households. When households default, they stand to lose the equity they have built into the property. The federal institution that guaranteed the mortgage and the lenders also stand to lose when mortgages are defaulted.

Most housing default studies have dealt with US data. Not enough housing research has been conducted using Canadian data. However there are some differences between the housing market in the US and Canada. The differences include mortgage rate terms (Adjustable Rate Mortgages vs. Fixed Rate Mortgages), mortgage liability (Recourse vs. Non-Recourse), and tax policies. These differences and others warrant a research on housing using Canadian data sources. The differences contributed to the different outcome of the sub-prime crisis in 2007. In part, the impact was lesser in Canada due to the nature of the housing market and the prudence of the banking sector.

Households have five discrete mortgage repayment options at their disposal. 1) Continue to pay the agreed monthly amount required on the mortgage term. 2) Pay an additional amount over the normal payment contractually required. 3) Delay mortgage payment but resume payment in the future. 4) Default on payment. This is distinguished from the delinquent case in that payment is not resumed. Delinquency is less severe than default. The banks take possession of the defaulted real estate property. 5) Pay off the entire balance on the mortgage when it comes due for renewal. This is not a common option; however, a household may experience some windfall which will enable the household to pay off all outstanding mortgage loans. The repayment options are namely: NORMAL, PREPAY, DELINQUENT, DEFAULT and REPAYMENT as respectively discussed. The third chapter models the NORMAL, PREPAY, and DEFAULT options.

The purpose of chapter 3 is to use a Canadian national cross-section disaggregated

data to investigate the factors that determine and instigate households to prepay or to default on their mortgages. In studies that include the classes of payment options discussed here, the default options are typically computed using utility functions. This basically examines mortgage repayment from the borrower's perspective. This study in addition discusses defaults from the institutional perspective. Hence, the results can be used by lenders in predicting the default behaviour of the borrowers before advancing loans.

Chapter 1

Real Estate Assets in a Stock-Flow Consistent Framework

1.1 Introduction

The economies of the world, led by the US, experienced turbulence in the first decade of the 2000s. This agitation led to a recession in most economies. The turbulence has been attributed to the housing markets — more specifically the housing sector of the US economy. The problem is fuelled by speculation in real estate in addition to the relaxing of the regular checks and balances of the banking sector.

The banking sector provided home subprime mortgages to households, many of which turned out to be nonperforming mortgage loans. Many nonperforming debt obligations are due to the securitization of the nonperforming subprime mortgage loans in assets such as collateral debt obligations (CDOs) and structured investment vehicles (SIVs) (Davidson, 2008). The current subprime nonperforming loan problem has brought on potential insolvency problems for major bank underwriters of mortgage backed assets. The treatment of bank insolvency is outside the scope of this chapter.

The purpose of this chapter is to use the stock-flow consistent framework developed by Godley and Lavoie (2007) to model the housing market together with mortgage debts and mortgage defaults to explain the financial problem triggered by the housing market. The constructed stock-flow consistent model can be simulated and used to predict the path and behaviour of various variables of the economic system. In particular, we can undertake fiscal and monetary policies to determine their impact on the various economic variables. In so doing, the model can be used to propose appropriate solutions to the housing financial problem that will return the economy to a suitable equilibrium. The chapter also examines other housing related behaviours of the household. These include the defaulting of mortgages and the recovery of the liens on the mortgages by the banking

sector.

Households demand for real estate is modeled as part of their portfolio selection problem. Hence households allocate a portion of available investible wealth in real estate depending on the expected return on real estate in comparison to the returns of other investible assets in the economy. The portfolio set of the households include money deposits, bills, and real estate. The buffer of households is their money deposits — the residual of the portfolio selection functions. The banks are assumed to be owned directly by the households. The supply of housing consists of newly constructed homes and the houses recovered by the banks from the households when some households defaulted on their mortgage debts payment obligation. The supply rate of new houses is positively related to the ratio between the price of real estate and the production cost of housing. Mortgages growth rate is a factor of the government sector growth rate and the rate of inflation. Households also default on a proportion of accumulated mortgage debts at the beginning of each period. In this model the default is assumed to be a constant proportion of all stock of mortgage demanded by the households in the previous period.

In the literature there are two papers that model the housing market with stock-flow consistency. These are Zezza (2008) and Eatwell et al. (2008). Zezza (2008) splits the household sector into capitalists and workers to investigate the puzzle of the coexistence of a shift in the distribution of income toward the richest 5 percent of the population and the decline in saving relative to disposable income. He found this behaviour since 1990 to be contrary to the Keynesian models of household behaviour. Zezza (2008) shows that “an increase in the expected market price of houses will generate a price bubble if the supply of new homes lags behind the increase in speculative demand” (p. 379). This leads to a rise in output and the fall in saving rates. Eatwell et al. (2008) investigate the driving forces, including the expansion of sub-prime mortgage lending that led to the recent financial bubble. Their model suggests that the “shadow banking system” rather

than the household sector was the cause of the crisis due to the growth of leverage which is now characteristic of financial firms throughout the financial system.

The outline of the chapter is as follows: Section 1.2 presents the model of the system. The balance sheet, the revaluation and the transaction flow matrices of the model are discussed in much detail. The real estate market's demand, supply and price models are also presented in section 1.2. Section 1.3 outlines the various sectors of the economy. The sectors in the model are the households, the production firms (or non-financial businesses), financial firms or the banks, the central bank and the government. The household sector is the central piece of the model. Section 1.3 also discusses mortgages and the portfolio selection criterion of the households. Finally, section 1.4 concludes.

1.2 The Model

The model in this chapter is a closed economy¹ with five sectors. The sectors are respectively the households, the non-financial firms, the banks, the government and the central bank. Banks are defined to include all aspects of the financial sector, including mortgage brokerage houses, commercial banks, money market funds, hedge funds, *etc.* The government and the central bank are treated as separate entities in this model.

1.2.1 The balance sheet matrix

The balance sheet matrix or *stock matrix* measures the level of all stock variables at some given point in time explaining the financial structure of an economy. The balance sheet is the basis of the revaluation and the transactions-flow matrices presented in sections 1.2.2 and 1.2.3 respectively. Only items that are of higher weights in value are included in the balance sheet. For example, households hold tangible assets in the form of residential real estate, cars, and appliances (fridges, stoves, dishwashers, *etc.*) but only the real estate is represented in the balance sheet. Households take loans to finance the purchase of real estate, and other loans to purchase other durable goods. For the same reason only mortgages are represented in the balance sheet. An example of the values of items represented in the balance sheet is given in tables 1.1 and 1.2 — the balance sheets of the household sector in the US and Canada for third quarter (Q3) of 2011. In the Canadian data, mortgages held by the households for Q3 of 2011 were \$970.08 billion compared to \$116.18 billion in other bank loans. In the US, for the same period, mortgages held were

¹This model can easily be transformed into an open economy model. The housing crisis in the US could still have occurred if the US economy was closed, since most of the triggers were homegrown. This provide a justification for keeping the model closed and simple, and getting a good insight of the housing crisis. Nevertheless, the benefits of an open economy extension are discussed on page 109.

valued at \$9,869.90 billion and other bank loans were valued at \$416.60 billion. That is, Canadian mortgages were 62.66% of total household liabilities as compared to 7.50% for other bank loans. In the US, the difference is even larger. Mortgages were 73.24% of total household liabilities as compared to 3.09% for other bank loans.

Table 1.1: US Household Balance Sheet

Assets	71,564.2	Liabilities	71,564.2
Real Estate R	16,233.4	Mortgages MG	9,869.9
HPM $H_h +$		Other Loans L_h	416.6
Deposits M_h	8,434.3		
Bills B_h	5,188.0		
Other assets	34,737.9	Other liabilities	3,189.6
Equities BE	6,970.6	Net Worth NW_h	58,088.1

Source: Z.1 statistics of the Federal Reserve,
www.federalreserve.gov/releases/z1, Table B.100, ‘Balance sheet
of households and nonprofit organizations’, Q3 2011 data, June
2012 release; units are billions of dollars.

Table 1.2: Canada Household Balance Sheet

Assets	7,113.8	Liabilities	7,113.8
Real Estate R	1,571.5	Mortgages MG	970.1
HPM $H_h +$		Other Loans L_h	116.2
Deposits M_h	980.4		
Bills B_h	88.2		
Other assets	3,805.8	Other liabilities	461.8
Equities BE	667.9	Net Worth NW_h	5,565.7

Source: Canadian National Balance Sheet Accounts, Table
378-0085, ‘Persons and unincorporated business, book value’,
Q3 2011 data, March 2012 release; units are billions of dollars.

Table 1.3 presents the balance sheet of the model. Households have a wide range of financial assets they can choose from. The portfolio choice of the households includes high-powered money H , money deposits M , and government issued bills B . In this

model, households additionally choose the amount of real estate, R_d at a given price of p_r , they wish to hold in their portfolios. Households are assumed to entirely own the banks privately. Households therefore hold the entire equity of the banks, BE , in their portfolios. For notational purposes, assets in the balance sheet (as in table 1.3) are represented with a plus sign (+) and liabilities are represented with a minus sign (−).

The net worth of households, NW_h , is the residual that makes households' assets equal their liabilities. Households' expenditure is normally less than their income; they therefore accumulate net financial assets (including real estate) over time. This implies a positive net worth on the liability side of the households' balance sheet. Under normal economic conditions net worth is usually a large value and tends to grow over time as seen in the household balance sheets in tables 1.1 and 1.2 for the US and Canada respectively. However, a slump in the real estate market can drastically affect real estate value in the balance sheet. This has a negative effect on net worth. This is the case of the sub-prime mortgage crisis which started in 2007 in the US. This crisis led to the fall in both real estate prices p_r and equity prices as shown in figures 1.1 (on page 13) and 1.4 (on page 26). However, net worth is likely to stay positive with the most adverse economic conditions. In the US for example the home owners' equity in real estate was 45.2% in Q2 2008 and 39.20% in Q3 2011. The US housing crisis has led to the fall of the households' net worth gradually from the last quarter of 2007. Households' net worth at the end of Q4 of the 2008 Z.1² Flow of Funds Accounts of the United States data was estimated to be \$51.5 trillion, \$5.1 trillion dollars less than the value in the preceding quarter. Figure 1.2 is the annual Z.1 household net worth for the US from 2000 to 2010. For 2008 as a whole, household net worth fell by more than \$12 trillion. As can be seen in the figure the fall in 2008 began to pick up in 2009 but still less than the net worth peak in 2007. Canada which did not experience a severe crisis as the US

²Z.1 Statistical Release is the flow of funds accounts of the United State government fiscal report.

has seen a continual increase in household net worth through 2008 and beyond as shown in figure 1.3. The growth rate however is not as high as the previous years.

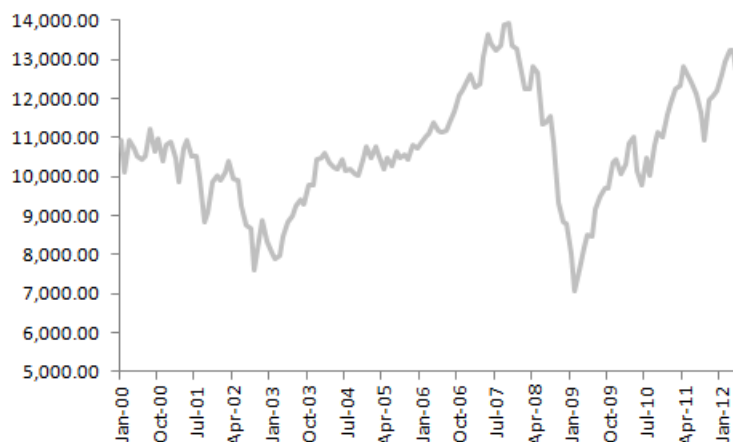


Figure 1.1: Dow Jones industrial average

Source: Dow Jones, <http://www.djindexes.com>. March 2012 release; units in dollars.

Table 1.1 is the balance sheet of US household from figures of Q3, 2011 Z.1 statistics of the Federal Reserve. In this table, loans are from the banks and other sources. The ‘other assets’ entry has a substantial portion of it in pension fund reserves and mutual funds. Similar accounting is done for the Canadian households’ balance sheet presented in table 1.2. The source of the data in Canada is the Q3, 2011 Statcan’s Canadian National Balance Sheet Accounts.

The balance sheets of the other sectors are similar in accounting to that of the household sector. The specification of the production sector in this model is kept simple as it is not the central piece of the model. In this model, firms do not hold any kind of financial asset. Firms are the production sector of the economy. They produce the real estate purchased by the households, the consumption goods purchased by the household and the other goods purchased by the government. For simplification of the production sector, the model does not include the fixed capital of the firms.

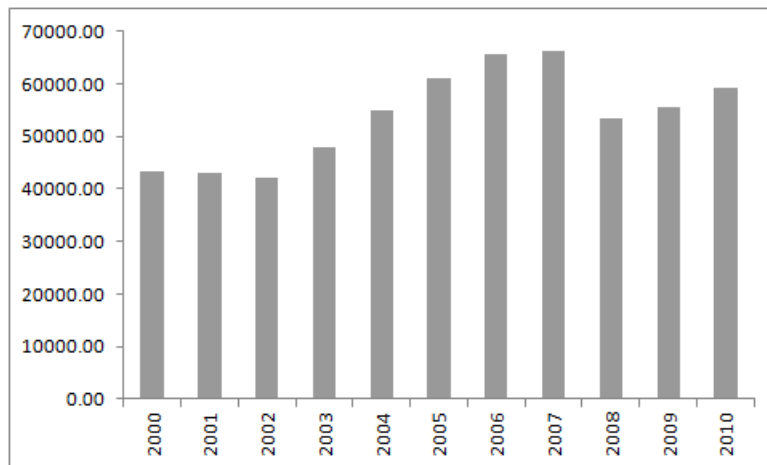


Figure 1.2: US household net worth

Source: Z.1 statistics of the Federal Reserve, June 2010 release; units are billions of dollars.

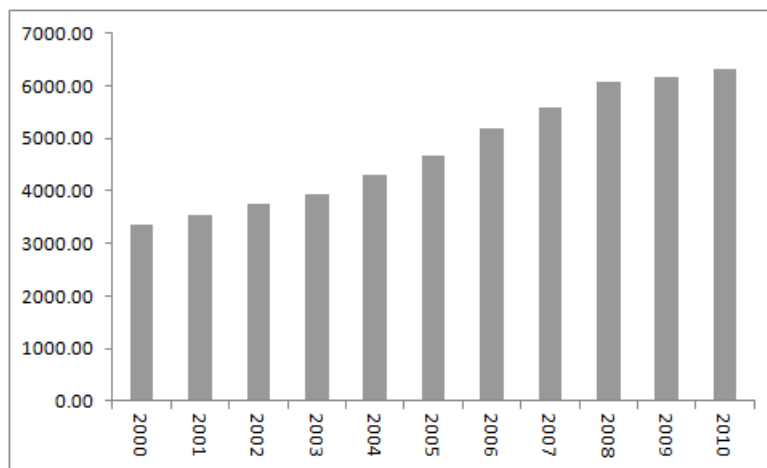


Figure 1.3: Canada household net worth

Source: Canadian National Balance Sheet Accounts, June 2010 release; units are billions of dollars.

The term ‘bank’ is used loosely to represent commercial banks and other financial institutions that perform banking functions. Banks advance loans in the form of mortgages, MG , to households. As can be seen in the balance sheet (table 1.3), the banks are the recipients of deposits (M) from the households. As assumed in the households’ balance sheet entry, the banks do not issue equities but are wholly owned by the households. The value of the banks’ equity is represented by BE in the balance sheet. The banks’ equity is calculated as net worth of the banks — the difference between all assets and all liabilities ($NW_b = BE$). In this model the banks are also *unwilling* holders of real estate worth $NPMG$. Non-performing mortgages ($NPMG$) is the amount of mortgages defaulted by households in a particular period. See section 1.3.1.3 for details. Note that in the balance sheet matrix, $R_{d.p_r} - NPMG = Ra_{d.p_r}$.

The government is distinguished from the central bank in this model. The government does not hold any portfolio but issues bills that are held by the households and the central bank. The central bank holding of bills is not a portfolio selection decision but an accounting requirement. The balance sheet budget constraint of the central bank dictates the amount of bills the central bank holds. This is equal to the high-powered money the central bank issues. The total of the bills issued constitutes the debt of the government. Government debt is given as V_g in the balance sheet. The non-interest bearing high-powered money (HPM) issued by the central bank is demanded by the households. Households hold HPM for transaction purposes — Keynes’ transactional motive for holding money. The central bank transfers all its profits to the government and hence its net worth is zero.

Table 1.4 is an example of a balance sheet of an economy. Most of the data for the example are drawn from the Q4, 2008 Z.1 statistics of the US Federal Reserve. In this example, the rate of default on mortgage repayment is assumed to be exogenously set at 5%. That is $npmg = 0.05$. Other entries in the balance sheet are computed from

Table 1.3: Balance sheet matrix

	Households (1)	Firms (2)	Banks (3)	Government (4)	Central Bank (5)	Σ (6)
1 Real estate	$+R_d \cdot p_r - NPMG$		$+NPMG$			$+R_d \cdot p_r$
2 Mortgages	$-MG$		$+MG$			0
3 HPM	$+H$				$-H$	0
4 Deposits	$+M$		$-M$			0
5 Bills	$+B_h$			$-B$	$+B_{cb}$	0
6 Bank capital	$+BE$		$-BE$			0
7 Balance	$-V_h$		0	$+V_g$	0	$-R_d \cdot p_r$
8 Σ	0	0	0	0	0	0

the Z.1 statistics values for coherence based on the double entry constraint principle, a characteristic of all social accounting matrices.

Table 1.4: US Q4 2008 Balance sheet matrix

	Households (1)	Firms (2)	Banks (3)	Govt (4)	Cen.Bank (5)	Σ (6)
1 Real estate	19,989		523			20,512
2 Mortgages	-9,931		9,931			0
3 HPM	156				-156	0
4 Deposits	7,685		-7,685			0
5 Bills	273			-429	156	0
6 Bank capital	2,769		-2,769			0
7 Balance	-20,941		0	429	0	-20,512
8 Σ	0	0	0	0	0	0

Source: Z.1 statistics of the Federal Reserve, Data from balance sheets Tables B.100, B.100.e, B.102 and B.103, Q4 2008 data, March 2009 release; units are billions of dollars.

1.2.2 The revaluation matrix

The revaluation matrix, table 1.5, records the change to the net worth of the sectors arising from revaluations of their assets or liabilities. That is gains (or losses) arising from the changes in the prices of the assets or liabilities. The change in net worth of the sectors arising from transactions or change in quantities of the assets or liabilities is presented in the transactions flow matrix in section 1.2.3. Only the household and the banks are represented in the revaluation matrix because the other sectors neither make nor receive any capital gain or loss in this model. All *sources* (incoming flows) of funds are represented with a plus sign (+) and all *uses* (outgoing flows) of funds are represented with a minus sign (-).

For assets or liabilities with prices the calculation of the capital gain is straightforward. It is simply the change in price of the asset multiplied by the quantity of the

Table 1.5: Revaluation matrix

	Households (1)	Banks (2)	Σ (3)
1 Real estate	$+\Delta p_r \cdot Ra_{d-1}$	$+\frac{\Delta p_r}{p_{r-1}} \cdot NPMG_{-1}$	$+\Delta p_r \cdot R_{d-1}$
2 Bank capital	$+\Delta BE$	$-\Delta BE$	0

asset at the beginning of the period. For example, the capital gain in real estate held by the banks is the product of the change in price of real estate, $\Delta p_r = p_r - p_{r-1}$, and the quantity of real estate held by the banks at the beginning of the period, $NPMG_{-1}/p_{r-1}$. The households directly own the banks; banks therefore do not float equities on the stock market. The bank capital can be conceived as one share valued at a price BE split into fixed amount of papers that are given to the households. The value of the banks increases as the price of the share, BE , increases. The capital gain or loss of the banks is therefore given as $(BE - BE_{-1}) * 1 = \Delta BE$. Since the banks do not raise capital by issuing shares on the open market bank capital does not have a transaction based entry in the transactions flow matrix.³

1.2.3 The transactions flow matrix

The transactions flow matrix records all the monetary transactions of the economy. The rows and columns of the matrix sum to zero for coherency. The zero-sum rule of each column represents the budget constraint for the corresponding sector. Each row represents the flows of transactions for each asset or for each kind of flow. The top part of the transactions flow matrix, table 1.6, from rows 1 through 10 is equivalent to the conventional income and expenditure matrix. The bottom part of the matrix, rows 11 through 14, is the flow equivalent of the balance sheet matrix.

³Change in number of shares of the banks is always zero.

The transactions flow matrix in table 1.6 satisfies the budget constraint. Each sector may have a balance among flows of tangible assets, financial assets, expenditure, factor income and transfers in stocks of assets and liabilities. As in the other discussed matrices, in the transactions flow matrix all *sources* (incoming flows) of funds are represented with a plus sign (+) and all *uses* (outgoing flows) of funds are represented with a minus sign (−). Sales and receipt of interest income constitute sources of funds while purchases and payments of interest are uses of funds.

The details of the variables in the transactions flow matrix are discussed in the subsequent sections. Interest rates are lagged in the matrix. The flow of interest on an asset or liability in the present period depends on the rate of interest and on the stock of asset or liability at the opening of the production period. For instance the flow of interest on deposits is $r_{m-1} \cdot M_{-1}$. The Δ notation describes a change in an asset or liability between the beginning and the end of the period under study. For example, the change in deposits between beginning and end of the period is represented by ΔM . For a detailed discussion of the transactions flow matrix, see Godley and Lavoie (2007, ch. 2).

Having presented the structure of the balance sheet, the revaluation and transactions flow matrices, the following sections present analyses of the variables and derived equations of the model. An appropriate modeling software can be used to solve the system derived from the accounting and behavioural equations of the model.

1.2.4 Identity equations

The accounting equations for the model are identified using Mouakil’s methodology in Mouakil (2006). The methodology is also used and described in Eatwell et al. (2008). Following this methodology, the accounting equations resulting from each non-ordinary⁴

⁴A row is non-ordinary if its solution does not result in an identity (as in $\Lambda = \Lambda$).

Table 1.6: Transactions Flow Matrix

		Households (1)	Firm (2)	Banks		Government (5)	Central Bank		Σ (8)
				Current (3)	Capital (4)		Current (6)	Capital (7)	
1	Real Estate	$-\Delta Ra_d \cdot p_r$	$+\Delta R_d \cdot p_r$		$-\Delta NPMG$				0
2	Consumption	$-C$	$+C$						0
3	Govt Expenditures		$+G$			$-G$			0
4	Taxes	$-T$				$+T$			0
5	Income (GDP)	$+Y$	$-Y$						0
6	Banks Profits			$-F_b$	$+F_b$				0
7	CBanks Profits					$+F_{cb}$	$-F_{cb}$		0
8	Int/Mortgage	$-r_{mg-1} \cdot MG_{-1}$		$+r_{mg-1} \cdot MG_{-1}$					0
9	Int/Deposits	$+r_{m-1} \cdot M_{-1}$		$-r_{m-1} \cdot M_{-1}$					0
10	Int/Bills	$+r_{b-1} \cdot B_{b-1}$				$-r_{b-1} \cdot B_{-1}$	$+r_{b-1} \cdot B_{cb-1}$		0
11	Δ Mortgage	$+\Delta MG$			$-\Delta MG$				0
12	Δ HPM	$-\Delta H$						$+\Delta H$	0
13	Δ Deposits	$-\Delta M$			$+\Delta M$				0
14	Δ Bills	$-\Delta B_h$				$+\Delta B$		$-\Delta B_{cb}$	0
15	Σ	0	0	0	0	0	0	0	0

row and column of the balance sheet, each column of the transactions flow matrix (budget constraints) and each non-ordinary row of the transaction flow matrix for this model are specified in equations 1.1 to 1.16. These identity equations are used to develop the system of equations of the model.

Sanity equations are equations that guarantee the consistency of the model. In addition to providing the base for most of the equations of the model, the identities equations are used in verbatim as sanity equations. For each equations in 1.1 to 1.16, the model replaces the identity sign ($\equiv$) with an equal sign ($=$) to test that the identities hold. At each point in the iteration the truthfulness of the identities must hold. A slight deviation from the identity in any period will not yield a consistent solution — a tested hidden equation.

The balance sheet matrix identities are given in equations 1.1 to 1.6 and the transactions flow matrix identities are given in equations 1.7 to 1.16.

$$B_h + B_{cb} \equiv B \quad (1.1)$$

$$V_h \equiv R_d \cdot p_r + V_g \quad (1.2)$$

$$NPMG + MG + V_h \equiv R_d \cdot p_r + H + M + B_h + BE \quad (1.3)$$

$$M + BE \equiv NPMG + MG \quad (1.4)$$

$$B \equiv V_g \quad (1.5)$$

$$H \equiv B_{cb} \quad (1.6)$$

$$\begin{aligned}
& \Delta R_d \cdot p_r + C + T + r_{mg-1} \cdot MG_{-1} + \Delta H \\
& \quad + \Delta M + \Delta B_h \\
& \quad \equiv Y + r_{m-1} \cdot M_{-1} + r_{b-1} \cdot B_{h-1} + \Delta MG
\end{aligned} \tag{1.7}$$

$$Y \equiv \Delta R_d \cdot p_r + C + G \tag{1.8}$$

$$r_{m-1} \cdot M_{-1} + F_b \equiv r_{mg-1} \cdot MG_{-1} \tag{1.9}$$

$$\Delta NPMG + \Delta MG \equiv \Delta M + F_b \tag{1.10}$$

$$G + r_{b-1} \cdot B_{-1} \equiv T + F_{cb} + \Delta B \tag{1.11}$$

$$F_{cb} \equiv r_{b-1} \cdot B_{cb-1} \tag{1.12}$$

$$\Delta B_{cb} \equiv \Delta H \tag{1.13}$$

$$\Delta R_d \cdot p_r + \Delta NPMG \equiv \Delta R_d \cdot p_r \tag{1.14}$$

$$r_{b-1} \cdot B_{-1} \equiv r_{b-1} \cdot B_{h-1} + r_{b-1} \cdot B_{cb-1} \tag{1.15}$$

$$\Delta B_h + \Delta B_{cb} \equiv \Delta B \tag{1.16}$$

1.2.5 The real estate market

Housing⁵ is an ordinary good if mortgage is readily available and unrestricted. In this case housing demand is negatively related to the price of houses. Households also purchase real estate for investment purposes and will continue to buy real estate in an inflationary market. Households mostly base their real estate purchases on the expected capital gain of the housing market. Other factors that may affect the demand for housing include current and future incomes from all sources, and the mortgage interest rate. The following functional form specifies the various factors that influence the demand for housing.

$$R_d = f(r_r, p_r, r_{mg}, YP),$$

This demand functional form is typical for real estate and is used in models such as that of Eatwell et al. (2008) and Kenny (1999). Empirical analysis by Kenny (1999)

⁵Real estate in this document refers to ‘residential real estate’ and this term will be used interchangeably with the term ‘housing.’

suggests that demand for housing is negatively related to house prices, positively related to increases in aggregate income and negatively related to mortgage nominal interest rates. More generally, housing demand depends:

1. positively on the rate of return on real estate, r_r
2. negatively on the price of real estate, p_r
3. negatively on the rate of interest on mortgages, r_{mg} ; and
4. positively on the personal income of households, YP

The demand function for real estate is related to the personal income of the household. The demand function of the model presented later in this chapter (see page 39) is related to the wealth of the household. This is because households choose housing as an investment asset in their portfolio.

If mortgages are not freely available and it becomes difficult for some borrowers to acquire the required funds to purchase houses, then other factors such as the credit worthiness of the customers can influence real estate demand. The demand for real estate is modeled into the households' portfolio selection problem discussed in section 1.3.1.4. In this model, only the expected rate of return r_r and price of real estate p_r are modeled to have a direct impact on the demand for real estate. All the other demand factors enter the portfolio equations indirectly. The personal income of the household enters the portfolio equations via the wealth of the household; and the interest rate of mortgages via the bill rate r_b and the deposit rate of interest r_m .

The potential number of available houses for sale can increase due to foreclosures and other forfeitures. This inspires the specification of the supply function of housing to include the stock of forfeited houses and newly built houses. The number of defaulted houses by the households in the previous period, $NPMG_{-1}/p_{r-1}$, is reintroduced into

the housing market by the banks. See section 1.3.1.3 for details. The rate of growth of housing (supply-side) is inspired by the models of Eatwell et al. (2008) and Kenny (1999). The supply rate of new houses is positively related to the ratio between the price of real estate p_r and the production unit cost of housing, UC_r . Empirical analysis by Kenny (1999) revealed the existence of a stable ratio of house prices to construction costs. Kenny found that housing firms pass on costs to home purchasers to maintain profit margins. Thus the housing stock adjusts positively in order to ensure the stability of the profit ratio. The unit cost of housing production is given by equation 1.62 on page 44. The supply of houses by the banks is given in equation 1.17. The total supply function of housing is given in equation 1.18.⁶

$$R_{sb} = \frac{NPMG_{-1}}{p_{r-1}}, \quad (1.17)$$

$$R_s = \left(1 + \beta_1 + \beta_2 \cdot \left(\frac{p_{r-1}}{UC_r}\right)\right) \cdot R_{s-1} + R_{sb}, \quad (1.18)$$

We model the price of the housing after both Zezza (2008) and Eatwell et al. (2008) who defined the rate of housing inflation (the pricing model) as the difference between the rates of growth of demand and supply as shown in equation 1.19. As stated in Eatwell et al. (2008) “such a price mechanism allows the model to achieve a steady state when both supply and demand grow at the same rate.” According to this equation, housing prices will remain constant if the growth of unsold houses remains constant. Similarly the market price of real estate increases as the number of unsold homes decreases. There are other housing price models. These include Klyuev (2008) and Arestis and Karakitsos (2008) who determined equilibrium house prices using the demand and supply fundamentals. The fundamentals include real disposable income, the real interest rate, and

⁶The supply functions in Eatwell et al. (2008) is given as $\Delta R_s / R_{s-1} = \beta_1 + \beta_2 \cdot (p_{r-1} / UC_r)$. That is equation 1.18 without the bank supply component.

the construction cost.

$$\frac{\Delta p_r}{p_{r-1}} = \sigma \cdot \left(\frac{\Delta R_d}{R_{d-1}} - \frac{\Delta R_s}{R_{s-1}} \right),$$

or

$$p_r = \left(1 + \sigma \cdot \left(\frac{\Delta R_d}{R_{d-1}} - \frac{\Delta R_s}{R_{s-1}} \right) \right) \cdot p_{r-1}, \quad (1.19)$$

For the majority of households, the accumulated equity in their homes is often the single largest item in the family's total wealth. Housing equity typically represents one-third of the net worth of the average household (Yamashita, 2007). In the US, after several years of strong growth, home prices are declining. Falling house prices has led to the expectations of further declines, depressing the demand for housing. According to S&P/Case-Shiller Home Price Indices, see figure 1.4, home prices peaked in the second quarter of 2006 and have continued declining through January 2009. As of January 2009, average home prices across the United States were at similar levels to what they were in late 2003. From the peak, the 20-City Composite has fallen 29.1%.⁷ The trend from 2009 to 2012 shows the home prices have not fully recovered from the crisis. The S&P/Case-Shiller US national home price index declined by 1.9% in Q1 2012 over that of Q1 2011. In March 2012, the 20-City Composites also fell by 2.6%. This decline in prices has led to the reduction of home owners' equity, undermining the incentive to service mortgage debt as well as the ability to sell or refinance the properties. This has triggered the increase in the number of foreclosures. This in turn adds to the inventory of homes for sale and prompts mortgage lenders to tighten underwriting standards.

⁷The composite measures the average change in single-family home prices in a geographic market covering 20 major metropolitan areas across US.

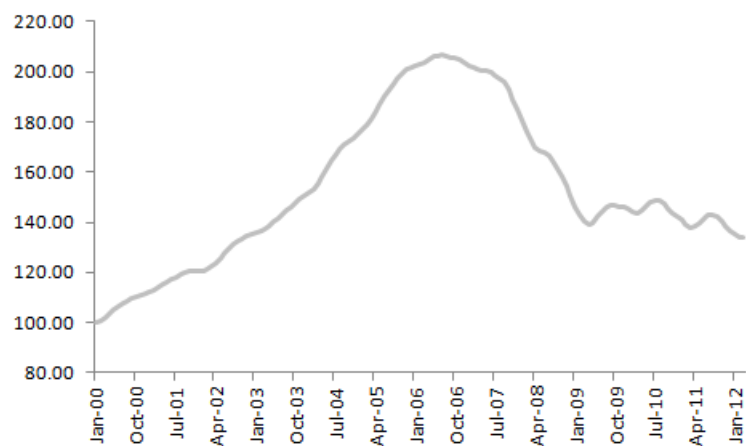


Figure 1.4: US home prices trend

Source: S&P/Case-Shiller Home Price Indices (20-City Composite), March 2012, (published March 2012)
<http://www.homeprice.standardandpoors.com>. The indices have a base value of 100 in January 2000.

1.3 Sectors of the economy

This section discusses and derives the behavioural equations for the five sectors of the model. The treatment of the household sector, which is the central focus of the model, is more detailed than the other sectors. There are several assumptions that are specified for the other sectors to simplify and to close the equations of the model.

1.3.1 Households

The decisions of the households are divided into income and consumption, mortgages (including defaulting of mortgages), and portfolio selection. The following subsections discuss these decisions.

1.3.1.1 Income and consumption

The nominal personal income, the right hand side of the accounting identity equation 1.7 or the income section of column 1 of the transaction flow matrix in table 1.6, is derived from the sources of funds to the households. These inflows consist of wages and interests on deposits and bills paid to the households. The nominal personal income of the households is presented in equation 1.20.

$$YP = Y + r_{m-1} \cdot M_{d-1} + r_{b-1} \cdot B_{hd-1}, \quad (1.20)$$

Households pay a fraction (θ) of their personal income as income taxes to the government. Equation 1.21 specifies the taxes paid by households.

$$T = \theta \cdot YP, \quad (1.21)$$

Nominal regular disposable income, YD_r , is also derived from the accounting identity given in equation 1.7 or from the income and expenditure section of column 1 of the transaction flow matrix in table 1.6. Disposable income (equation 1.22) is the residual after income taxes and interest on mortgages are deducted from the personal income of the households. Haig-Simons nominal disposable income YD_{hs} is defined as regular disposable income plus capital gains.

$$YD_r = YP - T - r_{mg-1} \cdot MG_{d-1}, \quad (1.22)$$

$$YD_{hs} = YD_r + CG_h, \quad (1.23)$$

Households make capital gains or losses on the assets that they hold. A capital gain or loss can be made on real estate, and bank equities (BE) held by the households. The capital gain on real estate is calculated on the realized stock of real estate of the households as shown in the revaluation matrix. The households' capital gain also includes the capital gain realized by the banks for their holding of real estate in a particular period. The banks' gains in both real estate holdings and equity are transferred to the households who wholly own the banks. The households' capital gain or loss, equation 1.24, is derived from the revaluation matrix (table 1.5). The capital gain of the banks is defined in equation 1.71 on page 47.

$$CG_h = \Delta p_r \cdot Ra_{d-1} + \Delta BE + CG_b, \quad (1.24)$$

Household wealth in equation 1.25 is computed from holdings and debts of the household in the balance sheet. This is the households' budget constraint as specified in the

balance sheet in table 1.3 or from identity equation 1.3.

$$V = R_d \cdot p_r - NPMG - MG_d + H_d + M_d + B_{hd} + BE, \quad (1.25)$$

In real terms nominal wealth is given as:

$$v = \frac{V}{p}, \quad (1.26)$$

Households' income is either spent on consumption or is used to augment their holdings of assets.⁸ This constraint is captured in the transaction matrix in table 1.6. Hence if we take away all the portions of disposable income used to augment financial assets, only the consumption portion will be left. This method of deriving the consumption function is also used by Skott (1989). The resultant consumption functions derived from identity 1.7 is given in equation 1.27. Real consumption is given in equation 1.28.

$$C = YD_r - \Delta p_r \cdot Ra_{d-1} - \Delta H_d - \Delta M_d - \Delta B_{hd} + \Delta MG_d, \quad (1.27)$$

$$c = \frac{C}{p}, \quad (1.28)$$

Real regular disposable income is defined as deflated regular disposable income minus the capital losses inflicted by price inflation (π in equation 1.30) and not simply a deflated nominal disposable income, $yd_r \neq \frac{YD_r}{p}$. The proof of real regular disposable income, equation 1.29, is given in Godley and Lavoie (2007, ch. 9, p. 293).

$$yd_r = \frac{YD_r}{p} - \pi \cdot \frac{V_{-1}}{p}, \quad (1.29)$$

⁸Keynes' two-stage decision (Keynes, 1936, p. 166).

$$\pi = \frac{p - p_{-1}}{p_{-1}}, \quad (1.30)$$

1.3.1.2 Mortgages

There are several housing models of demand for mortgage debt in the literature. Jones (1993) and Brueckner (1994) provide a model where the returns on assets and liabilities are assumed to be known. In these models the demand for mortgage debt, in addition to housing, consumption and investment goods, is a factor in the households' utility maximization problem. Thus the relative costs of mortgage debt (r_{mg}) and equity capital (r_l) are important determinants of the demand for mortgage debt and implicitly for housing. However, even though $r_{mg} < r_l$, only few unconstrained households move to a corner solution. In the US many households have little or no mortgage debt at all (Brueckner, 1994).

Brueckner (1994) also extended the model to show that, with uncertainty in financial asset returns, it may be optimal for the household to use less than the maximum allowable amount of mortgage debt, even if the expected returns on non-housing assets are greater than the cost of mortgage debt. However, the comparative statics of the uncertainty model are ambiguous in sign. Another alternative to the certainty model is the portfolio optimization model (Hendershott and Shilling, 1982; Hendershott and Won, 1992) in the presence of uncertainty in r_{mg} and r_l . With uncertainty a corner solution is less likely. The lack of comprehensive data makes empirical tests of these models difficult.

Empirical studies of mortgage demand have found that, in addition to the relative costs of mortgage debt to housing equity, several other household characteristics determine mortgage demand. First, the demand for mortgage debt is highly correlated with the demand for housing (Hendershott et al., 1997). Second, the demand for mortgage debt is constrained by the amount and perceived variability of the households' periodic

income (Ioannides, 1989). Ioannides' results support a positive relationship. Finally, characteristics such as wealth, age, marital status, and family size, are typically included in empirical specifications of mortgage demand. Nevertheless, a complete empirical specification of the demand for mortgage debt is an extremely challenging problem as discussed in Ling and McGill (1998). They found that larger mortgage debt burdens are strongly associated with greater valued residences and that the level of earned income is also positively related to mortgage burden — the “affordability” notion of household mortgage finance decisions.

Jones (1993) decomposed demand for mortgage into housing demand and non-housing demand. Any excess in mortgage demand over the minimum required to finance housing demand is used for the purchase of non-housing assets. Likewise any shortfall of housing demanded mortgages is financed with non-mortgage debts. Jones found the use of non-mortgage debt to finance owner-occupied housing to be quite modest but a very sizeable proportion of home mortgage demand derives from non-housing asset demands in both the US and Canada. In the model presented in this chapter no such decomposition of mortgage demand is made. The households make one loan (mortgage) demand. It is assumed that households use a major part of the mortgage loans for buying real estate and the remainder for other non-housing investment purposes. This is in line with the findings in Jones (1993). This is expected because the mortgage rate of interest is normally lower than the interest rate on non-mortgage loans. Households use the equity in their real estate as collateral for acquiring mortgage loans. In contrast, the demand for housing is a portfolio selection problem based on the wealth, for down payment purposes, and the expected returns on real estate among other factors.

Mortgage debts demand for this model is shown in equation 1.31. The model assumes there is enough supply of mortgages to match demand. Mortgages growth rate is a factor of the government sector growth rate and the rate of inflation (α_{mg} , in equation 1.32)

and the price of real estate (γ_{mg}). The parameter γ_{mg} is set exogenously in this model as shown in equation 1.33. In this mortgage debt specification, as the economy grows households demand more mortgage debts to finance the purchase of real estate. Here, the growth of the economy is proxied by the growth in the government sector and price inflation. All things being equal, an increase in the price of real estate triggers the need for more mortgages to finance real estate purchases. Of course the decision to purchase a real estate in this case has already been undertaken as part of the households' portfolio selection problem.

$$MG_d = MG_{d-1} \cdot (1 + \alpha_{mg} + \gamma_{mg} \cdot (p_{r-1})), \quad (1.31)$$

$$\alpha_{mg} = \alpha_g + \overline{pi}, \quad (1.32)$$

$$\gamma_{mg} = \overline{\gamma_{mg}}, \quad (1.33)$$

The real current mortgage value is given by equation 1.34.

$$mg_d = \frac{MG_d}{p_r}, \quad (1.34)$$

Aside from servicing of the mortgages by the payment of mortgage interest each period, households also pay back some percentage of all outstanding mortgages at the beginning of the current period. Mortgage repayment, REP in equation 1.35, is simply a percentage (ρ_{mg}) of the accumulated mortgage debts. This is in line with the proportion that banks demand from households as repayment on mortgages.⁹

$$REP = \rho_{mg} \cdot MG_{d-1}, \quad (1.35)$$

⁹At the micro level, the yearly repayment is typically given as $REP = \frac{r_{mg} \cdot MG_d}{1 - (1 + r_{mg})^{-n}}$, where n is the number of years the mortgage is amortized.

Figure 1.5 is the mortgage flow demand from 1977 to 2011 from Z.1 Q1 2012 statistics of the US Federal Reserve. Household borrowing through mortgages accelerated to an upward increasing trend in the early 2000's and attained a maximum in 2005 when households' demands for mortgage surpassed one trillion dollars. Total outstanding mortgage debts for households also had a steep increase in the same period as shown in figure 1.6. In the quarterly seasonally adjusted data, the increase in mortgage demand peaked in Q1 of 2006 at US\$1.18 trillion. After mortgage debt had increased at double-digit rates annually from 2001 to 2006, it grew by only 7 percent in 2007. In Q2 2008 to Q4 2011, mortgage demand started recording in the negative. In 2008, home mortgage debt decreased at an annual rate of 0.5 percent. The biggest fall in mortgage debt was recorded in 2009 at 1.4 percent. Before falling, home mortgage debt, which constitutes approximately 80 percent of total household debt, attained a record of US\$10.63 trillion in Q1 of 2008.

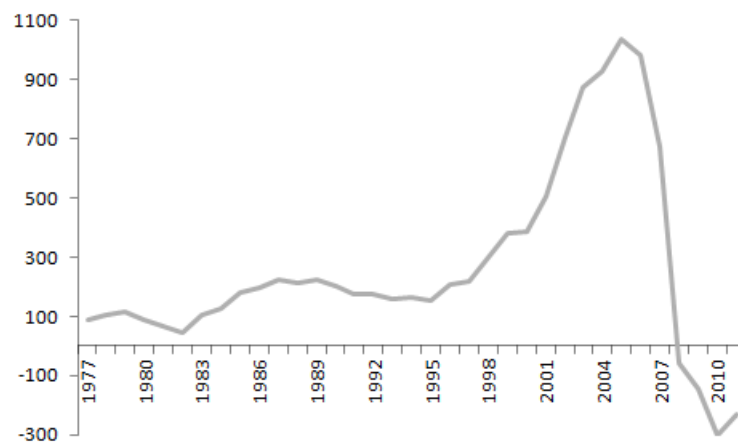


Figure 1.5: US households home mortgage flow

Source: Z.1 statistics of the Federal Reserve, www.federalreserve.gov/releases/z1, Table D.2 'Credit Market Borrowing by Sector', Q1 2012 data, June 2012 release; Billions of dollars.

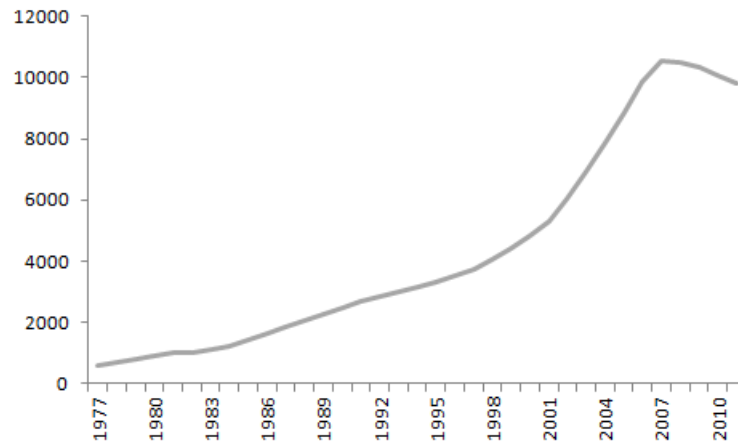


Figure 1.6: US households home mortgage stock

Source: Z.1 statistics of the Federal Reserve, www.federalreserve.gov/releases/z1, Table D.3 'Credit Market Debt Outstanding by Sector', Q1 2012 data, June 2012 release; Billions of dollars.

1.3.1.3 Mortgages defaulted by households

When households default on their mortgages, the household sector is credited with the full amount of the default. That is, the amount of mortgages is reduced by the default amount. Households do not make any financial gain as a result of defaulting. In aggregate, the households that default on their mortgages are assumed not to have any outstanding equity in their real estate because they are the ones most likely to default. Those households that default on the mortgages therefore transfer the lien properties to the banks. The banks keep the properties (real estate) and sell them in the next period. Thus, in the following period banks can make a capital gain or a loss when the property is put back on the market and sold. The capital gain or loss of the banks from the real estate sector is given in the revaluation matrix, table 1.5, and repeated as equation 1.71 on page 47.

Households are assumed to systematically default a fraction $npmg$ of the accumu-

lated mortgage debts from the previous period. The specification of defaults or the non-performing mortgages is presented in equation 1.36. Mortgages are assumed to be defaulted at the beginning of the current period. Thus the households do not pay mortgage interest on the defaulted mortgages during the period.

$$NPMG = nmg \cdot MG_{d-1}, \quad (1.36)$$

Households will not like to continue to default on mortgages as this behaviour leads to reluctance of the banking sector to advances mortgage loans to them. Defaults impose personal costs on households that include limits on occupational and credit opportunities, social stigma and damage to reputation (Kau et al., 1999).

Whereas most defaults are due to financial reasons, there are other factors that may influence households to default. Non-financial defaults include changes to households' personal or occupational circumstances that impel relocation. Households will default on their mortgage commitments to maximize wealth when the value of the property is less than the outstanding mortgage value. This situation will typically occur during a downward turn in the price of housing. Springer et al. (1993) found that foreclosure is accelerated in neighbourhoods where property values are falling, especially for homes with outstanding loan balances above the mean value of housing in the neighbourhood. Households that experience unpredictable changes in personal and financial conditions, such as faced with unemployment, may relinquish the properties to the banks. Mortgage defaults can also occur if homes stay longer on the for sale market. Gardner and Mills (1989) and Capone (2002) list the following as the reasons why mortgages are defaulted. The percentages of the various reason weighted is shown in figure 1.7. For example, divorce reasons for mortgage debt defaulting is 14%.

1. Loss of job or other reduction in income

2. Financial problems not associated with income
3. Divorce
4. Illness or death
5. Legal problems
6. Catastrophe

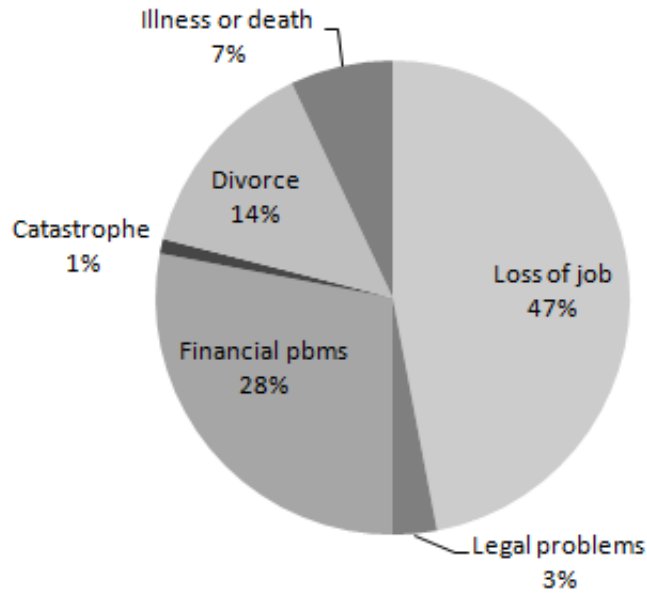


Figure 1.7: Weighted mortgage default reason

The debt default mechanism has a short term effect of reducing the total real estate accounting value of the households by the default amount. Fortunately for households the banks are bound to resell the defaulted properties back to them. The defaulted properties are sold at the value $(NPMG_{-1}/p_{r-1}) * p_r$ and are reacquired by the households. The banks advance new mortgages of the same value for the additional real estate on top of the newly constructed ones.

In this model, the demand for real estate by the household sector is through portfolio selection. The value of real estate is therefore a fraction of the investible wealth available

to the households. The households' desired value of real estate they wish to hold is given by $p_r \cdot R_d$ which is achieved as a result of the portfolio selection decision of the households. The realized or actual value of real estate that the households hold in the period is however affected by the defaulting of mortgages. The banks end up holding an amount $NPMG$ of real estate. The net real estate holding of the households is therefore $p_r \cdot R_d - NPMG$ or $p_r \cdot Ra_d$ (see table 1.3).

The following illustration is given to trace through the mortgage defaulting mechanism. All values are in billions of dollars. Assume that the households have a present value of \$6,000 in real estate. For this illustration the default rate $npmg = 0.05$ and the total mortgages currently owed by households is \$5,000. This implies a households' real estate equity of \$1,000 — represented as net worth in table 1.7. The total amount of non-performing mortgages is $NPMG = 250$.

Table 1.7: Household real estate balance sheet - A

Assets	6,000	Liabilities	6,000
Real Estate R	6,000	Mortgages MG	5,000
		Net Worth NW_h	1,000

The real estate value of the households is in the interim reduced by \$250 as shown in table 1.8.¹⁰ We assume that households finance the purchase of the 'new' real estate with new mortgages. For this illustration we assume no price change, *i.e.*, $\Delta p_r = 0$, and no newly constructed homes.

¹⁰Simple Guide: Mortgages fall from \$5,000 to \$4,750 since \$250 was defaulted. The banks claim an amount of \$250 in real estate from the households. The banks sell the new real estate to the household for \$250. This brings the value of total real estate back to \$6,000.

Table 1.8: Household real estate balance sheet - B

Assets	6,000	Liabilities	6,000
Real Estate	5,750	Mortgages	4,750
		Net Worth	1,000
‘New’ Real Est.	250	‘New’ Mortgages	250

1.3.1.4 Portfolio selection

Households make a two-stage decision (Keynes, 1936, p. 166) taking place in the same time frame. Households allocate expected disposable income between consumption and wealth accumulation in the first stage. In the second, stage households allocate the accumulated wealth among the various assets in their portfolio set. The first stage decision is captured by equations 1.25 and 1.27.

The expected wealth available for investment purpose (V_{inv}^e) is allocated to the various assets using the Brainard-Tobin formula (Brainard and Tobin, 1968; Tobin, 1969) with a methodology developed by Godley and Lavoie. As presented earlier, households allocate their expected investible wealth in money deposits, bills and real estate. The following matrix presents the portfolio selection behaviour of the households.

$$\begin{bmatrix} M_d \\ B_{hd} \\ p_r \cdot R_d \end{bmatrix} = \begin{bmatrix} \lambda_{10} & \lambda_{11} & -\lambda_{12} & -\lambda_{13} \\ \lambda_{20} & -\lambda_{21} & \lambda_{22} & -\lambda_{23} \\ \lambda_{30} & -\lambda_{31} & -\lambda_{32} & \lambda_{33} \end{bmatrix} \begin{bmatrix} 1 \\ r_m \\ r_b \\ r_r \end{bmatrix} V_{inv}^e$$

The assets demand functions described with the matrix algebra above are given in equa-

tions 1.37, 1.38 and 1.39.

$$\frac{M_d}{V_{inv}^e} = \lambda_{10} + \lambda_{11} \cdot r_m - \lambda_{12} \cdot r_b - \lambda_{13} \cdot r_r, \quad (1.37)$$

$$\frac{B_{hd}}{V_{inv}^e} = \lambda_{20} - \lambda_{21} \cdot r_m + \lambda_{22} \cdot r_b - \lambda_{23} \cdot r_r, \quad (1.38)$$

$$\frac{p_r \cdot R_d}{V_{inv}^e} = \lambda_{30} - \lambda_{31} \cdot r_m - \lambda_{32} \cdot r_b + \lambda_{33} \cdot r_r, \quad (1.39)$$

The rates of return are the primary factors and prominent components that the households rely on in choosing the weight assigned to a particular asset. The rate of return on deposits is presented in equation 1.69 (page 47), the rate of return on bills in equation 1.72 (page 48) and the rate of return on real estate in equation 1.40 below. The expected rate of return of real estate in this model is treated as an exogenous parameter.

$$r_r = \overline{r_r}, \quad (1.40)$$

The portfolio equations conform to the adding-up constraints (Godley and Lavoie, 2007; Tobin, 1969). Specifically the following vertical (equations 1.41 and 1.42) and symmetry (equations 1.43) constraints are imposed on the systems of portfolio equations.¹¹

$$\sum_{i=1}^3 \lambda_{i0} = 1, \quad (1.41)$$

$$\sum_{i=1}^3 \lambda_{ij} = 0, j \in [1, 3], \quad (1.42)$$

$$\lambda_{ij} = \lambda_{ji}, \forall i \neq j, i, j \in [1, 3] \quad (1.43)$$

The sum of the ratio of all portfolios to the total investible wealth is one. Thus equations 1.37, 1.38 and 1.39 imply the total investible wealth is comprised of the three

¹¹Note that the vertical constraints together with the symmetry constraint encompass the horizontal constraint: $\sum_{j=1}^3 \lambda_{ij} = 0, i \in [1, 3]$ (Godley and Lavoie, 2007, ch. 5).

portfolio assets as shown in equation 1.44. Total investible funds V_{inv} is allocated to assets such that equations 1.44 is satisfied.

$$V_{inv} = M_d + B_{hd} + p_r \cdot R_d, \quad (1.44)$$

From the household budget constraint in the identity equation 1.3, we can attain equation 1.45

$$NPMG + MG + V = p_r \cdot R_d + H + M + B_h + BE \quad (1.45)$$

Substitute equation 1.44 into equation 1.45 to get the investible equation in terms of household wealth as shown in equation 1.46.

$$V_{inv} = V + MG_d + NPMG - H_d - BE, \quad (1.46)$$

Money deposits, the residual of the portfolio selection decision, are derived from the system of equations in the model. Specifically deposits are modeled from the banking sector budget constraint in the balance sheet (identify equation 1.4). The deposits demanded by the households are met according to equation 1.47.

$$M_d = M_s, \quad (1.47)$$

Banks supply of deposits from the budget constraint is given by equation 1.48.

$$M_s = MG_s + NPMG - BE, \quad (1.48)$$

For simplicity, let the expected value of investible wealth in the portfolio equations be a factor of previous period's investible wealth as given in equation 1.49. In Godley

and Lavoie (2007) $\epsilon_v = 0$.

$$V_{inv}^e = (1 + \epsilon_v) \cdot V_{inv-1}, \quad (1.49)$$

In addition, the factor of the investible wealth grows at an exogenous rate of δ_{epv} per period. The growth rate is specified in equation 1.50.

$$\epsilon_v = \epsilon_{v-1} \cdot (1 + \delta_{epv}), \quad (1.50)$$

Realized or actual real estate holding, equations 1.51, is different from the desired real estate that is demanded by households. As households default on their mortgages, the banks take back an amount of real estate equal to the defaults. See section 1.3.1.3.

$$p_r \cdot Ra_d = p_r \cdot R_d - NPMG, \quad (1.51)$$

High-powered money demanded by households is realized and it is a fraction λ of the cash required for transactions arising from nominal consumption as shown in equation 1.52.

$$H_d = \lambda \cdot C, \quad (1.52)$$

1.3.2 Firms

The non-financial firms make production and costing decisions in the economy. The behavioural equations relating to these decisions are discussed in the following subsections.

1.3.2.1 Production

The national income identity equates firms' production to sales. Production is equal to consumption, government expenditure and new real estate. The nominal and real outputs are presented in equations 1.53 and 1.54 respectively. In general $p \neq p_r$, therefore the

real estate component of GDP is deflated using the price of real estate, p_r , and not the general price level, p .

$$Y = C + G + \Delta R_d \cdot p_r, \quad (1.53)$$

$$y = \frac{C + G}{p} + \Delta R_d, \quad (1.54)$$

The government expenditure is discussed in section 1.3.5.

1.3.2.2 Costing decisions

This model simply assumes wages to grow exogenously at a rate of w_{gr} per period. The wage specification is shown in equation 1.55. This wage aspiration of workers is simplified to remove the demand-led inflationary factor in the models of Godley and Lavoie (2007). This modification permits various simulations to be performed while holding price inflation — the Phillips curve — constant.

$$W = W_{-1} \cdot (1 + w_{gr}), \quad (1.55)$$

This model has two price levels, the price of real estate, p_r , and the price level relating to the government and the goods sectors, p . The growth rates of trend labour productivity of the two price sectors (respectively σ_r and σ_g) are different. The real estate sector's labour productivity trend is given in equation 1.56. The variable σ_{rgr} is assumed to be exogenous.

$$\sigma_r = \sigma_{r-1} \cdot (1 + \sigma_{rgr}), \quad (1.56)$$

Similarly, the growth rate of trend government and goods labour market productivity, σ_{ggr} , given in equation 1.57 is assumed to be exogenous.

$$\sigma_g = \sigma_{g-1} \cdot (1 + \sigma_{ggr}), \quad (1.57)$$

Given these labour productivities of the two price sectors, we can now define the labour employment relating to the price sectors. The labour employment of the real estate and goods and government sectors are given in equations 1.58 and 1.59 respectively.

Labour employment is the ratio of real output and the labour productivity growth trend. The real output of the real estate sector is $D(r_d)$ and the real output of the goods and government sectors is $c + g$.

$$N_r = \frac{D(r_d)}{\sigma_r}, \quad (1.58)$$

$$N_g = \frac{c + g}{\sigma_g}, \quad (1.59)$$

The combined labour employment of the economy is therefore the sum of the two employment levels (equations 1.60). The model assumes that the economy is not at full employment and that labour supply is readily available to match labour demand in the respective sectors.

$$N = N_r + N_g, \quad (1.60)$$

Nominal wage bill is determined by the labour employment and wage rates.

$$WB = N \cdot W, \quad (1.61)$$

Actual real estate unit cost, equation 1.62, is the cost of producing one unit of real estate. The real estate unit cost is used in determining the production sector's supply of real estate (see equation 1.18 on page 24). The supply of real estate (r_s) is in turn used in

determining the price (p_r) of real estate.

$$UC_r = \frac{W}{\sigma_r}, \quad (1.62)$$

The unit cost of the goods and government sectors, equations 1.63, is the cost of producing one object in these sectors.

$$UC_g = \frac{W}{\sigma_g}, \quad (1.63)$$

The model in this chapter uses a simple mark up pricing scheme for the goods and government sectors — where price is simply a mark up over unit cost. Unit costs, as given in equation 1.63 are the variable unit labour costs. The constant τ in the price, equation 1.64, is the percentage costing mark up on unit labour cost.

$$p = (1 + \tau) \cdot UC_g, \quad (1.64)$$

1.3.3 Banks

Banks respond passively to the need of households for mortgages. Banks do not select portfolios as households do. Banks make profits by setting the interest rates on mortgages and deposits relative to the bill rate. Banks are price takers with respect to the interest rates on bills and price makers with respect to the interest rates on mortgages and money deposits (Godley, 1999).

1.3.3.1 Basic constrained decisions

Money deposits are a result of budget constraint arising from their income and expenditure statement in the balance sheet specified in table 1.3. Banks' supply of deposits

is matched by the money that households deposit with them. These amounts are credited to the households making the deposits. The money deposit equations are given on page 40.

Mortgage loans (equation 1.65) are available to households on demand. Households finance a major portion of their real estate purchases with mortgages. Mortgage lenders typically target a Loan-to-Value (LTV) ratio¹² of 80% and may require the borrowers to obtain a mortgage insurance if LTV is above 80%.

$$MG_s = MG_d, \quad (1.65)$$

1.3.3.2 Interest rates determination

The profits of the banks are derived from accounting equation 1.9 of the transaction flow matrix in table 1.6. The banking sector is assumed not to pay taxes directly to the government. Taxes are paid by the owners of the banks (*i.e.*, the households). The resulting profit of the banks is presented in equation 1.66. The profits of the banks are the difference between the interests received on the mortgage loans granted to the households and the interests paid to households for their deposits made to the banks.

$$F_b = r_{mg-1} \cdot MG_{d-1} - r_{m-1} \cdot M_{d-1}, \quad (1.66)$$

The banks use the profits they make to increase their equities. The bank equity at the end of the period is given by equation 1.67.

$$BE = BE_{-1} + F_b, \quad (1.67)$$

¹²LTV ratio is the ratio of the mortgage amount to the appraised value of the property. LTV is a risk assessment ratio examined by mortgage lenders during the mortgage approval process.

Banks are required to maintain a minimum amount of their equities as a proportion of their liabilities. This ratio measures the banks' capital to their risk and is termed capital adequacy ratio (CAR). Banks therefore accumulate equity capital by way of retained profits (F_b) to increase their equities to manage fluctuations in the proportion of defaulting loans and to bring them in line with rules on capital adequacy ratios imposed on internationally-active banks by the Bank for International Settlements (BIS). Domestic operating banks have similar rules imposed on them by their central banks or regulatory agencies. In this model, the only loans advanced by the banks are the mortgages to the households. Therefore the resulting CAR specification for the model is as presented in equation 1.68. Bank reserves and deposits carry a zero percent risk weight; they therefore do not enter into the computation of CAR . Mortgages to households are risky and carry a 100% risk weight on average. Note that the Basel II recommends a risk weight of 35% for mortgages on owner-occupied residential properties (Basel Committee, 2006) and 100% risk weight for commercial mortgages. Once mortgages are securitized, they can attract risk weights up to 150% based on the credit rating of the securities. BIS imposes a minimum capital adequacy ratio of 8% to stop the spread of payment defaults of any internationally-active bank to other internationally-active banks.

$$CAR = \frac{BE}{MG_s}, \quad (1.68)$$

To make enough profits for equity growth in line with the BIS rules on capital adequacy ratios, given the bills rate of interests administered by the central bank, the banks determine the spread between the rate of interest on mortgages and the rate of interest on deposits. The specification of the deposit rate, equation 1.69, in this model is a fixed

spread over and above the given government bill rate. The spread is exogenous.

$$r_m = r_b + \delta_{rm}, \quad (1.69)$$

The banks seek to choose interest levels for mortgages in order to attain some target profits levels. These levels of interest rates are a spread over the rate of interest on deposits. The desired rate of interest on mortgages, represented by equation 1.70, is a constant markup (δ_{rmg}) over the rate of interest on deposits.

$$r_{mg} = r_m + \delta_{rmg}, \quad (1.70)$$

Banks stand to make capital gains or losses (CG_b) on their holding of real estate they claimed from the households as a result of households defaulting on their mortgages. The value of the capital gains or losses is wholly allotted directly to the household, see equation 1.24 on page 28. CG_b is given in the revaluation matrix in table 1.5 and reproduced as equation 1.71 below.

$$CG_b = \Delta p_r \cdot \frac{NPMG_{-1}}{p_{r-1}}, \quad (1.71)$$

1.3.4 Central bank

Bills are the only assets of the central bank. Therefore its profit, as per identity equation 1.12, is made up of interest payments it receives on the bills (equation 1.73). The central bank is a government entity; all of its profits are therefore transferred to the government. The liabilities of the central bank are the high-powered money consisting of banknotes. The value of its assets (B_{cbd}) must be the same as the total amount of high-powered money (H_s) that it issues. This equality, equation 1.76, is the central bank's

budget constraint in column 5 of table 1.3. The high-powered money supplied by the central bank is distributed to the households for transaction purposes. This is shown in equation 1.75. For simplicity, the rate of interest charged on government bills is set exogenously in this model (equation 1.72).

$$r_b = \bar{r}_b, \quad (1.72)$$

The rest of the equations in this section simply match supplies of assets passively with all their demand components.

Central bank profits:

$$F_{cb} = r_{b-1} \cdot B_{cbd-1}, \quad (1.73)$$

Household bills supplied on demand:

$$B_{hs} = B_{hd}, \quad (1.74)$$

Cash is supplied on demand:

$$H_s = H_d, \quad (1.75)$$

Central bank bills balance sheet constraint (also given by identity equation 1.6):

$$B_{cbd} = H_s, \quad (1.76)$$

The government supply of central bank bills (also given by identity equation 1.1):

$$B_{cbs} = B_s - B_{hs}, \quad (1.77)$$

The redundant equation of the model is given in equation 1.78 — the government

supply of bills to the central bank's supply and the demand for bills by the central bank. These identities are derived from two different sources as shown in equations 1.76 and 1.77. These quantities will be computed separately and compared to reveal the coherence of the model.¹³ By quasi-Walrasian principles, this equation must hold since all the other demand equations in the model are matched by supply equations.

$$B_{cbs} = B_{cbd}, \quad (1.78)$$

1.3.5 Government

Nominal pure government expenditure in equation 1.79 is made up of real government purchases g from the firms at the market price p .

$$G = p \cdot g, \quad (1.79)$$

Real pure government expenditure (equation 1.80) is modelled to be proportional to that of the previous period. The rate of growth of government expenditure, α_g , is assumed to be exogenous as specified in equation 1.81.

$$g = (1 + \alpha_g) \cdot g_{-1}, \quad (1.80)$$

$$\alpha_g = \overline{\alpha_g}, \quad (1.81)$$

The fiscal government deficit (equation 1.82) or *PSBR* (public sector borrowing requirement) can be read from the income and expenditure matrix portion of the transaction flow matrix. *PSBR* is equal to the difference of all government spending (pure expenditures, and interest payments on bills) and all government revenues (total taxes

¹³The redundant equation is not included in the simulation of the model.

received and the central bank's profits).

$$PSBR = G + r_{b-1} \cdot B_{s-1} - T - F_{cb}, \quad (1.82)$$

The total government bills issued, equation 1.83, is derived from the government's balance sheet constraint given by identity equation 1.11. Incidentally, the total bills supplied by the government is the government total debt which is derived by the equality in equation 1.5 and reproduced in equation 1.84 and finally in equation 1.85.

$$B_s = B_{s-1} + PSBR, \quad (1.83)$$

$$GD = V_g = B_s, \quad (1.84)$$

Since $B_s = B_{hs} + B_{cbs}$, it implies $GD = B_{hs} + B_{cbs}$. We also know by identity equation 1.6 that $B_{cbs} = H_{hs}$. Therefore,

$$GD = B_{hs} + H_{hs}, \quad (1.85)$$

1.4 Conclusion

In the present chapter, we analyzed a five-sector growth model in a stock-flow consistent framework that has the household sector undertaking real estate decisions. Housing is the largest asset in the portfolio of the household. The model presented in this chapter examines the housing market as an integral part of the households' portfolio choice problem. Other factors that affect the housing market are also investigated. Households need mortgage loans from the banking sector to purchase houses. Some percentage of households default on their mortgage debt payment obligations and the banks reacquire the houses of the defaulters. Banks do not need houses in their portfolio; they therefore offload the houses back into the housing market in the next period. Households typically make capital gains on their assets including their real estate holdings. In this model, the banks in addition make capital gains or losses on the housing they temporary hold due to non-performing mortgages. The capital gains or losses of the banks are transferred to the households — the owners of the banks. The amount the households allocate out of their investible assets to housing depends on the expected returns of the real estate market. Households also acquire two other assets in proportion to the returns that each of the assets generate.

Aside from the heavy modifications primarily to the household sector, the other sectors of this model come with some modifications as well. The production firms produce the houses that are purchased by the households. The supply of new houses is related to the ratio between the price and the production cost of housing. The houses held by the banks also go into the supply function. The value of the new houses contributes to the GDP of the economy. The labour force in the economy is divided into the housing

and goods (and government) sectors. This gives rise to a unit cost of production in the housing sector and another unit cost of production in the goods and government sectors.

The households and the central bank are the sectors of the economy that partake in the issue of government bills. The households acquire bills as part of their portfolio selection decisions, and the central bank as a balance sheet budget constraint. The government collects taxes directly from the household, and indirectly from the firm and the banking sectors. The real pure government expenditures of the model grow at an exogenous rate.

By applying appropriate monetary and fiscal policies and various other experiments involving the sectors of the economy of this model, the evolution of the variables of the system can be ascertained. The policy shocks which are applied after the system has attained a steady state can be temporary or permanent. The policy makers may want to insert a shock for a temporary period in order to solve a particular problem. For instance, the government may undertake a temporary fiscal policy of tax increases to generate extra revenue during a war period and undo the policy after the war. With the subject under study, policies may be undertaken to find solutions to the housing crisis or to prevent the outcome of such crisis (and damage) to the economy in the future. The following enumeration is some of the policies that can be applied (also see Godley and Lavoie, 2007, ch. 11). Note that where appropriate, the experiments may involve decreasing the policy variable. The policy may also be temporary or permanent depending on the goal of its application.

1. A one-period or permanent increase in real government expenditures, α_g in equation 1.80.
2. A permanent increase in the bill rate of interest, r_b in equation 1.72.
3. A permanent increase in the deposit rate of interest, δ_{rm} in equation 1.69.

4. A permanent increase in the mortgage rate of interest, δ_{rmg} in equation 1.70.
5. A permanent increase in the expected rate of return on real estate, $\bar{r}_r$ in equation 1.40.
6. An increase in the general price level via the mark up, τ in equation 1.64.
7. An increase in the tax rates of households, θ in equations 1.21.
8. An increase in the supply of real estate, β_1 and β_2 in equation 1.18.
9. An increase in the significance of demand-supply spread of real estate on prices, σ in equation 1.19.
10. An increase in the factors relating to the change of mortgage debt demand, γ_{mg} in equation 1.31.
11. An increase in the percentage of accumulated mortgage debts repayment by the household, ρ_{mg} in equation 1.35.
12. An increase in the default rate of mortgage debts, $npmg$, in equation 1.36.
13. An increase in the household demand for cash for transactions, λ in equation 1.52.
14. An increase in the growth rate of real estate sector labour productivity, σ_{rgr} in equation 1.56.
15. An increase in the growth rate of goods and government sectors labour productivity, σ_{ggr} in equation 1.57.
16. An increase in the growth rate of wages, w_{gr} in equation 1.55.
17. An increase in the investible wealth expectations, ϵ_v and δ_{epv} in equation 1.49 and equation 1.50 respectively.

1.A Model Parameters and Variables

Subscript	$_n$	Lagged time
Subscript	b	Banks
Subscript	cb	Central bank
Subscript	d	Demand
Subscript	g	Government
Subscript	h	Households
Subscript	l	Loans
Subscript	m	Deposits
Subscript	mg	Mortgage
Subscript	r	Real estate
Subscript	s	Supply
Superscript	e	Expected
α_g		Government expenditure to capital ratio
α_{mg}		Mortgages growth as a factor the government sector growth rate and the rate of inflation
β_1		Real estate supply function autonomous argument
β_2		Real estate supply function price-cost factor
δ_{epv}		The growth rate of investible wealth factor ϵ_v
δ_{rm}		Deposit rate markup over bill rate
δ_{rmg}		Mortgage rate markup over deposit rate
Δ_x		One period change in x
$\bar{x}$		Variable x is exogenous
ϵ_v		Factor in the expectation of investible wealth
γ_{mg}		The degree of influence of ratio of demand for real estate to the price of real estate on mortgage debt growth rate
λ		A fraction of nominal consumption required in cash for transactional purpose
λ_{ij}		Parameters in households demand for assets
π		The rate of inflation

ρ_{mg}	Percentage of accumulated mortgage debts repaid
σ	Significance of demand-supply spread on real estate on prices
σ_g	Labour productivity in the goods and government sectors
σ_{ggr}	The growth rate of trend labour productivity in the goods and government sectors
σ_r	The growth rate of trend labour productivity in the real estate market sector
σ_{rgr}	Labour productivity in the real estate market sector
θ	Percentage of income paid as income tax
τ	Price mark up (over unit cost)
B	Government issued bills
BE	Bank equities
C	Consumption
c	Real consumption
CAR	Capital adequacy ratio
CG_b	Capital gain (or loss) of banks
CG_h	Capital gain (or loss) of households
F	After tax profits
G	Government expenditure
g	Real government expenditure
H	High-powered money
M	Money deposits
m	Real money deposits
MG	Mortgage debts stock
mg	Real mortgage
$NPMG$	Non-performing mortgages (a.k.a. defaults)
$npmg$	Fraction of the accumulated mortgage debts defaulted
p	Price level
p_r	Price of real estate
$PSBR$	Public sector borrowing requirement
R	Real estate
R_{sb}	Bank's real estate supply
r	Interest rate

r_b	Interest rate on bills
r_m	Interest rate on deposits
r_r	The rate of return of real estate
Ra	Realized real estate demand
REP	Mortgage repayments
T	Taxes
UC	Unit cost
V	Nominal wealth of households
V_g	Debts of government
v	Real wealth of households
V_{inv}	Stock of wealth available for investment
W	Nominal wage rate
WB	Wage bill
Y	Nominal income
y	Real income
YD_{hs}	Haig-Simons nominal disposable income
YD_r	Nominal regular disposable income
YP	Personal income
yd_r	Real regular disposable income

Chapter 2

Portfolio Selection in the Real Estate Market: The Implementation

2.1 Introduction

In this chapter we implement the model presented in chapter 1. The model is a five-sector stock-flow consistency model consisting of the households, the production firms, the banks, the central bank and the government. Households allocate their income to consumption goods and investible assets. Households then allocate their investible assets into bills issued by the government, money deposits at banks, cash money for transactional purposes and real estate holdings for residential purposes.

This model has potentially a large set of experiments that can be undertaken on it. This chapter presents some of the most relevant experiments related to the housing market. The EvIEWS modeling software is the tool used in performing the experiments. In undertaking the experiments we consider the case where the shock parameter increases from the baseline value as opposed to decreasing it. Without loss of generality, the results hold inversely with the direction of the shock.

In each experiment some variables of the model are chosen and their paths are traced. The paths typically examined include the growth parameters of the economy and real estate parameters. The growth parameters mostly analyzed are consumption and income (disposable or otherwise). The real estate parameters include the demand, supply and price of real estate, and the demand for mortgage loans. In some experiments the paths examined are divided into two shock regimes — the one-time permanent shock and the one-period temporary shock.

The following are the simulations covered in this chapter.

1. Monetary policy and other interest rate changes: In this simulation, the interest rates of bills, deposits and mortgages are increased above the baseline scenario.

The changes are synchronized such that for each scenario, the downstream rate remains the same. The effects of the shocks are examined and they show that the shock in mortgage rates is most effective in increasing consumption and income in the economy.

2. Changes in the expected rate of return on real estate: The rate of return on real estate is the major determining factor households consider when allocating their limited investible wealth to real estate. Increases in this factor leads to a heated real estate market — where the demand, supply, price and mortgage demand all increase in response. In this experiment the rate of return on real estate is increased from the baseline scenario. The allocation of investible wealth into assets is also analyzed after the adjustment.
3. Changes in the mortgage defaulting rate: In this model households are assumed to systematically have some small portion of their mortgages as non-performing. This default rate affects some aspects of the economy. It directly affects the supply of real estate and indirectly affects the willingness of the banks to issue mortgage loans to the households. Intuitively, increasing the default rate has a negative implication on the economy. The one-period temporary shock regime in this experiment is non-effective in the long run as all variables achieving a rise (or a fall) in the short run return to their baseline level in the long run.
4. Government fiscal policy: The government fiscal policy is one of the most effective shock parameter in the model. In this experiment the growth of government expenditure is increased to a new level over the baseline scenario. Unlike other temporary shocks, the temporary fiscal policy shock has a significant impact on the economy. The shock also increases the level of employment in both the goods and government sectors and the real estate sector.

5. Expectations about housing price changes: Expectations of future price increase in the real estate market can potentially lead to price bubbles. In this experiment we trace some key parameters as households adjust their housing price change expectations. The long run effect of this shock is decreased levels of consumption and income relative to their baseline levels.
6. Default rate as a determining factor for mortgage rates: This experiment endogenizes the mortgage rate markup over the deposit rate. This experiment brings to light the black box nature of interest rate markups. The effect of the markup specification is mostly insignificant in this simulation. However, the shock highly favours the banks who seek to limit their risks when faced with persistent defaults. The profits and equity of the banks experience significant increased in levels relative to the baseline.

The remainder of the chapter proceeds as follows. Section 2.2 recaps the model of the system as presented in chapter 1. The bulk of this chapter appears in section 2.3. Various simulations are undertaken and the results of the simulations are presented graphically. The results are analyzed and their implications are addressed as well. The scenarios of the model generated from the various shocks including monetary and fiscal policy shocks, are compared with the baseline stationary steady state. The conclusions of the chapter are addressed in section 2.4.

2.2 The Model in a nutshell

The model simulated in this chapter, as presented in chapter 1, is a five-sector stock-flow model that consists of household, firm, bank, central bank and government sectors. The following sections describe briefly the sectors and an introduction to the real estate market.

2.2.1 The household

The household is the central sector in the model. Households are faced with a portfolio selection problem. The portfolio choices available in the model are bank deposits, government bills, bank equities and real estate. In each period households are faced with selecting government bills and real estate to optimize their portfolio. In choosing their portfolios, households take into account the returns on each of the assets. The rate of return on deposits, r_m , the rate of return on bills, r_b , and the expected rate of return on real estate, r_r , are all simultaneously taken into account in the selection of the assets.

Households take loans, or mortgages, from the banks, to finance their real estate purchases. Just as with business loans, some portion, $npmg$, of the mortgages are deemed non-performing by the banks. The banks are however able to recoup the defaults by way of collateral in the households' real estate properties.

The households sector is the only sector that pays taxes to the government. Households pay a percentage θ of their nominal personal income as taxes. The nominal personal income consists of wage bills, interest earned on government bills, and interest earned on bank deposits.

2.2.2 The Production Firm

The firms produce the goods and services in the economy. The model has two prices — the real estate price related to the housing sector, p_r and the general price, p , related to the government and the goods and services sectors. Firms hire two different types of labour skills for the two price sectors. The firms pay a remuneration of UC_r and UC_g respectively for each unit of labour employed in the real estate and the goods and government sectors.

Whereas the price model of the real estate sector is a complex mechanism involving the demand and supply of housing and indirectly by way of the supply function the unit cost of real estate, the price of the government and goods and services sectors is simply a markup over the unit cost.

2.2.3 The Commercial Banks

The commercial banks in the model are owned by the households. The bank equity, BE , therefore is part of the households' portfolio. The banks make profits, F_b , by charging interest on mortgage loans they issue to the households after deducting the interest they pay for deposits with them. The banks set these interest rates as a markup on the bills rate set by the central banks. The banks also make capital gains or losses on the real estate properties they seize when the households default on their mortgages.

2.2.4 The Central Bank

In this model the government and the central bank are modeled as separate entities. Nevertheless, the central bank is a governmental unit. The central bank therefore transfers all profits, F_{cb} , that it makes to the government.

The redundant equation of the model is derived from the bills supplied to and de-

manded by to the central bank, $B_{cbs} = B_{cbd}$. See section 2.3.1 for more on the redundant equation.

2.2.5 The Government

The role of the government is important in this model. The government can initiate fiscal policies to expand or contract the economy. The government implements fiscal policies by means of taxation and government spending. The growth rate of real government expenditure, α_g , is an exogenous parameter. Government deficits and government debt are good indicators of the health of the economy — see section 2.3.6.2.

2.2.6 The Real estate sector

The chapter is about the real estate sector; more specifically about how households allocate their investible wealth in housing as a portfolio. The demand for real estate, R_d , is modeled as a portfolio selection problem where the choice is a factor of households' investible wealth, the rate of interest of assets, the price of housing, and the expected return on real estate. The supply of housing, R_s , is made out of two components — the production component and the banks' component. The banks add to the supply of housing by selling off all houses they garnished from the households due to non-performing mortgages. We assume in the model that households systematically default a proportion ($npmg$) of their outstanding mortgages in each period.

The price of real estate, p_r , is set as a factor of the difference between the growth rate of demand and the growth rate of supply of real estate. The prices of housing will therefore remain constant if the growth of unsold houses is constant and the price will increase as the number of unsold homes decreases.

2.3 The Simulation

The first chapter presents a model that is specified by equations. All the equations of the model, reproduce in appendix 2.B, are put together in a computer modeling software to enable the model to be fully simulated. The simulation uses the EvIEWS (Quantitative Micro Software, LLC, 2009) modeling software. Computer representation and simulation of stock-flow consistent models have been employed by several researchers some of which include Eatwell et al. (2008), Godley (1999), Godley and Lavoie (2007), Le Heron and Mouakil (2008), and Zezza (2008). With computer modeling, it has become possible to see how the elements of the model interact in a concerted mode in studying the theoretical model. There are 78 equations, 78 endogenous variables and 28 exogenous variables for the model all together.

Based on stylized facts, the parameters of the model are assigned values within reasonable limits. The model is then solved using a dynamic-deterministic simulation solution. The simulation examines how the model performs as it forecasts many periods into the future. The Newton's solver iterative method is used. The Newton solver at each iteration point takes a linear approximation to the model and then solves the linear system to find a root of the model. The parameter values chosen for the model are presented in Appendix 2.A.

The simulation chooses enough periods to allow the model to reach a steady state. The raw steady state of the model is termed the baseline solution. It is from this steady state that we apply shocks to the model. At the steady state, all stocks and all flows grow at a constant rate. It is of interest to start at a steady state with all stocks and all flows rising at the same rate. Shocks can then be introduced to simulate and rectify the

housing crisis we seek to address in this chapter.

2.3.1 Coherence

The model has no explicit equation that sets the number of bills held by and supplied to the central bank. This is the hidden or redundant equation (see equation 1.78). Yet the system of equations solves to reveal this equality. This shows the coherence of the system and that all the accounting constraints of the system are met.

In the following sections we start the model from a stationary steady state or baseline solution and apply shocks to the system and analyze the impacts of such shocks. The model starts at year 1990 and runs for 100 years to 2090.¹ From the baseline solution, we apply the shock at year 2010 and analyze the effect of the change in policy relative to the baseline solution from year 2010 to year 2080. We expect all scenarios (a scenario is the new trend of the variables of the system) including the baseline scenario to be coherent — that is, the hidden equation solves. For all the scenarios discussed in this chapter, figure 2.1 is the outcome for the test of coherence. The figure shows the equality of the demand (B_{cbd}) for and the supply (B_{cbs}) of the central bank's bills.

2.3.2 Simulation 1: Monetary policy and other interest rate changes

The first set of simulation experiments examines the responses of the system if, starting from a stationary steady state, the interest rates were to change. As per the interest rate equations of the model, each equation has a variable that can be exogenously set. In this simulation, the bill rate of interest (equation 1.72) is first increased. The effect of an increase in the rate is an increase in the other rates of interest — namely, the

¹In the simulation we define a period as a 'year.' The reference years, such as beginning and end years are for references only; any values used will have the same effect on the results of the simulation.

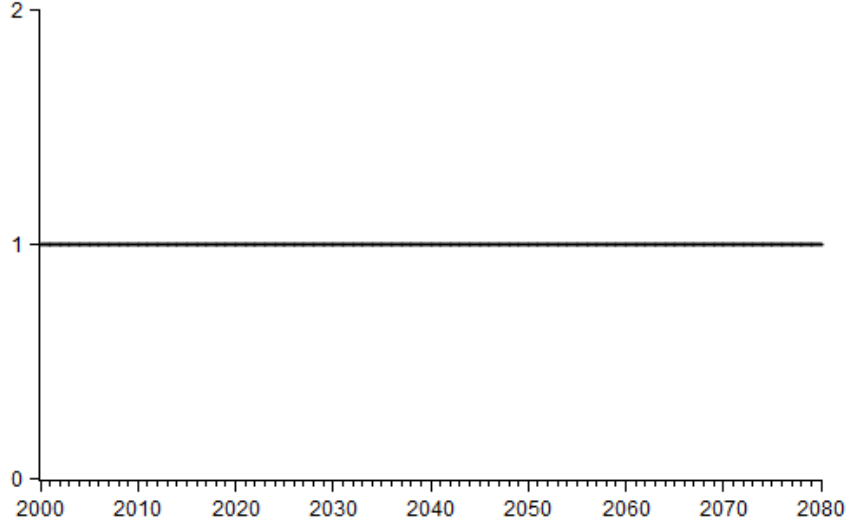


Figure 2.1: Redundant equation of the model plotted for B_{cbs}/B_{cbd}

deposit (equation 1.69) and the mortgage (equation 1.70) rates of interest. Conceivably, as a monetary policy change vehicle, the central bank can adjust the bill rate of interest.² The commercial banks and other related financial institutions respond to the rate change by the central bank by immediately changing their deposit and borrowing rates. In the first scenario, the bill rate is increased from 3.5% to 4.0%. This has the effect of adjusting the deposit rate from 3.35% to 3.85% and simultaneously adjusting the mortgage rate from 3.65% to 4.15%. In the second scenario, while holding the bill rate at the stationary steady state level, the deposit rate is adjusted to the same value as was achieved when the bill rate was changed. Following from equation 1.70, the mortgage rate of interest will also be increased as a result. Thus the bill rate is held at 3.5% but the deposit rate is increased from 3.35% to 3.85%. This has the effect of adjusting the mortgage rate from 3.65% to 4.15%. In the third scenario, both the bill and deposit rates are held at

²In Canada, the central bank does this by setting the target overnight rate (the key policy rate) — the interest rate at which major financial institutions borrow and lend one-day funds among themselves.

their stationary steady state levels and the mortgage rate is adjusted to the level that was attained when the other rates were increased in the prior cases. That is, holding the bill rate at 3.5% and the deposit rate at 3.35%, we increase the mortgage rate from 3.65% to 4.15%. Note that mortgage rates are additionally determined by factors other than the overnight rate. The commercial banks may therefore adjust the mortgage rate in response to changes in these factors. These factors may include the London Interbank Offered Rate (LIBOR) and capital markets dynamics.

In the following subsections we analyze the effect of such a policy change on consumption, income and the real estate market.

2.3.2.1 Consumption and income

Figures 2.2 and 2.3 show the evolution of real consumption and real disposal income for a one-time permanent increase in the bill, deposit and mortgage rates. The evolution is relative to their stationary steady state solutions. For the bill rate change, the initial impact of the shock drives both real consumption and real disposable income to a sharp dip before recovering in subsequent periods to settle at a rate higher than their initial baseline solution.

An increase in the bill rate leads to an increase in the profits of the central bank. However this increase is not enough to offset the increase in interest payments that the government has to make on all issued bills. The increase in interest payments in the short run decreases the amount of money available for government expenditures. Thus in the short period following the shock, government expenditure decreases triggering the fall in real disposable income and consequently a fall in real consumption. In subsequent years, the government issues more bills to cover its expenditures. The increase in government expenditure being an expansionary fiscal policy triggers an increase in real consumption and real income. Furthermore, the increase in the bill rate increases the

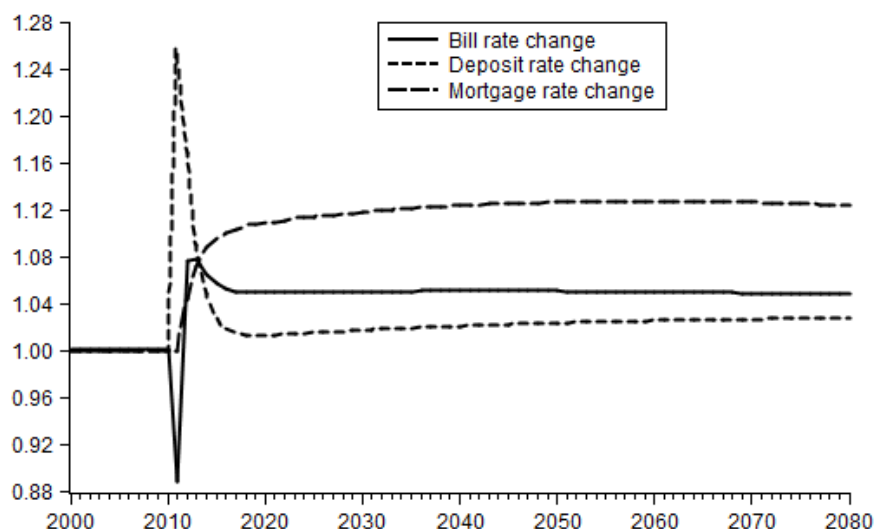


Figure 2.2: The evolution of the level of *real consumption*, relative to the baseline solution, following a one-time permanent increase in the bill, deposit and mortgage rates

deposit and mortgage rates. The increase in these rates has a direct effect on personal income and hence real disposable income and real consumption — by way of increased interest payments households receive from the government and banks for their held bills and deposits respectively. Hence the increase in the bill rate has the effect of an increase in both real consumption and real disposable income reaching a new steady state over their baseline stationary steady state.

An autonomous increase in deposit rates while holding the bill rate constant has the effect of increasing mortgage rates as well. The cost of borrowing increases if the banks have to pay more interest on households' deposits. Due to capital market operations, banks may need to increase the deposit rates to induce households to put more of their money as deposits with the banks. Because of the direct effect of deposit rates on household personal income and subsequently real disposal income and real consumption, the initial reaction of these real values is a sharp rise. Real consumption gradually falls

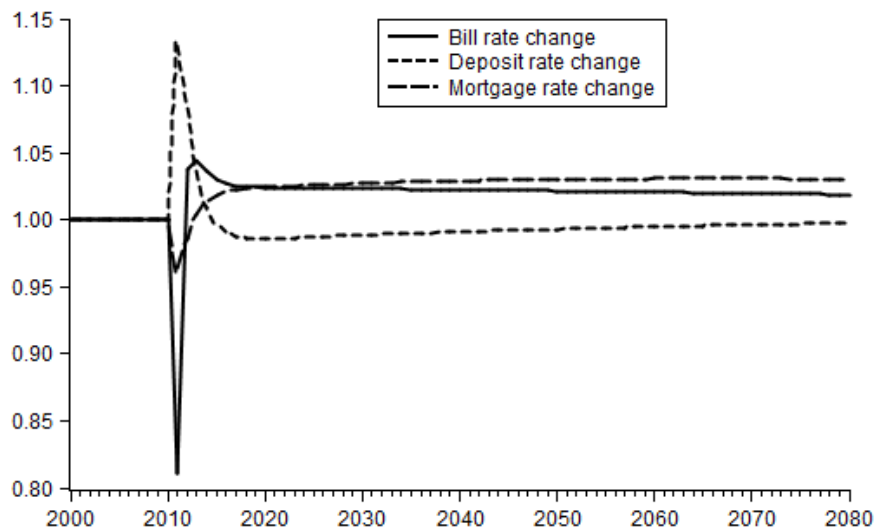


Figure 2.3: The evolution of the level of *real disposable income*, relative to the baseline solution, following a one-time permanent increase in the bill, deposit and mortgage rates

to a new steady state above the baseline values. In the simulation, real disposal income falls to levels below their baseline steady state levels.³ The fall in disposable income and consumption can be attributed to the negative effect of mortgage on disposable income. This cancels out the effect of deposits on personal income.

Finally, the effect of an autonomous increase in mortgage rates, while holding the bill and deposit rates at their baseline levels, is examined. The increase in mortgage rates has the effect of increasing the profits of the banks and consequently the equity of the banks. This further increases the wealth of the households who spend more of the wealth on consumption and other investible goods. This induces consumption to rise gradually till it reaches a new steady state over that of the baseline. Unlike real consumption, the increase in mortgage rate first leads to a fall in real disposable income before it rises to a new steady state over that of the baseline. The initial fall is due to the fact that an

³Even though towards the end of the simulated period the new scenario's values approached those of the baseline, it was still below them.

increase in mortgage rates first leads to a fall in the nominal disposal income before the wealth effect pulls income up to levels over those of the baseline.

We also simulated the case where the target bill rate is not changed immediately in one period. The rate is rather changed over two or more periods till the target rate is achieved. In a simulation involving changes in the bill rate from 0.035 to 0.040 over 3 consecutive 2-year periods no significant difference was observed in the resulting new steady state in comparison with the one-time permanent shock. It is assumed that households have no forward-looking expectations of possible interest rate changes. In figure 2.4 the target rate for both the one-time and the multiple-step increase in the bill rate is 4%. We observe the impact of the one-time shock on the initial real disposable income to be very significant compared the stepped bill change. However both changes quickly coincide and converge to the same steady state within a decade. The other variables in the economy respond to the same path of the one-time and the multiple-step shocks.

2.3.2.2 Real estate market

Figures 2.5, 2.6 and 2.7 present the reaction of the housing sector to the change in the bill, deposit and mortgage rates. For all rate changes, the demand for real estate, depicted in figure 2.5, responds with a fall relative to the baseline. In the short-run, the increased in the bill rate generates the biggest fall in demand for real estate and the price of real estate. However, in the long-run, the change in the mortgage rate generates the steepest fall in the demand for real estate, the price of real estate and demand for mortgage. This is not surprising since mortgage rates are directly related to the real estate market. Household portfolio selection for real estate is triply depressed by the rate changes. As bill rates increase households are induced to invest more of their investible wealth in acquiring more government bills. Similarly, an increase in deposit

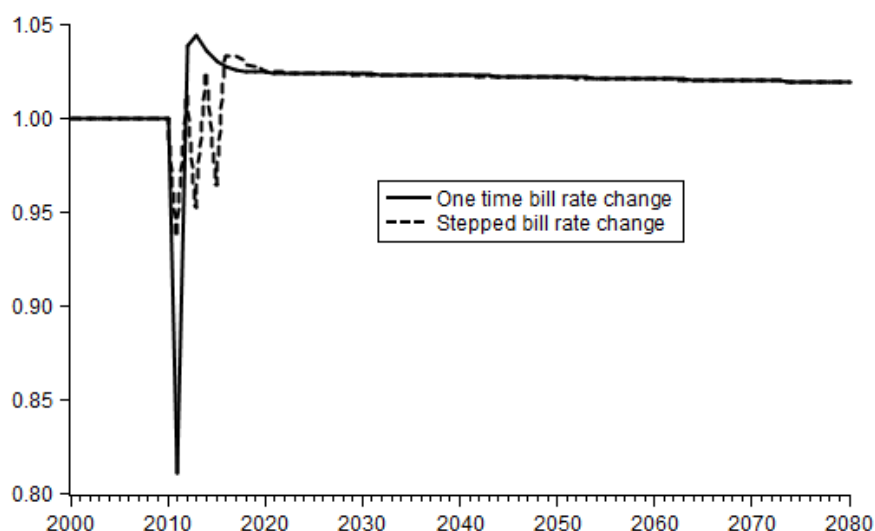


Figure 2.4: The evolution of the level of *real disposable income*, relative to the baseline solution, following a one-time permanent and multiple-step permanent increases in the bill rate.

rates implies that households put more of their investible income into bank deposits at the expense of making real estate purchases. Additionally an increase in mortgage rates implies it becomes expensive for households to borrow for investment in the real estate sector. All these effects lead to the rapid demand fall in the real estate sector compared to their baseline counterparts.

All things being equal, the fall in demand for real estate generates a decrease in the price of real estate. The fall in real estate prices, as shown in figure 2.6 has the same path as the fall in demand. The price function is defined as the difference between the rates of growth of demand and supply. Typically, a fall in price will have a feedback effect on the demand for real estate because it leads to the expectations of further price declines which further depresses the demand for real estate.

As a response to the fall in the demand for real estate (and prices), all things being equal, households will demand less mortgage debts to purchase and finance real estate.

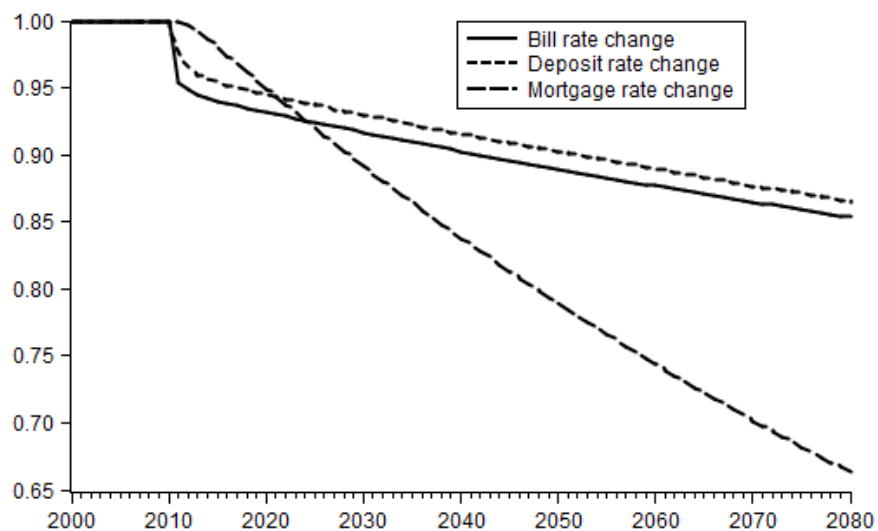


Figure 2.5: The evolution of the level of *real estate demand*, relative to the baseline solution, following a one-time permanent increase in the bill, deposit and mortgage rates

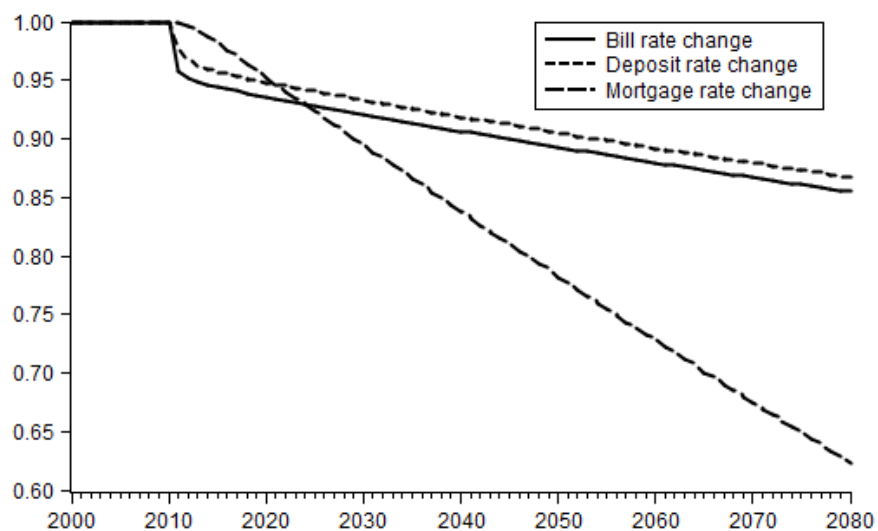


Figure 2.6: The evolution of the level of *real estate prices*, relative to the baseline solution, following a one-time permanent increase in the bill, deposit and mortgage rates

This leads to a fall in the mortgage debt as shown in figure 2.7. This is expected as the demand for mortgage is directly proportional to the price of real estate.

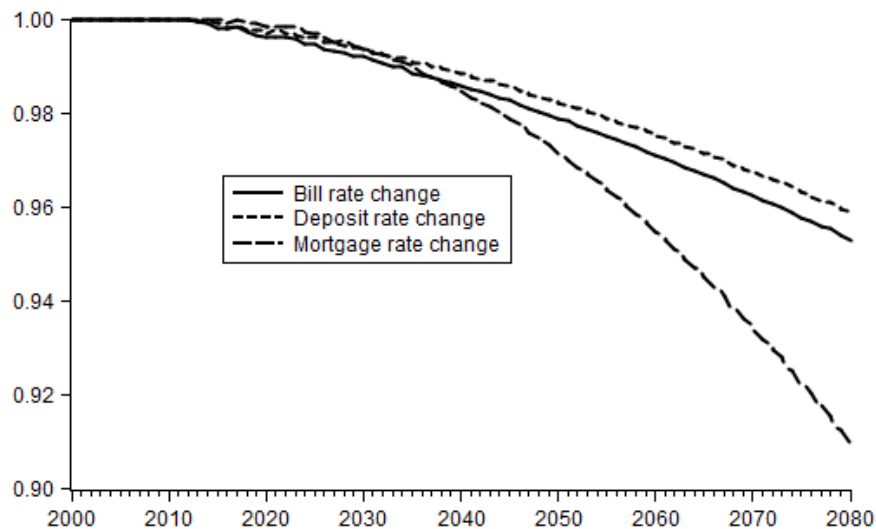


Figure 2.7: The evolution of the level of *mortgage demand*, relative to the baseline solution, following a one-time permanent increase in the bill, deposit and mortgage rates

2.3.3 Simulation 2: Changes in the expected rate of return on real estate

In the second simulation we investigate the response of the variables in the economy to a change in the expected rate of return on real estate. The expected rate of return on real estate is an exogenous parameter in the portfolio equations of the model — equations 1.37 to 1.39. We consider a case where the households' expectation increases from its stationary steady state baseline value from 4.5% to 5.5%. Future returns on real estate in terms of price increase expectations are the major contributory factor to the housing bubble in the US (Case and Shiller, 2003).

2.3.3.1 Consumption and income

An increase in expectations of the returns on real estate will induce households to invest more of their investible income into the real estate market. This invariably leads to an increase in the demand for real estate as shown in figure 2.9. Real estate makes up a major component of household nominal income (see equations 1.53) and hence real disposable income as shown in equation 1.22. Therefore an increase in expectation about real estate returns has an impact of initially shooting up the value of real income and real disposable income at the time of the shock. However, the increase in real estate from the total investible wealth comes at the expense of other assets, namely, deposits and bills. The returns on these assets are also part of household real disposable income. In the long-run, the push-pull effect on real disposable income will cancel out. This returns real disposable income to its previous stationary steady state. Figure 2.8 shows the path of real disposable income and real consumption.⁴

No matter how real consumption is formulated, it depends on real disposable income. In some models consumption is directly dependent on disposable income (*e.g.*, Godley and Lavoie (2007, ch. 11, eq. 11.53)). The model here treats consumption as a residual of household spending out of disposable income (1.27). The path of real income follows the path of real disposable income in our model. For the same dynamics, real consumption initially shoots up and then drops to match the baseline stationary steady state as households' expectation of returns on housing increase.

2.3.3.2 Real estate market

The expectations of increases in future returns on real estate can cause real estate prices to be temporarily elevated. Home buyers assume that a real estate property that was

⁴The curve of real disposable income is raised up by shifting the y-axis by 1.025 in order to show it with that of real consumption on the same graph. The paths of the two curves are similar.

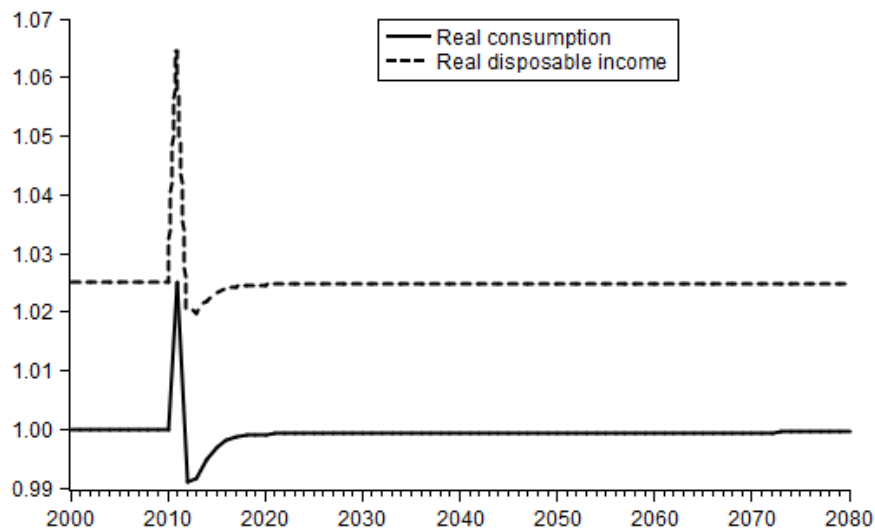


Figure 2.8: The evolution of the levels of *real consumption* and *real disposable income*, relative to the baseline solution, following a one-time permanent increase in the expected rate of return on real estate

considered too expensive is now an acceptable purchase because of the future compensation due to the expected increase in the returns on the property (Case and Shiller, 2003). Agents will allocate more of their investible wealth to real estate if they think the future compensation is high. In doing so, the households hold less of the other investible assets. Hence the demand for real estate increases and the demand for bills decrease relative to their baseline stationary steady state values as shown in figures 2.9 and 2.10 respectively.

The increase in real estate demand and the fall in bills demand settle and remain at a higher constant level in the new steady state relative to their baseline levels. The increase in the demand triggers an increase in housing prices due to speculation. The price of real estate moves to a higher steady state compared to the baseline state. The path of the increase in price is similar to that of demand. Figure 2.11 shows the real estate price path due to the increase in the expectations for an increase in expected returns on real estate. Case and Shiller (2003) opined that prices under this condition are inherently

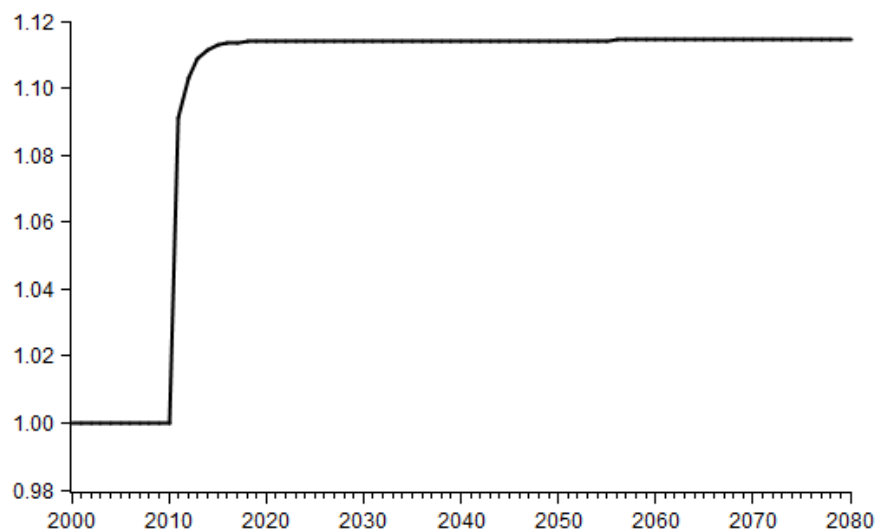


Figure 2.9: The evolution of the level of *real estate demand*, relative to the baseline solution, following a one-time permanent increase in the expected rate of return on real estate

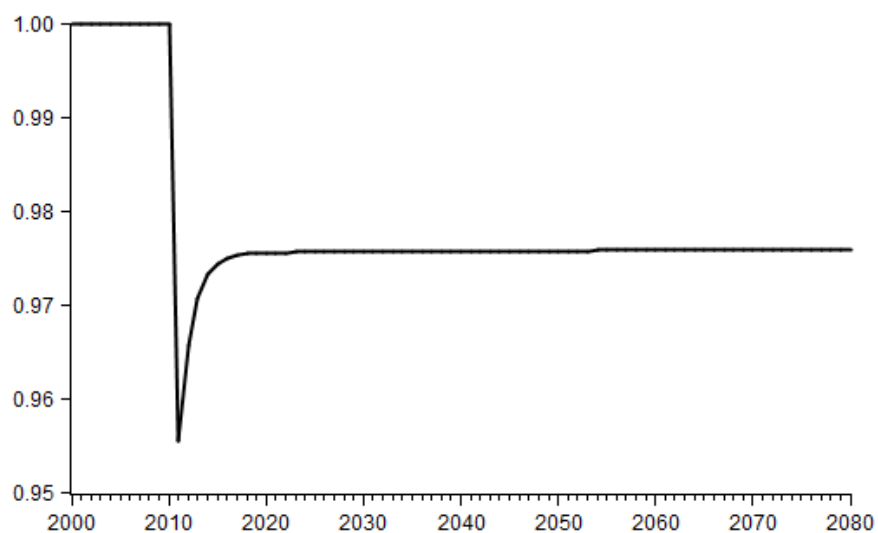


Figure 2.10: The evolution of the level of *bills demand*, relative to the baseline solution, following a one-time permanent increase in the expected rate of return on real estate

unstable and, when household expectations fall, the support for high home prices could break down and fall due to diminished demand. According to Case and Shiller (2003) this is the major source of the bubble in the housing market.

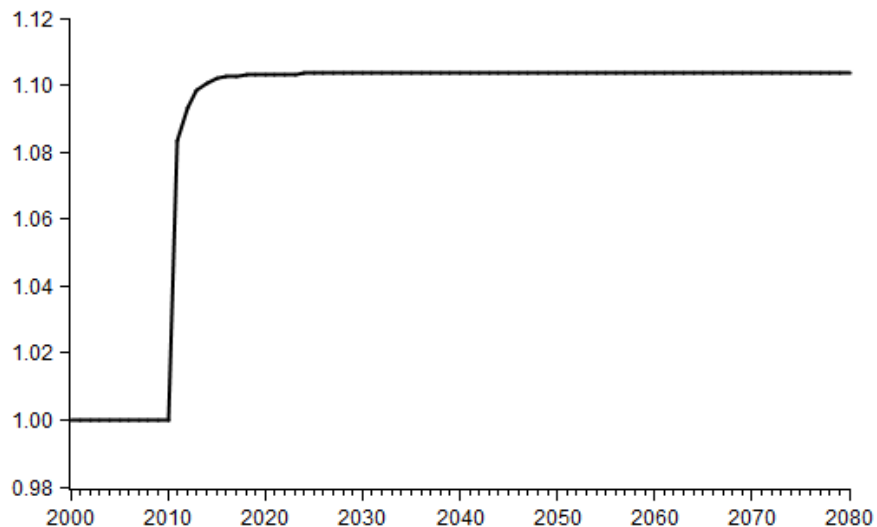


Figure 2.11: The evolution of the level of *real estate prices*, relative to the baseline solution, following a one-time permanent increase in the expected rate of return on real estate

As households demand for real estate increases, they require more mortgage from the banks to finance their real estate purchases. This requirement causes the demand for mortgages (figures 2.12) to increase approximately linearly above their baseline stationary steady state levels.

2.3.4 Simulation 3: Changes in mortgage defaulting rate

In the normal sense, the change of the default rate on mortgages, $npmg$, is by itself a response to some trigger in the housing market. For instance, a drastic increase in the mortgage interest rate can possibly induce households to default on their mortgages.

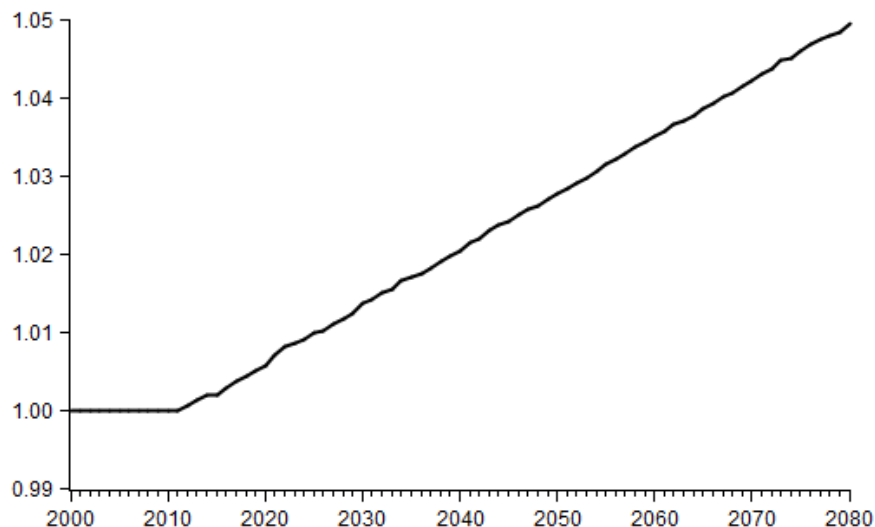


Figure 2.12: The evolution of the level of *mortgage demand*, relative to the baseline solution, following a one-time permanent increase in the expected rate of return on real estate

This trigger can cause an increase in the default rate. For more discussion on reasons for mortgage defaults see section 1.3.1.3 of chapter 1. For the discussion in this section, we will assume the trigger has happened and the default rate has increased from its stationary steady state value. We will consider the case where the default rate for the economy increases and stays at that rate in perpetuity and another case where the default rate increases temporarily for just one period. At the aggregate level we can conceive of the later case as a cross section of households losing their jobs for a short period of time causing them to default on their mortgages in the short term but resuming mortgage payments in the following period. In the simulation we increase the default rate from 4.50% to 5.00% in year 2010 and let it stay there throughout the simulation period for the one-time permanent increase case and in the one-period temporary case, the rate is returned to 4.50% in year 2011.

Figure 2.13 shows the effect of the change in the default rate on the total value of

defaults relative to the baseline. In this simulation we notice that the change results in an increase of total default over their baseline values. At the onset of the shock we see an immediate sharp rise of the default amount for both the one-time permanent and the one-period temporary cases. In the permanent shock case, the increase default amount stays at the new high value whereas in the one-period temporary shock, the increased default immediately returns to its previous baseline stationary state value. As will be seen in all the other scenario results of the one-period temporary shock of the default rate, all parameters eventually return to their original steady state once the shock is withdrawn. The increase of total default, $NPMG$, is as expected, as it is defined as a product of the default rate and the amount of outstanding mortgage stock (equation 1.36).

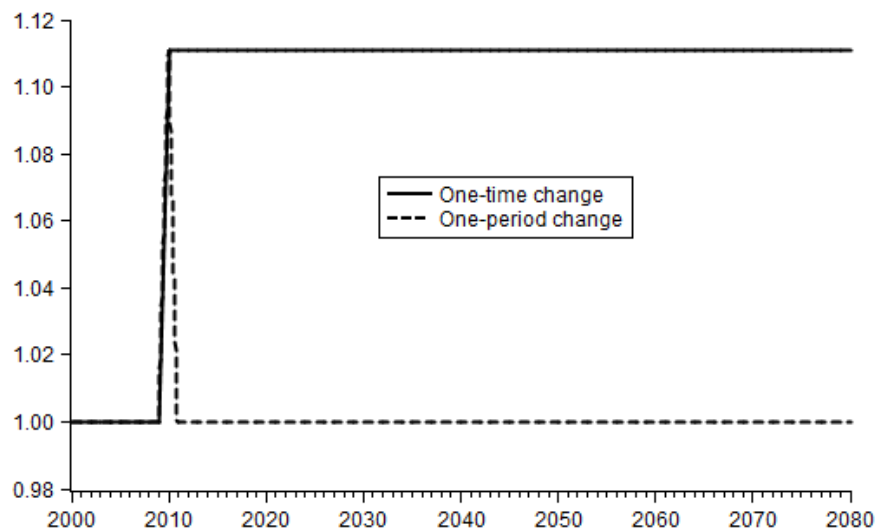


Figure 2.13: The evolution of the level of $NPMG$, relative to the baseline solution, following a one-time permanent and one-period temporary increase in the mortgage default rate

2.3.4.1 Consumption and income

The real consumption and real disposable income response to the rise in the rate of $npmg$ are depicted in figures 2.14 and 2.15 respectively. In both figures there is a sharp drop in real consumption and real disposable income relative to their baseline values at the point of shock. In the one-period temporary shock case, we see an immediate recovery to a higher value over and above the baseline steady state values momentarily, with the variable then gradually dropping back to the baseline stationary steady state level in the long run. In the case of the one-time permanent shock, in the short term, there is a gradual recovery, but the variable settles to a new steady state below that of the baseline in the long run. The path of the shock for both the real disposable income and real consumption are identical. As noted earlier, a major trigger for default by households is the fall in personal income. As households' personal income falls, they are faced with mortgage defaults and they are also forced to cut down on their consumption. This further leads to a fall in their nominal disposable income. This dynamic leads to the fall of real consumption and real disposable income of the households relative to their baseline solutions.

The sharp fall in consumption and income is due to the burden of income loss. But immediately households default on their mortgages, their debt burden eases. This translates into increase in wealth (see figure 2.16) and, as a side effect, households increase consumption which also leads to an increase in income. In the one-period temporary case, households increase consumption with all the gains leading to levels above those of the baseline before settling back to the same levels as those of the baseline. However in the one-time permanent case, households spending is in check and they gradually increase consumption but to levels below those of the baseline.

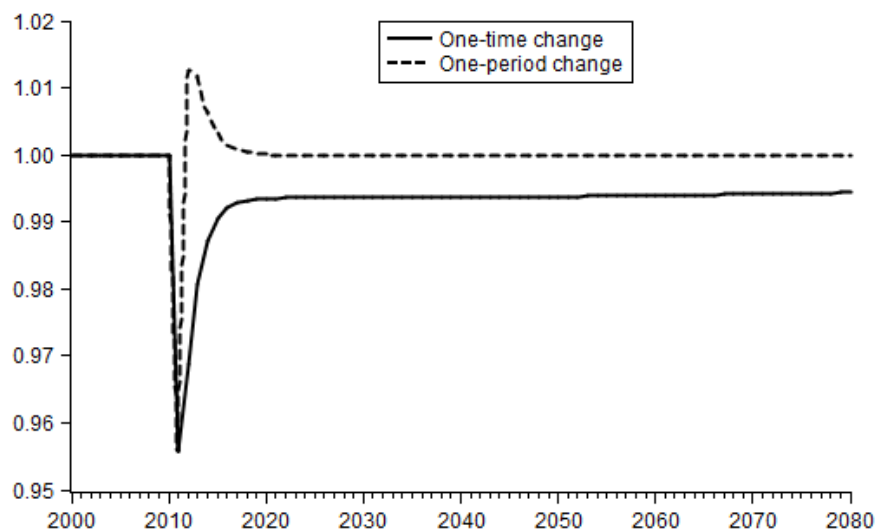


Figure 2.14: The evolution of the level of *real consumption*, relative to the baseline solution, following a one-time permanent and one-period temporary increase in the mortgage default rate

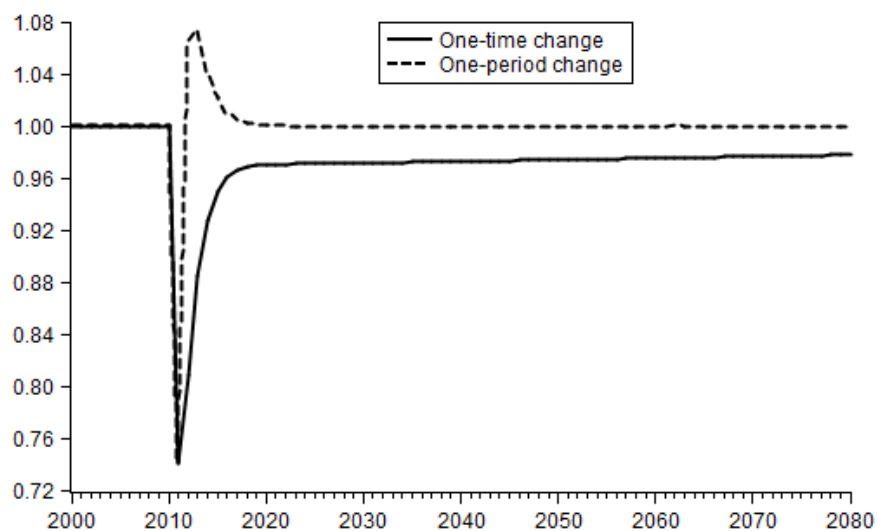


Figure 2.15: The evolution of the level of *real disposable income*, relative to the baseline solution, following a one-time permanent and one-period temporary increase in the mortgage default rate

2.3.4.2 Portfolio demand

In this subsection the treatment of the one-period temporary increment is dropped because its resulting behaviors are always the same — they follow the same path as the short run shock impact of the one-time permanent increment and then settle back to the same levels as those of the baseline steady state.

There are lots of dynamics determining the path of real estate variables in this experiment. As the rate of defaults increases, the value of defaults increases. This increment has the effect of increasing the demand for deposits (supply of deposits is always matched by demand in this model), following equation 1.48. Intuitively, as households default on mortgages, banks are able to reclaim these funds by way of selling the collateralized properties back to the households. These funds go to increase the level of money supply which is wholly matched by households' deposits demand. The increase in deposits in the long run increases both households' wealth and investible wealth as shown in figure 2.16. From the portfolio equations, all things being equal, the increase in investible wealth implies an increase in the portfolios. Therefore households increase both demand for bills and demand for real estate. This brings the portfolios to a higher level than their baseline levels. The new level of bills and real estate demands are shown in figure 2.17. The feedback effect between wealth and portfolios is the reason why they continue to rise in value at an increasing rate.

The result here simply says households become richer as they default on their mortgages. This sounds counterintuitive but logical. The most logical reason for defaulting by households is when the value of their real estate property is less than the market value. When households default on their mortgages, they get rid of their negative equity and improve their balance sheet accounting.

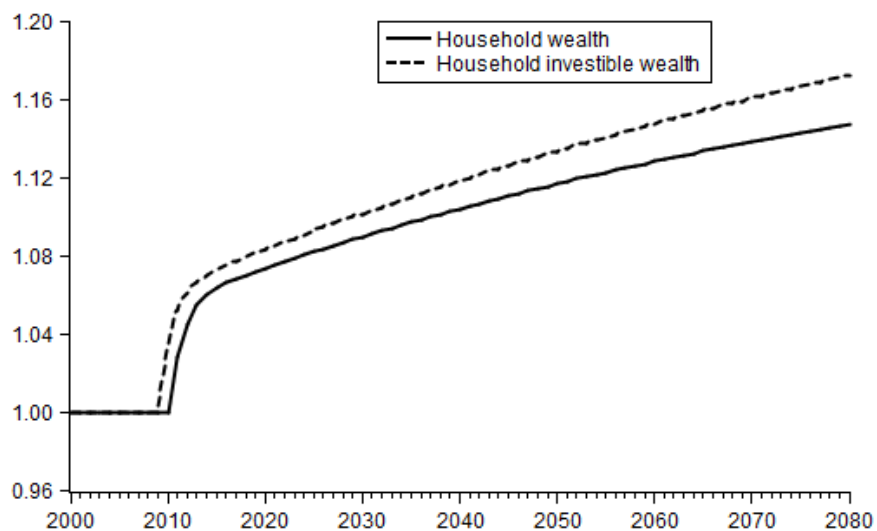


Figure 2.16: The evolution of the levels of household *wealth* and *investible wealth*, relative to the baseline solution, following a one-time permanent increase in the mortgage default rate

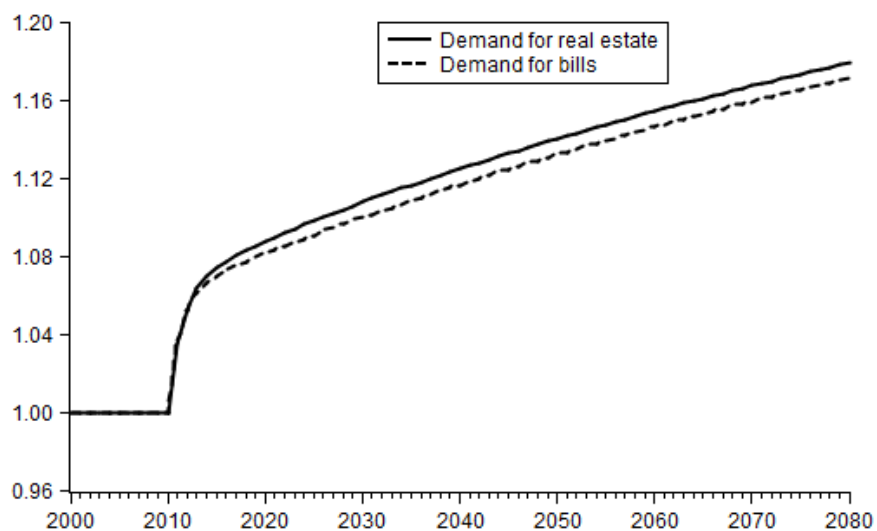


Figure 2.17: The evolution of the levels of household demand for *real estate* and *bills*, relative to the baseline solution, following a one-time permanent increase in the mortgage default rate

2.3.5 Simulation 4: Government fiscal policy

In this section we examine the effect on the economy of an increase in the real pure government expenditure, g . The simulation includes both a one-period temporary and one-time permanent boost to the growth rate of real government expenditure. From the system of equations, a change of the growth rate of real government expenditure directly influences the rate of mortgage growth. In the one-time permanent change in the growth rate of government expenditure we increase the rate from 3% to 3.2% in year 2010 and permanently hold it at that rate. In the one-period temporary increase, the rate is increased temporarily from 3% to 3.2% in year 2010 and returned to 3% in year 2011. The result of the changes is shown in figures 2.18 to 2.27.

2.3.5.1 Consumption and income

Figure 2.18 shows the path of real consumption and real disposable income relative to the baseline levels following a one-period temporary increase in government expenditure. The curves of real consumption and real disposable income both follow approximately the same path. They rise sharply in year 2010 at the onset of the shock. They then fall sharply to a lower level, but still above their baseline levels. The curves then rise gradually to new steady state levels even above the levels that were attained on the onset of the shock. Naturally, the rise in rate of growth of real government expenditure leads to increased levels of government expenditure. This has a direct effect of increasing real income. The increase in real income also increases the level of personal income of households and consequently increases both real disposable income and real consumption. Even after the removal of the source of the shock, that is returning the growth rate of real government expenditure to its previous value, the impact of the shock remains and continues to settle at higher levels for the variables of the economy. This comes from

the fact that the initial impact also increases the government debt. Government issues more bills to cover its increased expenditure. As government pays interest on these bills its debts continue to grow. Hence after removal of the shock, the system of equations maintains the initial growth that was introduced as the other wheels get into motion.

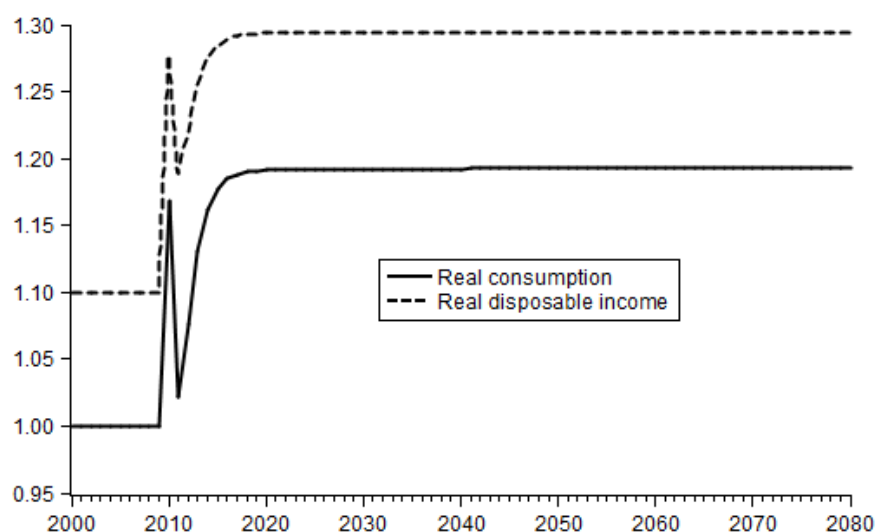


Figure 2.18: The evolution of the levels of *real consumption* and *real disposable income*, relative to the baseline solution, following a one-period temporary increase in government expenditure

In figure 2.19, the effects of a permanent increase of the growth rate of real government expenditure on real consumption and real disposable income are shown. The effect of the rise on the variables of the economy is the same as in the case of the one-period temporary rise in the shock variable. The path of the real consumption and real disposable income are however different. In the one-time shock scenario, the shock is not removed and it perpetuates. The effect of the increase in the government debt with constant price levels leads to the continuous growth of real consumption and real disposable income.

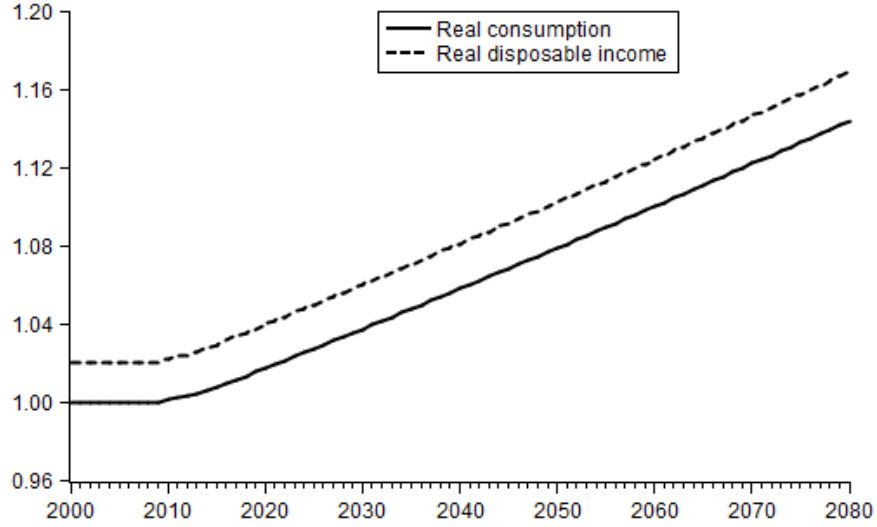


Figure 2.19: The evolution of the levels of *real consumption* and *real disposable income*, relative to the baseline solution, following a one-time permanent increase in government expenditure

2.3.5.2 Labour market

The response of the labour market to the rate of growth of real government expenditure is analyzed in this section. Figure 2.20 illustrates the impact on the employment rate following a one-time permanent increase in the growth rate of real government expenditure. Both the real estate and the goods and government sectors rates of employment increased above their baseline employment rates. The new rates actually continue to grow as a result of the shock. In this model, the employment level of the real estate sector is defined as the ratio of the change in the demand in real estate and labour productivity in the real estate sector (equation 1.58). Labour productivity is exogenous in the model and does not experience any growth in the new scenario relative to the baseline scenario. Thus the employment level changes are determined by the change in real estate demand. The demand (and also supply) of real estate as a result of the shock is positive (see the next section for details), hence the positive growth in the real

estate sector's employment rate relative to the baseline. Similarly, the employment level of the goods and government sectors is defined as the ratio of real consumption and real government expenditure, and labour productivity in the goods and government sectors (equation 1.59). With the labour productivity being exogenous, the growth in the rate of employment is determined by the sum of real consumption and real government expenditure. Real consumption is shown to rise as a result of the shock in the previous section. Real government expenditure *is* the shock. Hence the rise of the employment rate relating to the goods and government sectors.

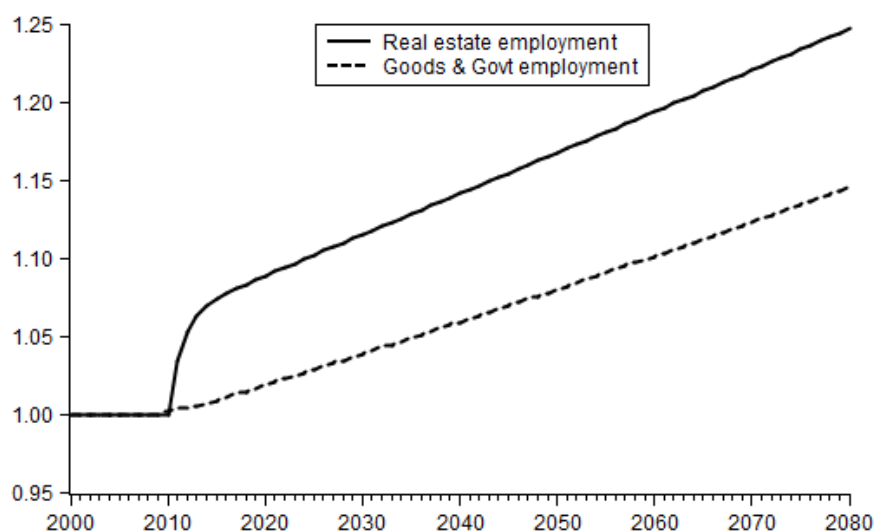


Figure 2.20: The evolution of the levels of employment levels in the *real estate* and *goods and government* sectors, relative to the baseline solution, following a one-time permanent increase in government expenditure

Figure 2.21 shows the increase in the employment rate following a one-period temporary increase in the growth rate of real government expenditure. As in the case of real consumption and real disposable income, the temporary shock results in a permanent increase in the total level of employment (the sum of employment in the real estate, in the goods and government sectors) in the economy. Both the real estate and the goods

and government sectors individually experienced an increase relative to their baseline rates. As in the foregoing analysis, the rate of employment in the real estate sector is determined by the change in the demand for real estate. Likewise, the rate of employment in the goods and government sectors is determined by real consumption and real government expenditure. The increase in the demand for real estate (see section 2.3.5.3) and the increase in both real consumption (see section 2.3.5.1) and real government expenditure (the shock) imply an increase in the total level of employment rates relative to the baseline solution. Unlike in the case of the permanent shock where the level of labour employment is increasing forever, in the case of the temporary shock, the level of labour employment becomes constant relative to the baseline in the long run.

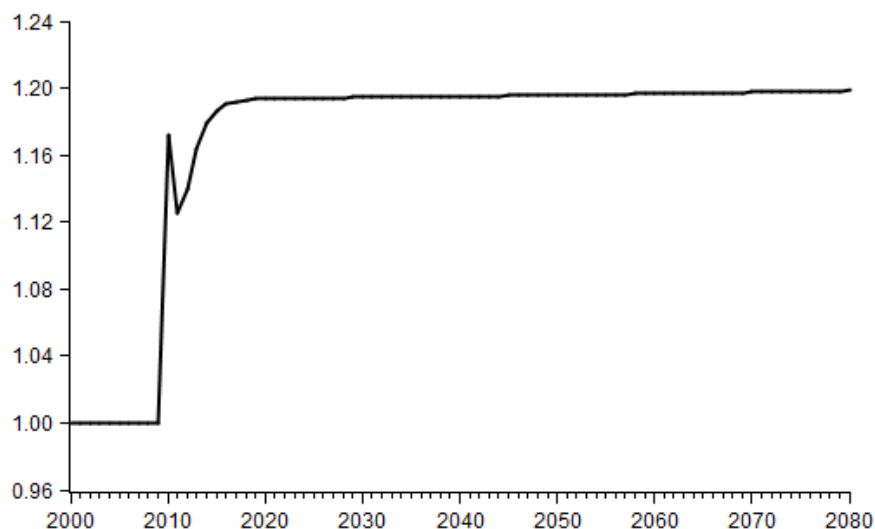


Figure 2.21: The evolution of the level of total *employment level*, relative to the baseline solution, following a one-period temporary increase in government expenditure

2.3.5.3 Real estate market

The demand for and the supply of real estate for the case of one-time permanent increase in the growth rate of real government expenditure are presented in figure 2.22. Both demand and supply are rising continuously and are over and above their baseline values following the impact of the shock. As the economy picks up with the expansionary fiscal policy, households' disposable income increases as discussed in section 2.3.5.1. Consequently the wealth of households increases giving households more investible wealth to increase their investment including real estate properties. As a result the demand for real estate of households increases above that of the baseline values and continue to grow. The supply also increases as firms increase their supply to satisfy the growing demand. However, the growth rate of demand outstrips the growth rate of supply and this leads to an increase in the price of real estate (see the price specification in equation 1.19). The faster growth rate of demand over supply results in a rising price of real estate relative to the baseline real price as shown in figure 2.23. When demand for real estate increase with increases in real estate prices, households will need to borrow more to finance their real estate purchases. As a result the demand for mortgage after an increase in the growth rate of real government expenditure rises above the baseline levels as depicted in figure 2.24.

Figures 2.25, 2.26 and 2.27 respectively show the demand and supply of real estate, the price of real estate, and the mortgage demand relative to their baseline values for the case of a one-period temporary increase in the growth rate of real government expenditure. Unlike the case of a one-time permanent change, the levels here do not continue to grow but attain a maximum. The demand for real estate at the onset of the shock shoots up, and then drops slightly to its long run level. The supply also rises up faster in the initial periods of the shock to attain a maximum and then settles at a new steady state

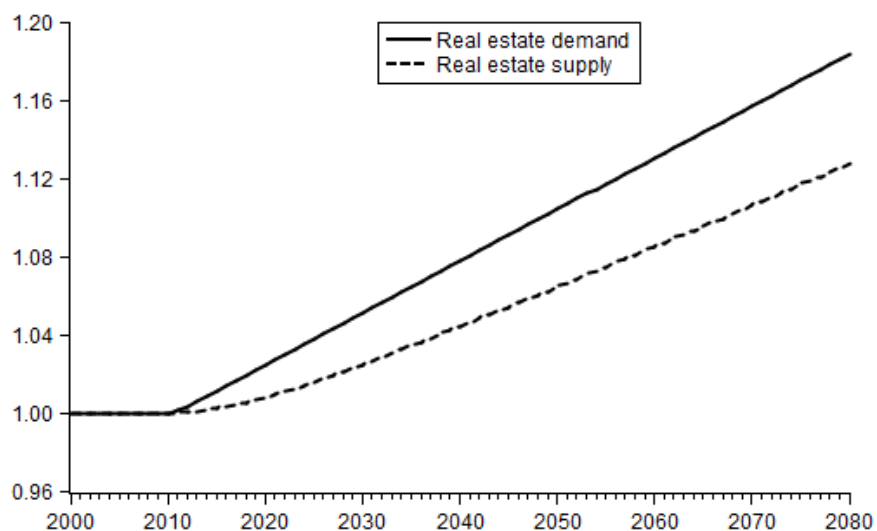


Figure 2.22: The evolution of the levels of real estate *demand* and *supply*, relative to the baseline solution, following a one-time permanent increase in government expenditure

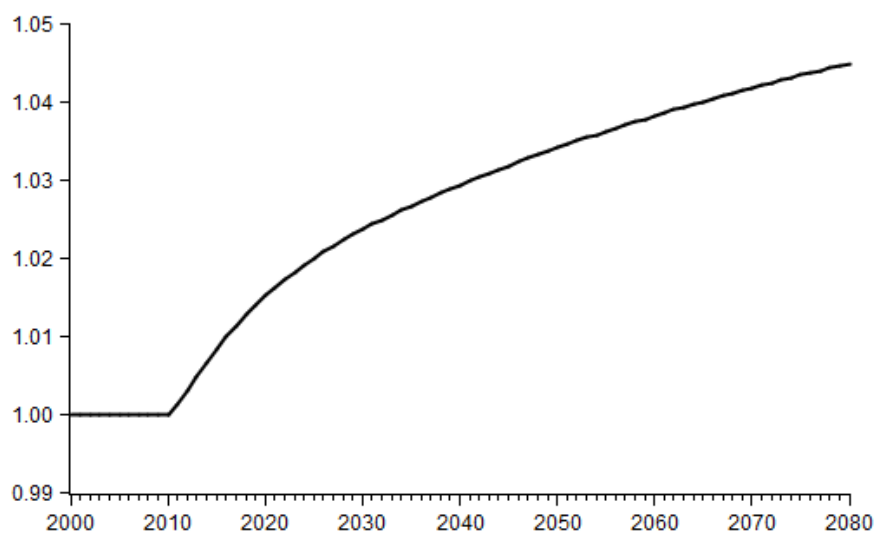


Figure 2.23: The evolution of the level of *real estate prices*, relative to the baseline solution, following a one-time permanent increase in government expenditure

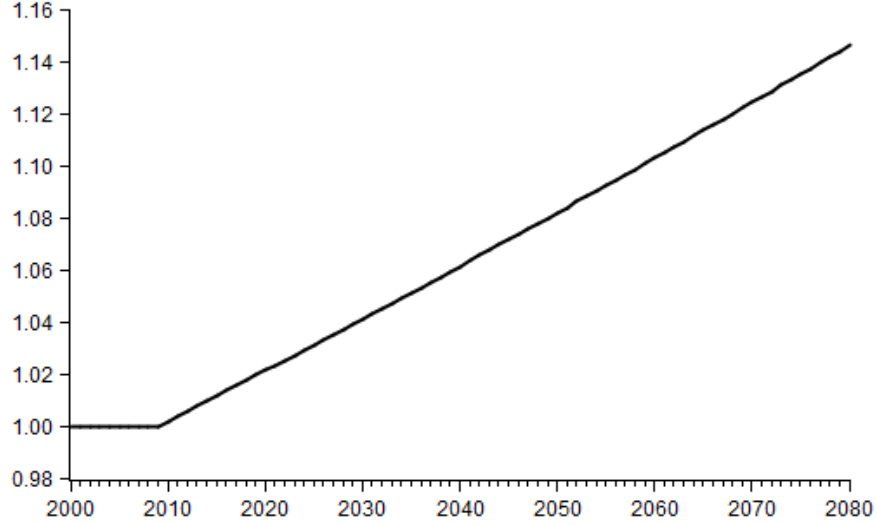


Figure 2.24: The evolution of the level of *mortgage demand*, relative to the baseline solution, following a one-time permanent increase in government expenditure

over and above the baseline values. Following the dynamics of the demand and supply of real estate, the price of real estate also shoots up and quickly attains a maximum relative to the baseline and begins to fall as the growth of the supply surpasses that of the demand. The new steady state demand for mortgages is above the stationary steady state baseline levels. The growth rate of real government expenditure is a direct factor of the demand for mortgages by the household (see equation 1.31). An increase in α_g has the direct effect of increasing the demand for mortgages relative to the baseline level. The relationship gives the demand for mortgages curve its sharp nature — an immediate sharp rise to the long run steady state level. The increase in the demand for mortgage stays at the new level after the removal of the shock. Alternatively, the increase in the demand for mortgage relative to the baseline solution can be attributed to the increase in both the demand and price of mortgages that are above their baseline steady state levels. Households need to demand more mortgage loans to finance real estate purchases

as a result of the new higher levels of demand and price.

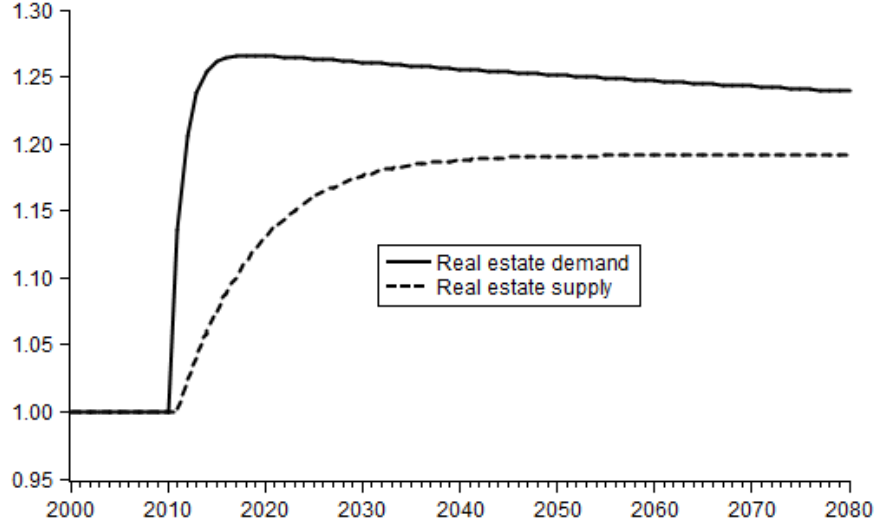


Figure 2.25: The evolution of the levels of real estate *demand* and *supply*, relative to the baseline solution, following a one-period temporary increase in government expenditure

2.3.6 Simulation 5: Expectations in housing price changes

The experiment in this section examines the effect on the system when the exogenous factor in the price of real estate is increased as a result of real estate price change expectations in the economy. Households form expectations on house price changes by relying on several economic parameters. Expectations in interest rate changes and historical prices of real estate among other reasons can affect real estate future prices. We capture the price change expectations of households using the parameter σ in equation 1.19. In this experiment we assume that households' real estate price change expectation increases such that σ moves from the baseline value of approximately 1% to 2%.

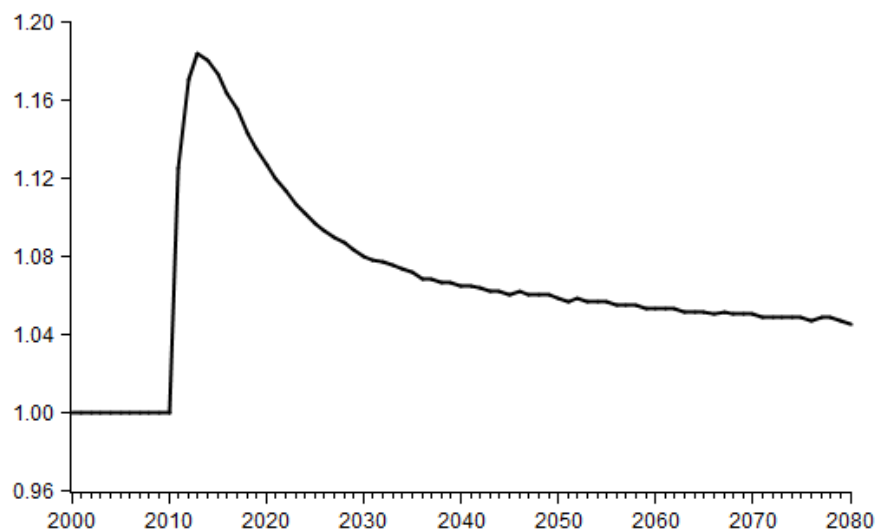


Figure 2.26: The evolution of the level of *real estate prices*, relative to the baseline solution, following a one-period temporary increase in government expenditure

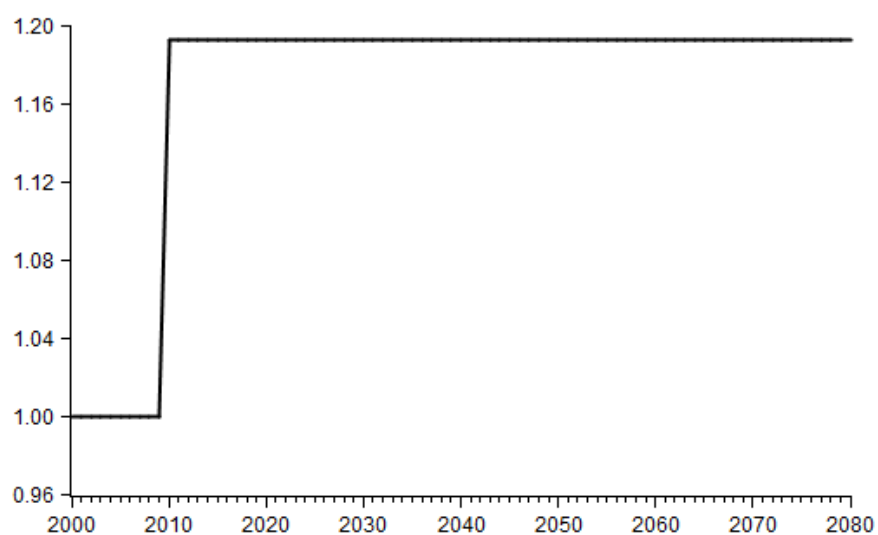


Figure 2.27: The evolution of the level of *mortgage demand*, relative to the baseline solution, following a one-period temporary increase in government expenditure

2.3.6.1 Real estate market

Real estate demand and supply functions relative to the baseline solutions for the increase in the expectation of the price change of real estate are presented in figure 2.28. The results show a fall of both the demand for real estate and the supply of real estate relative to the baseline solution levels. In the case of the demand function, a rise in the price of real estate clearly implies a fall in demand all things being equal. However, the rise in the real estate prices with respect to the supply function is ambiguous (see equations 1.17 and 1.18). Nevertheless, the negative price factor (in equation 1.17) together with the decline in demand eventually drags down the supply of real estate in the current scenario in comparison to the baseline scenario.

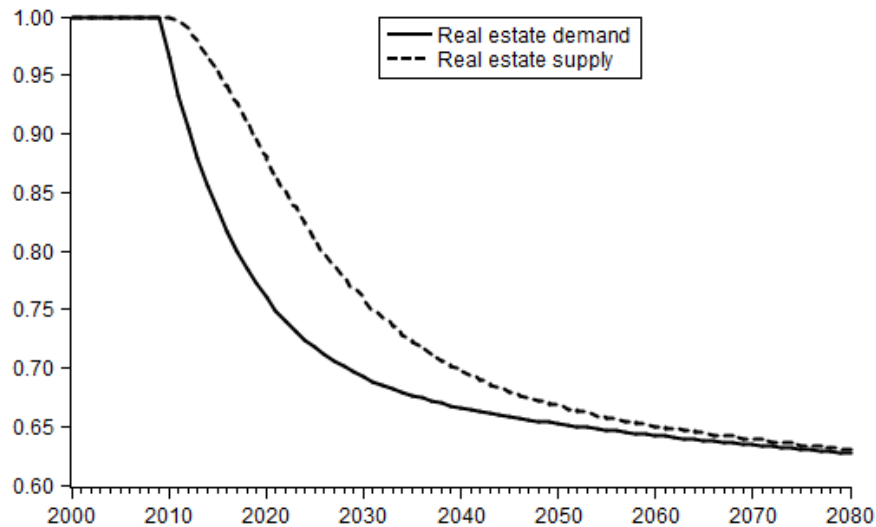


Figure 2.28: The evolution of the levels of real estate *demand* and *supply*, relative to the baseline solution, following a one-time permanent increase in housing price rise expectation

The one-time permanent shock due to price increase expectation generates higher real estate price levels over the baseline solution, as expected. The path of the real estate price for the experiment is shown in figure 2.29. Following the formulation on the

mortgage demand (equation 1.31), the price increase has the direct effect of increasing mortgage demand as well. The curve for the demand for mortgage is shown in figure 2.30.

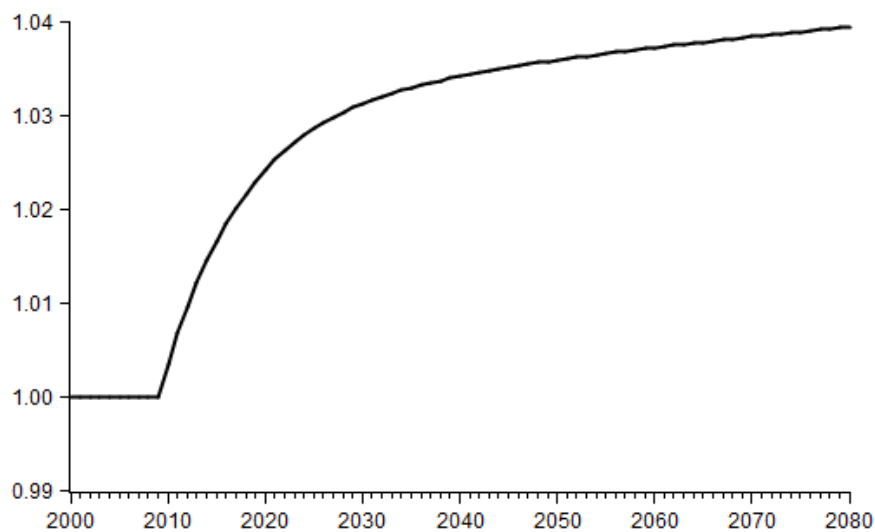


Figure 2.29: The evolution of the level of *real estate prices*, relative to the baseline solution, following a one-time permanent increase in housing price increment expectation

2.3.6.2 Consumption, income and government

There are a lot of dynamics involved in this model when the price of real estate changes due to expectations. With respect to real consumption and real income as shown in figure 2.31, following the initial impact of the shock, GDP first responds with a sharp rise relative to the baseline solution as per equation 1.53. This increase in income also pulls up consumption. However in subsequent years the price effect on consumption gradually limits the level of consumption relative to the baseline values. As the level of consumption declines, it in effect brings the level of real income relative to the baseline value down. In addition, households buy fewer houses because of high prices. This gradually brings the level of GDP and consequentially, consumption, down. Both real

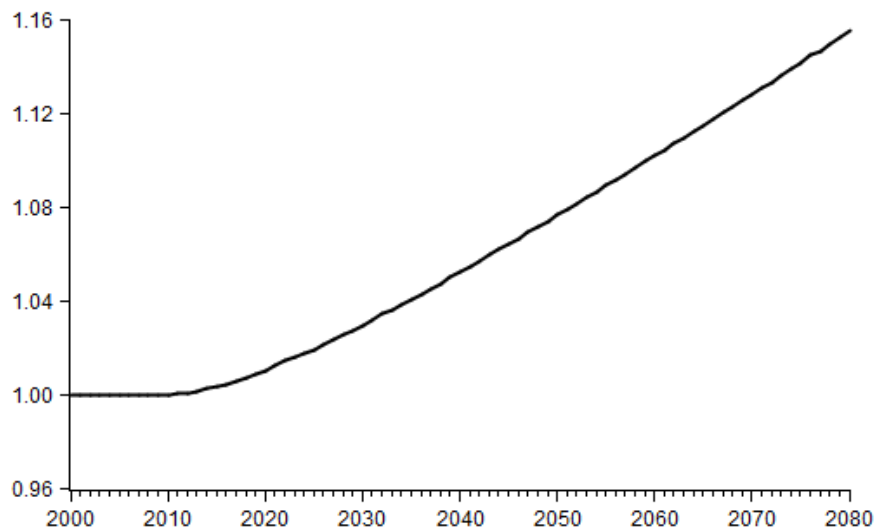


Figure 2.30: The evolution of the level of *mortgage demand*, relative to the baseline solution, following a one-time permanent increase in housing price increment expectation

consumption and real income finally settles at a new steady state slightly below their baseline stationary steady state levels.

In this section we also present the government deficit to GDP ratio and government debt to GDP ratio. These ratios are shown in figure 2.32. The government debt to GDP ratio is one of the indicators of how well an economy is performing. Another fiscal indicator is government deficit to GDP ratio. The deficit is simply the difference between government spending and receipts. In this model government receipts are taxes and central bank's interest received on bills held. Government disbursement includes spending on goods and services and payment of interest on bills issues (equation 1.82). The experiment shows that in the short run these ratios jump to higher levels in comparison to the baseline steady state following a permanent increase in the expectation of a price jump in real estate. The ratios both fall back to values closer to the baseline and then gradually rise up in the long run to levels over the baseline values. The result

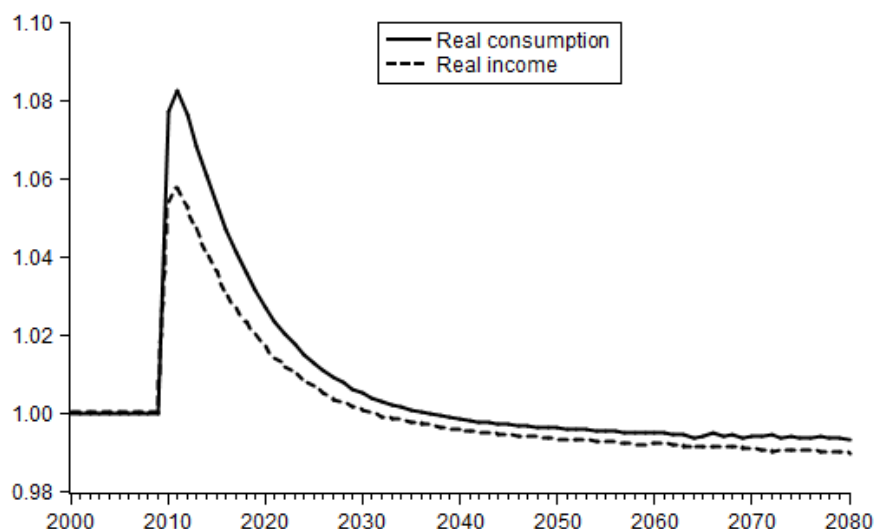


Figure 2.31: The evolution of the levels of *real consumption* and *real income*, relative to the baseline solution, following a one-time permanent increase in housing price increment expectation

follows from the resulting response of the income curve in figure 2.31. The rate of growth in these ratios is continuous and, if not corrected, the health of the public sector will deteriorate in the long run. The government may inject an expansionary fiscal policy to remedy the situation caused by households' price change expectations. As observed in Godley and Lavoie (2007), the experiment demonstrates "to a large extent, these two ratios are determined by factors that are out of the direct control of the government" (p. 410).

2.3.7 Simulation 6: Default rate as a determinant of the mortgage rate

The interest rates of bills are set exogenously and they directly affect the deposit rates and the mortgage rates which are just exogenous markups on the bill rates. In the section, we undertake the same fiscal policy change but allow the markup on mortgage rates to

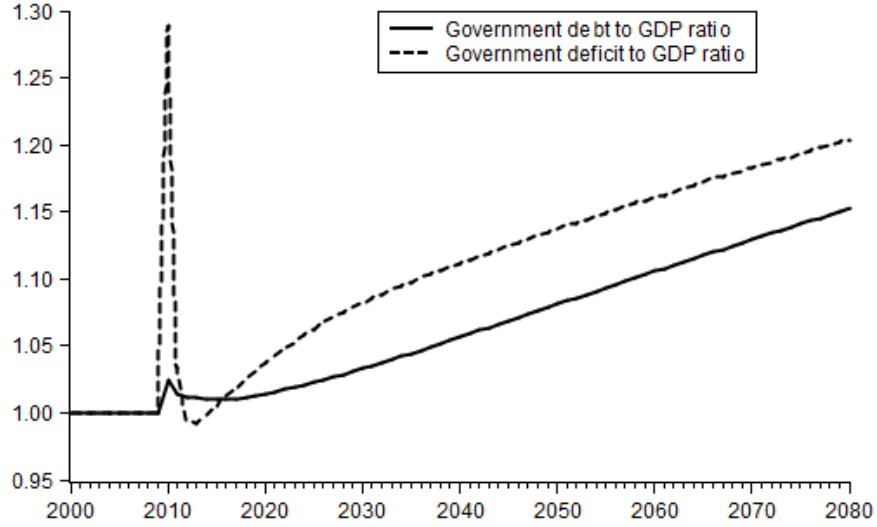


Figure 2.32: The evolution of *government deficit to GDP ratio* and *government debt to GDP ratio*, relative to the baseline solution, following a one-time permanent increase in housing price increment expectation

be endogenous. Hitherto in this model, banks simply charge an exogenous markup over the deposit rates to derive the mortgage rate. The default rates on housing mortgages are a concern of banks. In order for the banks to alleviate this concern, the model is slightly changed to enable the banks to charge rates on mortgages taking into account the housing default rates.

The rates of interest equations from chapter 1 are the bill rates, equation 1.72, the deposit rates, equation 1.69 and the mortgage rates, equation 1.70. They are reproduced below.

$$r_b = \overline{r_b},$$

$$r_m = r_b + \overline{\delta_{rm}},$$

$$r_{mg} = r_m + \overline{\delta_{rmg}},$$

The modification makes the variable δ_{rmg} endogenous. The modified variable is de-

defined in equation 2.1 below. In this formulation, δ_{rmg} , responds with a coefficient, γ_{rmg} , to the mortgage default rate, $npmg$. In addition, coefficient, γ_{rmg} , is itself adjusted each period at an exogenous rate of γ_{rate} as shown in equation 2.2.

$$\delta_{rmg} = \delta_{rmg-1} \cdot (1 + \gamma_{rmg} \cdot npmg), \quad (2.1)$$

$$\gamma_{rmg} = \gamma_{rmg-1} \cdot (1 + \gamma_{rate}), \quad (2.2)$$

The outcome of the change in mortgage rate in comparison with the other interest rates is shown in figure 2.33. The transformation of δ_{rmg} to an endogenous variable has the effect of making the mortgage rate an upward sloping curve (line “Endogenous markup mortgage rate”) compared to the baseline horizontal curve (line “Exogenous markup mortgage rate”). The bill rates and the deposit rates which remain the same in both cases are also shown in figure 2.33. We will term, henceforward, the markup as “exogenous markup” and “endogenous markup” regimes respectively for exogenous δ_{rmg} and endogenous δ_{rmg} mortgage rates.

We now repeat the fiscal government policy experiment with this new modification and compare some aspects of the results with the result attained in section 2.3.5. It should be noted that each of the two experiments (exogenous markup and endogenous markup regimes) will be compared with their own respective baseline stationary steady state. The comparison is therefore relative to the levels of the interested variables after the fiscal policy shock is applied.⁵ In this simulation the fiscal shock is a one-time permanent shift of the government expenditure growth rate from 3% to 3.2%.

Figure 2.34 shows the result of real consumption and real disposable income. We

⁵To do this in EViews, we first run the model with the two cases of δ_{rmg} . The results of the outcomes are stored in separate workfiles. Secondly, we execute the same shock experiment of the two outcomes and merge the results of the two experiments in the same workfile. Finally, we do a comparison analysis on the merged worksheet.

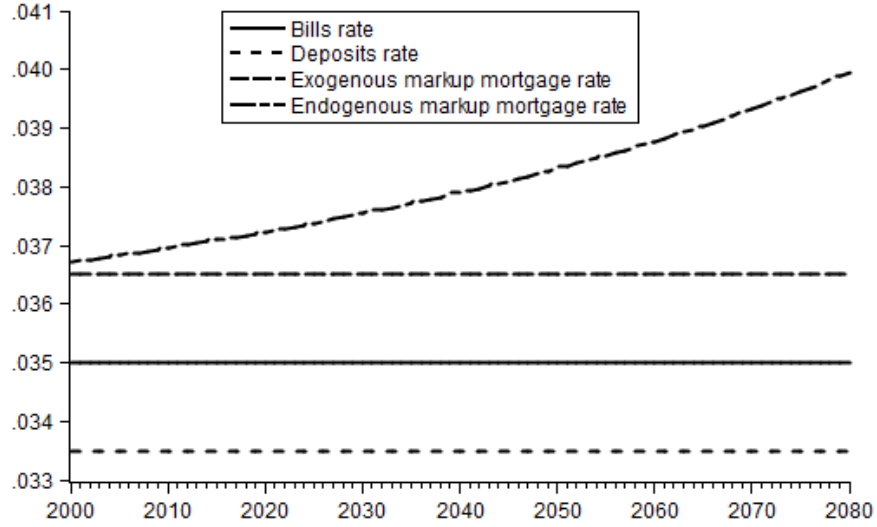


Figure 2.33: Interest rates for baseline model and *default rate* adjusted mortgage rate model

can see that the curves of real consumption of the two regimes coincide. Similarly the curves for the real disposable income also coincide. The curves are exactly the same as those described in section 2.3.5. In essence the growth of both real consumption and real disposable income as a result of increasing the growth rate of real government expenditure is the same for both regimes of the mortgage rate markup. In other experiments, similar effects for other variables, including the supply function of real estate, were noticed.

2.3.7.1 Real estate market

One perplexing result is the increase in the demand for real estate (relative to its baseline steady state) when the mortgage rate markup became endogenous. The choice of values for the variables in the markup guaranteed the upward sloping curve starting at the same point when the markup was exogenous (see figure 2.33). Naturally this implies an increasing interest rate of mortgage loans to the households. But as seen by the demand for real estate in figure 2.35, for the regime of endogenous markup, households increased

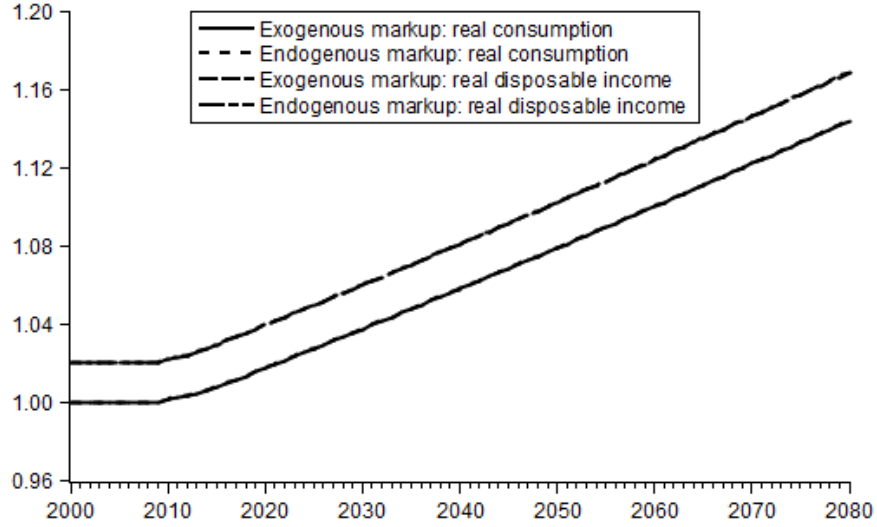


Figure 2.34: The evolution of the levels of *real consumption* and *real income*, relative to the baseline solution, following a one-time permanent increase in government expenditure. For the cases of exogenous and endogenous mortgage markups. Note: bottom coinciding lines are real consumption curves

their housing purchases over the baseline steady state levels. Consequently, the increase in demand with stable supply growth in the endogenous regime in comparison to the exogenous regime implies a price rise in the endogenous regime. The real estate price comparison is shown in figure 2.36. The reason for this baffling result is speculations of future returns in the housing market due to expected price increment. So the rise in housing prices further triggers increases in demand due to speculation resulting in a vicious cycle with the potential of triggering a bubble in the housing market.

2.3.7.2 Banks' profits

We started with the premise that banks introduce the endogenous regime in order to alleviate their worries when faced with mortgage defaults. Even though banks are wholly owned by the households, they are private profit seeking entities. Continual rising mort-

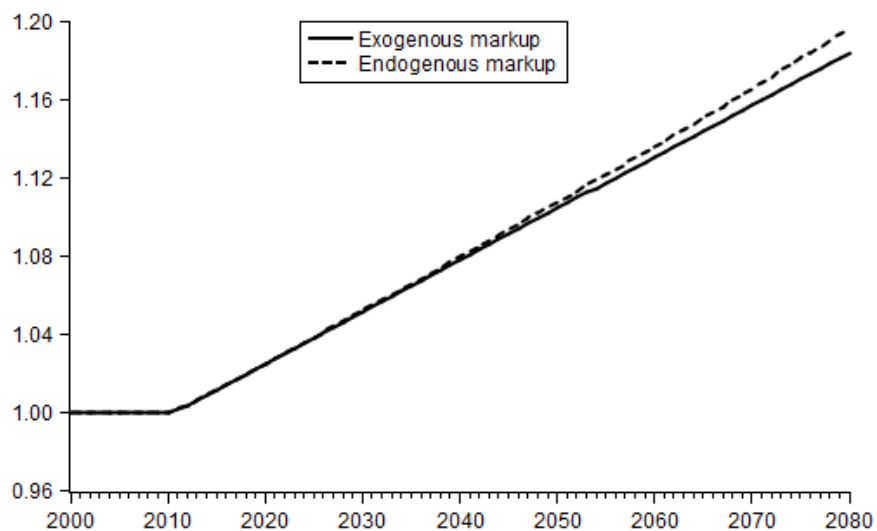


Figure 2.35: The evolution of the level of *real estate demand*, relative to the baseline solution, following a one-time permanent increase in government expenditure. For the cases of exogenous and endogenous mortgage markups

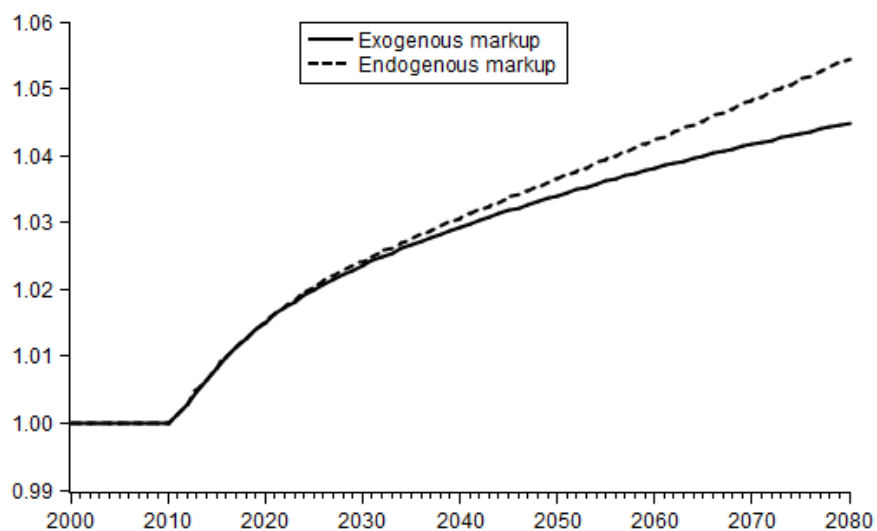


Figure 2.36: The evolution of the level of *real estate price*, relative to the baseline solution, following a one-time permanent increase in government expenditure. For the cases of exogenous and endogenous mortgage markups

gage rates that do not affect demand simply mean more profits for the banks. We examine the profitability of the banks in the two regimes and as expected in the endogenous regime banks made more profits than in the exogenous regime relative to their respective baseline solutions. Figure 2.37 shows the comparison of bank equity, which is the accumulation of the banks' operational profits. See equation 1.67. Banks therefore manage to remain profitable when faced with mortgage defaults if they incorporate the default rate parameter when setting mortgage rates.

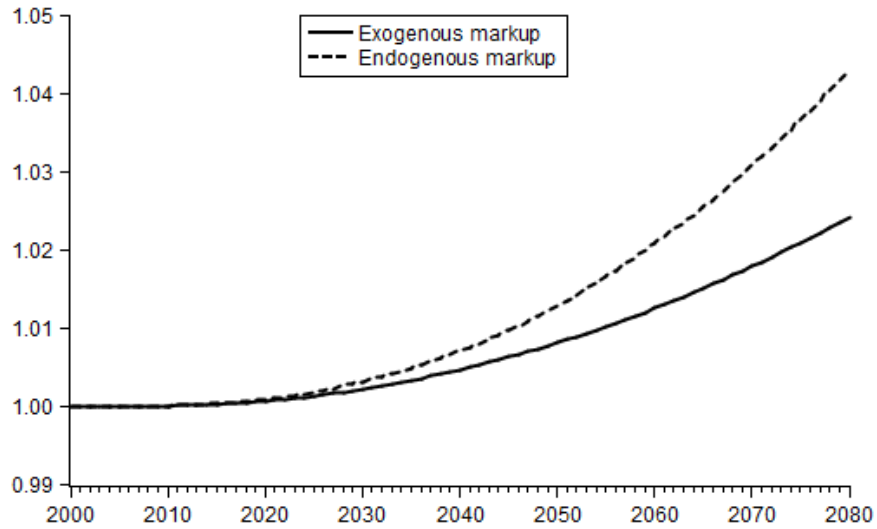


Figure 2.37: The evolution of the level of *bank equity*, relative to the baseline solution, following a one-time permanent increase in government expenditure. For the cases of exogenous and endogenous mortgage markups

2.4 Conclusion

This chapter builds upon the theoretical framework model presented in chapter 1 by solving the model and analyzing the results. The model is a five-sector growth model in a stock-flow consistent framework consisting of a household sector faced with a portfolio selection problem which includes real estate. The real estate is the largest asset in the portfolio of the household. The other sectors, namely, the firms, the banks, the central bank and the government complete the model. There are several possible experiments that can be undertaken with the model. Some of the possible experiments are discussed in the concluding section of chapter 1. This chapter presents a simulation of the most relevant experiments.

By providing values of the parameters of the model based on stylized facts, we use the Eviews modeling software to simulate the stock-flow consistency model. The simulation is run for several periods to guarantee that the solution of the model reaches a stationary steady state. The solution of the simulation is coherent. The redundant equation of the model solves, guaranteeing that the central bank readily absorbs all the extra bills issued by the government which the households do not wish to hold.

The first experiment is based on monetary policy and other rate changes. Even though an increase in the bill rate of interest has the effect of increasing the deposit and mortgage rates of interest, the effect of the economy is different from the scenario where there are increases in the deposit or the mortgage rates while leaving the bill rate untouched. As rates of interest increase, households cut down their consumption of real estate and redirect consumption to other goods and services as their disposable income increases with the policy. However, for income and consumption to increase and

simultaneously cool down the real estate market, a policy that increases the mortgage rate of interest directly is more effective than an increase in the mortgage rate via a monetary policy. For example, a bill rate increase has the potential of dragging household disposable income drastically lower and potentially destabilizing the economy before recovering. The perturbation due to deposit rates direct adjustment is too optimistic and non-expansionary in the long run. However, the mortgage rate change introduces a small fall in real disposable income in the short run and recovers to a higher level than the other rate change policies in the long run. The mortgage rate changes also have a better success in slowing the levels of the demand for real estate, the price of real estate and the demand for mortgage.

The monetary policy makers can limit initial shocks to the economy by gradually adjusting rates to reach the target policy rate. A one-time adjustment to the rate has the potential of causing initial perturbations even though the final results are the same as the multiple-period adjustment. Most central banks adhere to this system as they gradually adjust rates to achieve their policy target (inflation targeting or otherwise). These adjustments are usually done in 25 basis points (0.25%) increments. That is, if the target is to increase the bill rate by 1%, the adjustment will be done over 4 periods.

In selecting the proportion of their total assets that households wish to hold in housing, they mostly rely on the expected rate of return on their investment in real estate. The second experiment examines a rise in household expectation of this rate over the baseline rate. Households will adjust their real estate demand to take advantage of the increase in expectations. Because the available investible income is fixed, households will cut down their holdings in other assets and acquire more real estate. We observed in the simulation that households' demand for real estate increases at the expense of their holdings in government bills and other assets.

The increase in households' expectations regarding the rate of return on housing

does not help the bottom line of the economy. The expectation initially shoots up the economy's consumption and disposable income. The excitement however is short lived and is followed by a drop of both consumption and income before recovering back to their baseline steady state levels. The increased expectation is accompanied by increased activities consisting of an increased in the demand for real estate, an increased in real estate prices, and an increasing rate of demand for mortgages in the housing sector. The housing sector increased activities is not accompanied by a corresponding growth in the economy.

A portion, $npmg$, of households' mortgages is considered as non-performing. The change in this proportion has some effect on the model. In the third experiment we seek to investigate the influence of the default proportion on the income and consumption behavior of the economy and the real estate market's response. In this experiment we tested two scenarios — the case of a one-period temporary and the case of one-time permanent change in the default rate. For all cases of the one-period temporary change in the default rate, the observation on the economic variables follows the same common path. Basically a fall (or an increase) in the variable is followed by a gradual rise (or fall) of the variable and then settling back to the same growth level as that of the baseline. For example, when the default rate rises, it leads to a sharp fall of both consumption and disposable income followed by a rise to a level over that of the baseline and then gradually dropping back to the baseline growth level in the long run. The one-period temporary change in the default rate does not have an impact on the growth of the economy in the long run. However, the one-time permanent change has the effect of arriving at a lower than baseline level of consumption and income in the economy.

The increase in household default rate has the effect of increasing the households' wealth and investible wealth (in comparison to the baseline) which they use to acquire more assets for their portfolio. This increment however marginally lowers the level of

consumption and income compared to the baseline.

The next experiment is the government fiscal policy. In this experiment we increased the growth rate of government expenditure from 3.0% to 3.2%. The change is perpetual in the one-time permanent case and in the one-period temporary case the rate is returned to 3.0% in the following period. Unlike the case of one-period temporary increase in the default rate experiment, the one-period temporary fiscal policy is effective and it does modify the long run path of the measured variables. Real consumption and real disposable income both rise to a higher steady state in the long run for the one-period temporary case. They both reach a stable and constant growth level in the long run. In contrast, the one-time permanent change smoothly increases the level of both consumption and real disposable income over the baseline and continues to grow forever after the application of the shock.

In the fiscal policy experiment the labour market is also examined. There is an increase in both the level of employment in the goods and government sectors and the real estate sector, and hence in total employment. The response of the growth in the real estate sector is much more favourable than in the goods and government sectors relative to the baseline level. The nature of the increase is similar in consumption and disposable income — increasing levels for the one-time permanent shock and constant level increases for the one-period temporary shock.

In the real estate market in the case of the one-time permanent shock both demand and supply continuously increase above their baseline values. The growth rate of demand is higher than the growth of supply resulting in the upward sloping and increasing level of real estate prices. The increase in demand and in prices implies that real estate becomes costlier relative to the baseline. The high cost implies that households require more mortgage loans to make purchases in the real estate market. For the case of the one-period temporary shock, all real estate measured parameters surpassed their baseline

levels. Both demand and supply increased but whereas supply attained a constant growth rate, that of demand after attaining a maximum in the short run began to gradually fall. The fall in the growth rate of demand with a constant supply growth rate pulls down the growth in the price of real estate, all relative to the baseline.

Our model captures the changes in price change expectations of households. Price change expectation is an important aspect of real estate. As in the findings of Zezza (2008), this model shows that a rise in the expectation of future higher returns and expectation of future higher real estate prices will generate a price bubble if real estate supply lags behind real estate demand. An increase in price change expectations leads to a short run increase in both consumption and income but in the long run their levels falls below those of the baseline. The model also shows how an increase in price change expectations negatively impacts other indicators of the economy. Both the government deficit to GDP ratio and the government debt to GDP ratio show a continual growth over those of the baseline.

Making the default rate a factor of the mortgage rate of interest does not significantly affect the results of the model. Using the government fiscal policy shock, a comparison of the mortgage rate of interest specified exogenously and endogenously is performed. The consumption and income levels are the same for the two mortgage rate regimes. For the demand and price of real estate, the endogenous rate is slightly higher than the exogenous rate. As expected, the banks by cutting their risks of households' defaults on mortgages with the endogenous regime increase their profits significantly. Even though an attempt has been made to make one interest markup endogenous, the other interest rates rely on exogenous markups. A future research in providing economic backing to these "black box" markups in the bill rate of interest, deposit rate of interest, mortgage rate of interest, mortgage default rate, and rate of return on real estate, to make them endogenous will be beneficial.

The government fiscal policy is most effective in generating growth in the economy. Fiscal policy can also be used to effectively regulate the real estate market; thus supporting the Keynesian theory advocating for government intervention. For instance, in an overheated real estate market, a decrease in government expenditure has the effect of decreasing consumption, income, real estate demand, supply, prices, and mortgage demand. Nevertheless, monetary policies are another effective means of regulating the real estate market. Financial institutions are also effective in controlling the extent of households' interactions in the real estate market. They can do this by primarily setting the mortgage rate either endogenously or exogenously. The banks need to be regulated, or else they stand to amass huge profits at the expense of the households by manipulating mortgage rates of interest.

The model presented and solved here is based on a closed economy. Whereas it is justifiable to study the housing crisis in the US under a closed economy model, there will be further benefits to examine the crisis in a global perspective. After all, the crisis affected the global economy even though it originated from the US. The interrelations involved in the global financial market warrants future work that would extend this model to an open economy to examine the impact of the crisis on US and non-US economies.

A natural extension of this model in future research is the incorporation of real estate inventory. When supply exceeds demand, the unsold houses have to be introduced into the supply function in the next period. This will impact the housing start component in the supply function of equation 1.18. Another area for future research is the introduction of a fixed capital stock and capital depreciation for the production firms. These firms may also be modeled to take loans from the financial firms to replenish their capital stock. In this model, the household portfolio set is limited (with concentration on real estate). But will housing still be the preferred selected portfolio asset for investment purposes if firms' and banks' equities as well as bonds are introduced into the portfolio

set? As another future research area, real estate should be modeled together with other assets to assess the true choice of households vis-à-vis the rate of returns of these assets. Finally, another extension for future research is the introduction of agents' expectations into the model. Households are rational forward looking agents and build expectations about price changes and interest rates adjustments. Incorporating these expectations into the model will shed more light on the results.

2.A Parameters Default Values

	Parameter	Description	Value
1.	$\overline{\alpha}_g$	Constant government expenditure growth rate	0.03
2.	α_{mg}	Growth parameter in the demand for mortgages	0.04
3.	b_{cbd}	Demand for bills by the central bank	260
4.	b_{cbs}	Supply of bills to the central bank	260
5.	b_d	Total demand for bills	3510
6.	b_{hd}	Household demand for bills	3250
7.	b_{hs}	Supply of bills to households	3250
8.	b_s	Total supply of bills by the government	3510
9.	be	Bank equity	1200
10.	β_1	Real estate supply autonomous argument	-0.0996
11.	β_2	Real estate supply price-cost factor	0.00547
12.	cn	Nominal consumption	5200
13.	cn_x	Real household consumption	cn/p
14.	δ_{epv}	Parameter in expectation formations on wealth growth	0.005
15.	δ_{rm}	Term deposit interest adjustments	-0.0015
16.	δ_{rmg}	Interest markup for mortgage on deposit rate	0.003
17.	ϵ_v	Parameter in expectation formations on wealth growth	0.02
18.	f_{cb}	Central bank “profits”	9.10
19.	g	Pure government expenditures	1152
20.	g_x	Real government expenditure	g/p
21.	γ_{mg}	Parameter influence of real mortgage demand	0.000012
22.	γ_{rate}	The growth rate of the influence factor of default rate on mortgage rates markup	0.005
23.	γ_{rmg}	Influence factor of default rate on mortgage rates markup	0.15
24.	gr_n	Rate of population growth	0.06

continued ...

... continued

	Parameter	Description	Value
25.	gr_{np}	Rate of productivity	0.03
26.	h_{hd}	Households demand for cash	260
27.	λ	Percentage of consumption held in cash	0.05
28.	λ_{20}	Parameter in households demand for bills	0.256
29.	λ_{21}	Parameter in households demand for bills	1.10
30.	λ_{22}	Parameter in households demand for bills	2.20
31.	λ_{23}	Parameter in households demand for bills	1.10
32.	λ_{30}	Parameter in households demand for real estate	0.215
33.	λ_{31}	Parameter in households demand for real estate	1.10
34.	λ_{32}	Parameter in households demand for real estate	1.10
35.	λ_{33}	Parameter in households demand for real estate	2.20
36.	m_d	Household demand for deposits	2700
37.	mg_d	Mortgage debts demand (stock)	3732.057
38.	n	Employment level	63.99
39.	$npmg$	Amount of real estate defaulted	167.943
40.	$npmg_r$	Fraction of mortgages defaulted	0.045
41.	p	General price level	3.015
42.	p_r	Equilibrium price of real estate	60
43.	$\overline{\pi_b}$	Fixed bank profit margin realized	0.10
44.	$\overline{\pi}$	Expected price inflation	0.01
45.	$\overline{r_b}$	Exogenously interest rate on bills	0.035
46.	r_d	Realized demand for real estate	100
47.	r_m	Rate of interest on deposits	0.0335
48.	r_{mg}	Mortgage rate of interest	0.0365
49.	$\overline{r_r}$	Expected constant rate of return on real estate	0.045
50.	r_s	Total real estate supply	100
51.	ra_d	Realized demand for real estate	97.201
52.	rep	Mortgage debts repayment	74.6412
53.	ρ_{mg}	Percentage of accumulated mortgage debts repaid	0.02
54.	σ	Equilibrium housing price factor	0.0088

continued ...

... continued

	Parameter	Description	Value
55.	$\overline{\sigma}_g$	Labour productivity in the goods and government sectors	20
56.	σ_{ggr}	Growth rate of labour productivity in the goods and government sectors	0.03
57.	$\overline{\sigma}_r$	Labour productivity in the goods and government sectors	1
58.	σ_{rgr}	Growth rate of labour productivity in the real estate sector	0.01
59.	τ	Mark-up pricing	0.005
60.	θ	Household tax rate	0.22844
61.	uc_g	Unit cost of goods and government sectors	3
62.	v_g	Government expenditure	3510
63.	v_h	Wealth of households	9510
64.	v_{inv}	Investible wealth of households	13150
65.	v_{inv}^e	Expected investible wealth of households	13413
66.	v_x	Real wealth of households	v_h/p
67.	$\overline{w}$	Wage rate	60
68.	w_{gr}	Growth rate of wages	0.05

2.B Equations of the Model

$$B_h + B_{cb} \equiv B \quad (2.3)$$

$$V_h \equiv R_d \cdot p_r + V_g \quad (2.4)$$

$$NPMG + MG + V_h \equiv R_d \cdot p_r + H + M + B_h + BE \quad (2.5)$$

$$M + BE \equiv NPMG + MG \quad (2.6)$$

$$B \equiv V_g \quad (2.7)$$

$$H \equiv B_{cb} \quad (2.8)$$

$$\begin{aligned} \Delta R_d \cdot p_r + C + T + r_{mg-1} \cdot MG_{-1} + \Delta H + \Delta M + \Delta B_h \\ \equiv Y + r_{m-1} \cdot M_{-1} + r_{b-1} \cdot B_{h-1} + \Delta MG \end{aligned} \quad (2.9)$$

$$Y \equiv \Delta R_d \cdot p_r + C + G \quad (2.10)$$

$$r_{m-1} \cdot M_{-1} + F_b \equiv r_{mg-1} \cdot MG_{-1} \quad (2.11)$$

$$\Delta NPMG + \Delta MG \equiv \Delta M + F_b \quad (2.12)$$

$$G + r_{b-1} \cdot B_{-1} \equiv T + F_{cb} + \Delta B \quad (2.13)$$

$$F_{cb} \equiv r_{b-1} \cdot B_{cb-1} \quad (2.14)$$

$$\Delta B_{cb} \equiv \Delta H \quad (2.15)$$

$$\Delta R_d \cdot p_r + \Delta NPMG \equiv \Delta R_d \cdot p_r \quad (2.16)$$

$$r_{b-1} \cdot B_{-1} \equiv r_{b-1} \cdot B_{h-1} + r_{b-1} \cdot B_{cb-1} \quad (2.17)$$

$$\Delta B_h + \Delta B_{cb} \equiv \Delta B \quad (2.18)$$

$$p_r = \left(1 + \sigma \cdot \left(\frac{\Delta R_d}{R_{d-1}} - \frac{\Delta R_s}{R_{s-1}} \right) \right) \cdot p_{r-1}, \quad (2.19)$$

$$YP = Y + r_{m-1} \cdot M_{d-1} + r_{b-1} \cdot B_{hd-1}, \quad (2.20)$$

$$T = \theta \cdot YP, \quad (2.21)$$

$$YD_r = YP - T - r_{mg-1} \cdot MG_{d-1}, \quad (2.22)$$

$$YD_{hs} = YD_r + CG_h, \quad (2.23)$$

$$CG_h = \Delta p_r \cdot Ra_{d-1} + \Delta BE + CG_b, \quad (2.24)$$

$$V = R_d \cdot p_r - NPMG - MG_d + H_d + M_d + B_{hd} + BE, \quad (2.25)$$

$$v = \frac{V}{p}, \quad (2.26)$$

$$C = YD_r - \Delta p_r \cdot Ra_{d-1} - \Delta H_d - \Delta M_d - \Delta B_{hd} + \Delta MG_d, \quad (2.27)$$

$$c = \frac{C}{p}, \quad (2.28)$$

$$yd_r = \frac{YD_r}{p} - \pi \cdot \frac{V_{-1}}{p}, \quad (2.29)$$

$$\pi = \frac{p - p_{-1}}{p_{-1}}, \quad (2.30)$$

$$MG_d = MG_{d-1} \cdot (1 + \alpha_{mg} + \gamma_{mg} \cdot (p_{r-1})), \quad (2.31)$$

$$\alpha_{mg} = \alpha_g + \overline{pi}, \quad (2.32)$$

$$\gamma_{mg} = \overline{\gamma_{mg}}, \quad (2.33)$$

$$mg_d = \frac{MG_d}{p_r}, \quad (2.34)$$

$$REP = \rho_{mg} \cdot MG_{d-1}, \quad (2.35)$$

$$NPMG = npmg \cdot MG_{d-1}, \quad (2.36)$$

$$\frac{M_d}{V_{inv}^e} = \lambda_{10} + \lambda_{11} \cdot r_m - \lambda_{12} \cdot r_b - \lambda_{13} \cdot r_r, \quad (2.37)$$

$$\frac{B_{hd}}{V_{inv}^e} = \lambda_{20} - \lambda_{21} \cdot r_m + \lambda_{22} \cdot r_b - \lambda_{23} \cdot r_r, \quad (2.38)$$

$$\frac{p_r \cdot R_d}{V_{inv}^e} = \lambda_{30} - \lambda_{31} \cdot r_m - \lambda_{32} \cdot r_b + \lambda_{33} \cdot r_r, \quad (2.39)$$

$$r_r = \overline{r_r}, \quad (2.40)$$

$$V_{inv} = M_d + B_{hd} + p_r \cdot R_d, \quad (2.41)$$

$$NPMG + MG + V = p_r \cdot R_d + H + M + B_h + BE \quad (2.42)$$

$$V_{inv} = V + MG_d + NPMG - H_d - BE, \quad (2.43)$$

$$M_d = M_s, \quad (2.44)$$

$$M_s = MG_s + NPMG - BE, \quad (2.45)$$

$$V_{inv}^e = (1 + \epsilon_v) \cdot V_{inv-1}, \quad (2.46)$$

$$\epsilon_v = \epsilon_{v-1} \cdot (1 + \delta_{epv}), \quad (2.47)$$

$$p_r \cdot Ra_d = p_r \cdot R_d - NPMG, \quad (2.48)$$

$$H_d = \lambda \cdot C, \quad (2.49)$$

$$Y = C + G + \Delta R_d \cdot p_r, \quad (2.50)$$

$$y = \frac{C + G}{p} + \Delta R_d,$$

$$y = c + g + \Delta R_d, \quad (2.51)$$

$$W = W_{-1} \cdot (1 + w_{gr}), \quad (2.52)$$

$$\sigma_r = \sigma_{r-1} \cdot (1 + \sigma_{rgr}), \quad (2.53)$$

$$\sigma_g = \sigma_{g-1} \cdot (1 + \sigma_{ggr}), \quad (2.54)$$

$$N_r = \frac{D(r_d)}{\sigma_r}, \quad (2.55)$$

$$N_g = \frac{c + g}{\sigma_g}, \quad (2.56)$$

$$N = N_r + N_g, \quad (2.57)$$

$$WB = N \cdot W, \quad (2.58)$$

$$UC_r = \frac{W}{\sigma_r}, \quad (2.59)$$

$$UC_g = \frac{W}{\sigma_g}, \quad (2.60)$$

$$p = (1 + \tau) \cdot UC_g, \quad (2.61)$$

$$MG_s = MG_d, \quad (2.62)$$

$$F_b = r_{mg-1} \cdot MG_{d-1} - r_{m-1} \cdot M_{d-1}, \quad (2.63)$$

$$BE = BE_{-1} + F_b, \quad (2.64)$$

$$CAR = \frac{BE}{MG_s}, \quad (2.65)$$

$$r_m = r_b + \delta_{rm}, \quad (2.66)$$

$$r_{mg} = r_m + \delta_{rmg}, \quad (2.67)$$

$$CG_b = \Delta p_r \cdot \frac{NPMG_{-1}}{p_{r-1}}, \quad (2.68)$$

$$r_b = \bar{r}_b, \quad (2.69)$$

$$F_{cb} = r_{b-1} \cdot B_{cbd-1}, \quad (2.70)$$

$$B_{hs} = B_{hd}, \quad (2.71)$$

$$H_s = H_d, \quad (2.72)$$

$$B_{cbd} = H_s, \quad (2.73)$$

$$B_{cbs} = B_s - B_{hs}, \quad (2.74)$$

$$B_{cbs} = B_{cbd}, \quad (2.75)$$

$$G = p \cdot g, \quad (2.76)$$

$$g = (1 + \alpha_g) \cdot g_{-1}, \quad (2.77)$$

$$\alpha_g = \overline{\alpha_g}, \quad (2.78)$$

$$PSBR = G + r_{b-1} \cdot B_{s-1} - T - F_{cb}, \quad (2.79)$$

$$B_s = B_{s-1} + PSBR, \quad (2.80)$$

$$GD = B_{hs} + H_{hs}, \quad (2.81)$$

Chapter 3

Mortgages Repayment Determinants in the Real Estate Market

3.1 Introduction

While home ownership is a long-term goal of most Canadians,¹ not all mortgages are repaid. Several studies try to gain insight into the risk of default represented by the loan and borrower characteristics. Default is costly to nearly everyone, and therefore scholars and policy analysts have interest in this research area. When households default, they possibly stand to lose the equity they have built into the housing property. In addition, the federal institution (CMHC in Canada)² that guaranteed the mortgage, if applicable, and the lenders stand to lose when mortgages are defaulted. In most cases the foreclosure proceeds from the default are less than the value of the financial asset.

Most housing default studies have dealt with US data. Not enough housing research has been conducted using Canadian data. There are some differences between the housing market in the US and Canada. Mortgages in Canada are mostly Adjustable Rate Mortgages (ARMs). ARM mortgages are relatively new in the US housing market. The majority of mortgages in the US are locked in 30-year terms — known as Fixed Rate Mortgages (FRMs). ARM mortgages have a fixed rate of interest during their initial period, after which the rate readjusts. The most common period in Canada for ARMs is five years.³ With ARMs, the borrower is contractually obligated to pay off the outstanding mortgage balance at the end of five years term. Thus the borrower takes another

¹As in the US and other places all over the world.

²Canada Mortgage and Housing Corporation (CMHC) is a government-owned corporation that provides mortgage loan insurance, mortgage-backed securities, housing policy and programs, and housing research to Canadians.

³Though ARMs are underwritten for 5-year terms, mortgages are usually based on a 25-year amortization period. The government now uses the amortization period as a policy tool in regulating the housing market. The government eases the amortization period to make it easier for Canadians to purchase homes and tightens it to lower demand and slow down overheated housing market. The government increased the period from 25 years to 40 years in 2006 and then reduced it to 35 years in 2008, to 30 years in 2011 and now to 25 years in 2012.

loan, until the loan is fully paid. ARMs provide some advantages to the lender who at the end of mortgage term has no obligation to refinance or roll over the loan. If the lender at the end of the mortgage term determines that the borrower is no longer credit worthy, the mortgage is not renewed.

Apart from mortgage rate terms, mortgage liability is handled differently in the US and in Canada. In most US states mortgages are Non-Recourse where the liability of the mortgages is limited to the real estate property. Defaulters keep all the other assets they own and the banks get only the houses. In Canada mortgage loans are Recourse. If households default on their mortgage and the property is foreclosed, the lenders can go after their other assets and garnish future wages.

Another difference has to do with the tax policies in the US and in Canada. In the US, home owners are allowed to treat mortgage interest payments as tax deductible. This incentive induces Americans to spend as little as possible on mortgage payments with little incentive to pay off their mortgages. The rationale is that mortgage interest payments are lower than interest payments on other loans and investments and they are also tax deductible. This tax deduction is a saving for some homeowners, which they will forfeit if they pay off their mortgages. To the households losing the interest deduction it means that the return on the saved interest payments will be smaller. In addition, because of the low interest rates on mortgages, some households may be able to earn more by investing in higher return earning products.

These differences and others warrant a research on housing using Canadian data sources. The differences contributed to the different outcome of the sub-prime crisis in 2007. In part, the impact was lesser in Canada due to the nature of the housing market and the prudence of the banking sector. As stated by Jim Murphy, president of the Canadian Association of Accredited Mortgage Professionals, "The (mortgage) market here is much healthier, the lenders are more prudent in terms of their approval process

and Canadians are just more conservative in terms of their products.”⁴

At any point in time mortgage holders have five discrete mortgage repayment options available to them. Most borrowers will choose to continue to pay the agreed monthly amount required on the mortgage term. This is the normal case. In addition to making the normal payment contractually required, the borrowers can make an additional prepayment on the outstanding balance on the mortgage. Most Canadian mortgage lenders allow borrowers to make additional payments up to 20% over and above the monthly payment. Additionally the borrowers can pay at the end of the mortgage financial year an additional 20% of the total balance of the mortgage. This scheme is termed 20/20 by the banks.⁵ Households that are capable to make this payment choose this option because it saves them future interest payments. The additional future payments go to reduce the mortgage amount and build equity faster. Where such prepayment plan does not exist or where prepayment exceeds the allowable rate, lenders will typically charge a penalty on households who make such prepayments. The lenders institute prepayment penalties as a measure to reduce prepayment risk. If mortgage contracts are prepaid before the contract period, the lenders will not receive their full promised earnings.

The other payment option available is delinquency. When faced with declines in income or an increase in mortgage payment-to-income ratios households may choose to delay mortgage payment. Households become delinquent when they fail to make their contractual monthly mortgage payments. These households however do not default on the mortgage and resume payment in the future. The next repayment option is defaulting. This is distinguished from the delinquent case in that payment is not resumed. In this option, the lender takes possession of the defaulted real estate property. As in Zorn and Lea (1989), to capture the effect of default in a single-period model, it is

⁴In an interview with the Toronto Star published on Monday April 30, 2007.
<http://www.thestar.com/Business/Mortgages/article/208229>.

⁵Some financial institutions allow only 15% in each case — termed 15/15.

assumed here that the decision to default occurs at the time the household first ceases payment. Delinquency is considered less severe than default and there is less research in this area. Nevertheless, delinquency costs borrowers penalty charges, lower credit ratings and it causes emotional distress. For lenders, delinquency is as troublesome and costly as defaults (Sandor and Sosin, 1975). In Canada, the delinquency rate of real estate mortgage is nowhere near that of the US. Even with a recent significant jump in delinquency, the rate is far less than 1% in Canada as compared to the double digit percentage rate in the US. Figure 3.1 presents the graph of the quarterly data on delinquency rates in Canada compared to those of the US for the period from Q1 1991 to Q1 2010. For example, in Q4 2009, the delinquency rate on mortgages in Canada was 0.44% compared to 11.29% in the US. Due to the insignificant value of delinquencies in Canada, the DELINQUENT option of repayment is not included in this chapter's analysis which uses a Canadian-based data set.

The last repayment option available to households is paying off the entire balance on the ARM when it comes due for renewal. Though not a common option, occasionally a household may experience some windfall which will enable the household to pay off all outstanding mortgage loans. The repayment option⁶ is rare in Canada (Zorn and Lea, 1989) and is not used in the model in this chapter. For simplicity this chapter adopts the nomenclature of Zorn and Lea (1989) for the options. Namely, NORMAL, PREPAY, DELINQUENT, DEFAULT and REPAYMENT as respectively discussed. This chapter models the NORMAL, PREPAY, and DEFAULT options.

The purpose of this chapter is to use a Canadian national cross-section disaggregated data, Statistics Canada SHS (2005), to investigate the factors that determine and instigate households to prepay or to default on their mortgages. In addition to being

⁶Note that some researchers refer to this option as *prepayment*. The options of the model in Vandell and Thibodeau (1985) include a *prepayment* through refinancing, and a *prepayment* through resale.

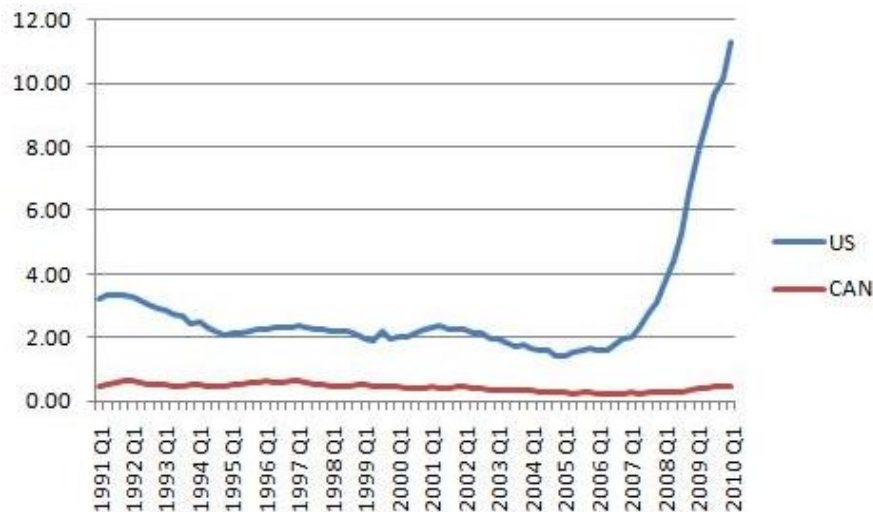


Figure 3.1: US/Canada mortgage delinquency rates

Source: Federal Financial Institutions Examination Council (FFIEC), Consolidated Reports of Condition and Income (1985-2000: FFIEC 031 through 034; 2001-: FFIEC 031 & 041) Q2 2008 data, September 2008 release; units are billions of dollars. Canadian Bankers Association. Number of Residential Mortgages in Arrears. DB50 PUBLIC, Q1 1990 to Q3 2010.

Canadian based, unlike other studies whose data are limited to one or to a few cities, the data used here is national. Thus we are able to examine default nation-wide. In studies that include the classes of payment options discussed here, the options are computed using utility functions basically examining mortgage repayment from the borrower's perspective. The results in this chapter can be used by lenders in predicting the default decisions of the borrowers.

In the next section, section 3.2, we briefly review some of the literature on mortgage defaults using classification and statistical methods. Section 3.3 presents the econometrics model. The data set and the proxies used in this research are discussed in section 3.4. Section 3.4 also presents the results of the econometrics test. The last section, section 3.5, presents the conclusion.

3.2 Literature Review

The availability of public aggregated and disaggregated data on residential borrowing and defaults has dictated the type of research studies on mortgage repayments and defaults. The available information on the borrowers is collected by lenders at the time of loan origination (ex-ante data) and is not the more desirable information contemporaneous with (at the time of) the default decision (ex-post data). Data contemporaneous with the default decision have been estimated through the use of proxy and other measures (Quercia and Stegman, 1992). The use of proxies varies from researcher to researcher. For instance, Vandell (1978) used the proxy measure *household income* to capture unemployment, death, and divorce.

There are several research areas related to mortgage payment options. One area is related to the investigation of default and delinquency from the perspective of the individual mortgage lender. In this area, empirical studies are conducted in an attempt to predict the possibility of borrowers defaulting on mortgages in the future based on the characteristics of the mortgage and borrowers at the time of the origination of the loan. This area has been the longest ongoing research programme on mortgages and default. It goes back as far as 1962 (Jung, 1962).

Earlier studies have concluded that delinquency and default rates are directly related to loan-to-value ratios (LTV), mortgage interest rates, housing expenses-to-income ratios, and the number of dependents. These studies also concluded that delinquency and default rates are inversely related with the age of the loan, the home equity, the purchase price, the age of the borrower, and the occupation of the borrower. Page (1964) was the first to provide empirical justification for these characteristics. However a recent study

examining the default experience of fixed-rate multifamily mortgages by Archer et al. (2002) suggests that LTV does not contribute significantly in explaining default. They rather found the borrower's ability to service the debt (the debt coverage ratio) to be more important in explaining default.

Later studies considered households to be rational and will consider other factors before making a default decision. Borrowers are likely to default if they expect negative home equity net of transaction costs such as sales commission and factors such as sentimental attachment to homes, a lower credit rating and the stigma of being a defaulter (Foote et al., 2008; Von Furstenberg, 1969). In his study, Von Furstenberg (1969) found home equity as the most important predictor of default risk. A household will not default but will rather sell off its house if the house has a positive equity. Negative home equity does not necessarily mean a household will default. Using Massachusetts data, Foote et al. (2008) found that only 6.4% of negative equity household subsequently foreclosed. The low default rate of negative equity is also attributed to the attempt of lenders to mitigate foreclosure-related losses by extending assistance to borrowers. The lenders' loss-mitigation strategies include *loan modification* where the terms of the loan, such as the outstanding balance or the interest rate, are adjusted to the benefit of the borrower and *forbearance* where the borrower receives only a temporary reduction of the monthly mortgage payment which is repaid at future date. Another main characteristic of the borrower that influences default is income. Von Furstenberg (1969) believes that the effect of household income on defaults captures the effect of the LTV ratio on default. Herzog and Earley (1970) conclude that the borrower age, marital status and number of dependents have no effect on delinquency or defaults. Morton (1975) however found a significant correlation between both delinquency and default when there are five or more dependents.

Some researchers have also examined the characteristics of household property on

defaults. Von Furstenberg and Green (1974) found that suburban locations are less likely to default than centrally located households. They also found that high unemployment rate areas have higher default rates. Surprisingly, high crime areas (captured using “per capita changes in crimes against property” in Pittsburgh) had no effect on default rates (Williams et al., 1974).

Mortgage default research in the 1970’s incorporated the economic theory of consumer behaviour. These studies model the behaviour of individual households who rationally decide whether to default or continue to make mortgage payment in the course of maximizing their utility. Most researcher use an optimization model of borrower choice. They use the *NORMAL*, *PREPAY*, *DELINQUENT* and *DEFAULT* options described in section 3.1. Borrowers choose the outcome that maximizes their utility over time. The set of options are mutually exclusive and there is simultaneity of mortgage payment decisions in these models. It is assumed the utility-maximizing choice s_i from the set $S = \{NORMAL, PREPAY, DELINQUENT, DEFAULT\}$ can be represented as a probability function $P = (s_i|X) = f_i(X)$, where the X ’s are the exogenous variables. Because of the simultaneity of the decision to continue payment, prepay, delay payment or default, the multinomial logit estimation is the ideal estimator for these models (Cunningham and Capone, 1990; Zorn and Lea, 1989).

Jackson and Kaserman (1980) used the net equity and cash flow (also know as ability-to-pay) approaches to test the optimization model. Net equity is the contemporaneous market value of the property less the contemporaneous market value of the loan. In the net equity approach households will choose to default if the home equity is negative after they have rationally assessed all financial costs and benefits. Thus they maximize their financial gain or minimize their financial loss that results from this decision. In the cash flow approach, households will refrain from defaulting on a loan as long as their income flow remains sufficient to meet the periodic payment without undue financial burden.

Jackson and Kaserman (1980), using ex-ante data obtained from the US Federal Housing Administration (FHA) file of individual loans insured under the Section 203(b)⁷ program, found that the net equity approach of default dominated the cash flow approach. They also found that loan-to-value ratios and the mortgage interest rate are positively related to default in both approaches. In particular the significance of the loan-to-value ratio in determining default probability was in-line with most research results on mortgage defaults. Elul et al. (2010) found that negative equity and illiquidity interact with each other to significantly determine mortgage default. They considered illiquid households as those with high credit card utilization rates. They also found unemployment shocks and a second mortgage to be associated with higher default risk.

Zorn and Lea (1989) primary interest in mortgage repayment was to make a comparison between ARM and FRM borrowers behaviour. Using data from the Canadian lender's loan portfolio for Hamilton and Toronto they were able show that, consistent with previous studies, the probability of default rises if borrowers have less net equity and increasing mortgage interest rates. The degree of influence of these variables on defaults was however small. Cunningham and Capone (1990) using American data used a similar method as Zorn and Lea (1989) to examine the difference between ARM and FRM. They pointed out that in using Canadian data no comparison could be drawn from between Canadian ARM and US FRM even though Zorn and Lea (1989) argued on page 130 that "Canadian borrowers are motivated by the same incentives as borrowers in the United States and that borrowers' marginal decisions remain largely unaffected by the differences between the two financial systems." Cunningham and Capone (1990) limited the option set to NORMAL, PREPAY, and, DEFAULT. Their results match expected

⁷FHA Loan Section 203(b) is the most popular FHA program. Interest rates on FHA loans are generally slightly higher than market rates, while down payment requirements are lower than conventional loans. Everyone, who has a satisfactory credit record, enough cash to close the loan, and sufficient income to make monthly mortgage payments can be approved for a Section 203(b) mortgage (see <http://www.fhatoday.com/203b.htm>).

mortgage related variables significantly. A falling current payment-to-income ratio and unemployment variables trigger an increase in defaults — a “negative” effect. But these variables are insignificant in the determination of prepayment. They also found current loan-to-value ratios to influence defaults but having an opposite effect on prepayment. This means households are more likely to default than prepay if net equity is low or negative and vice versa. In ARM and FRM comparison, based on the variables tested, Cunningham and Capone (1990) conclude that default experience results only from the contractual provisions of ARMs and not from borrower characteristics. The conclusion drawn by Cunningham and Capone (1990) about the US data on the ARM and FRM are however arguable in the Canadian context: “The expectation of lenders and insurers that ARMs have greater default risk than FRMs appears justified. In contrast, ARMs appear to have lower prepayment probabilities.” In Canada where ARMs are prevalent, because mortgage interests are not tax deductible and home sale does not attract large capital gains, household are more likely to make more prepayments. However, based on the importance of equity and mortgage interest rates in the default decision, Zorn and Lea (1989) also suggested that the default risk of ARMs in the US is likely to be higher than that of FRMs due to the fact that mortgage-related capital gains are less likely with frequently adjusting ARMs.

Other researchers (Evans et al., 1985; Quigley and Van Order, 1991, 1992) are also involved in studying mortgages from an institutional perspective. This originates from the fact that large mortgage loans are held by few institutions. Since mortgages are turned into securities, these studies are more concerned with estimating the probability that a particular fraction of a large mortgage loan pool will default than they are with modeling individual borrowers’ default decisions. These studies predominately use proportional hazard estimation methods to calculate default probabilities. The mortgage lenders (and investors) are concerned more about the measure of expected mortgage loss

than default rates since default rates are not an adequate measure of mortgage risk. For instance, default rates do not capture the fact that the proportion of dollars loaned that become losses in default varies by loan. The risk among defaulted loans varies significantly. Expected losses give a better fundamental for estimating mortgage insurance premiums and mortgage interest rate premiums.

Lenders will typically try to minimize losses and will normally choose to foreclose rather than renegotiate loans if they can minimize losses. Hence foreclosures are more likely if costs are lower. The ability of lenders to minimize losses relates to the jurisdiction in which the loans are given. For instance in the US, foreclosure costs are lower in states where power-of-sale foreclosure, foreclosure by advertisement and trustee's sale are permitted. In these states, lenders avoid costly court supervised foreclosures. Costs are also lower where the lenders are permitted to go after the borrower's personal assets to cover any deficiency in sales of the property (Clauretie, 1987). The characteristics of loans are factors in the estimation of risk of losses in loan pools. Price Waterhouse (1990) found that as the LTV ratio increases the negative effect of equity also increases, leading to defaults. Also smaller loans are riskier than bigger loans, indicating the fact that only high-income borrowers qualify for bigger loans.

Lastly, Giliberto and Houston (1989) research on defaults centered on life-cycle and economic events. These events may lead homes and mortgages to become suboptimal. When a home and/or a mortgage become suboptimal, borrowers may choose to default and relocate. Life-cycle events include marriage, divorce, death, and a change in job or a transfer of job location. Economic events include a decline in home value or a loss of job or income and an increase in housing costs, which make the mortgage payments excessively burdensome. Some researchers use the option pricing theory to investigate repayment. Default is considered as a put option and prepayment is considered a call option (Ambrose and Buttimer Jr., 2000).

Table 3.1 shows the results from the two studies using the multinomial logit regression method discussed in this section.

Table 3.1: Multinomial logit mortgage repayment research

	Dependent Variables	Data Source	Variable	Default	Prepay
Zorn and Lea (1989)	Default, delinquent prepay and make payment	Disaggregate, Canadian borrowers with rollover mortgages	Age of borrower	–	–NS
			Number of dependents	+	–NS
			Net equity	–NS	+
			Interest rate	–NS	–
			Household income	–NS	–NS
Cunningham and Capone (1990)	Default, prepaid, serviced loan ARMs and FRMs	Disaggregate, 879 loans originated 1962-85 (411 ARMs and 468 FRMs)	Contemporaneous LTV ratio	+	–
			Age of loan	+	+
			Rate spread (market & note)	–	–
			Borrower's age	+	–NS
			Payment-to-income ratio	–	–NS
			Net worth at origination	+	+
			Renter at origination	+	–NS
			Years employed at origination	–	–NS
			Regional unemployment rate	–	–NS
			Interest rate expectations	+	+
			Years between note-rate adjustments	–	+NS
			Cap or Spread expected adjustment	+NS	+
			Maximum lifetime cap	+	–NS
			Current note rate & original rate as % of lifetime cap	–	–NS
			Market & current note rate as % of period cap	–NS	–

Note: + = significant positive effect,
– = significant negative effect,
+NS = positive effect but not significant,
–NS = negative effect but not significant.

3.3 Theoretical Analysis

This chapter uses Canadian national cross-section disaggregated data to investigate the factors that influence housing defaults and prepayments using multinomial logistic regression. The model in this chapter uses the same mortgage repayment options in Cunningham and Capone (1990); Zorn and Lea (1989). However this chapter is different from these studies in several ways. These include (1) the method used in the derivation of the options based on proxies from the data set; (2) the use of national-based data set as compared to the typical mortgage studies data limited to one or too few cities; and (3) the choice of predictor variables.

The three options, NORMAL, PREPAY, and DEFAULT, are defined using unemployment, health and capability proxies derived from the data set. The use of unemployment and health (or sick) indicators as trigger proxy events for defaults is prevalent in empirical research on mortgage repayment. Other trigger proxy events are divorce and death (Giliberto and Houston, 1989; LaCour-Little, 2004; Vandell, 1978). Data contemporaneous with the default and prepayment decisions have been estimated through the use of proxy and other measures. As Quercia and Stegman (1992, p. 344) put it: “Unfortunately, the available information is collected by lenders at the time of loan origination (ex-ante data) and is not the more desirable information contemporaneous with (at the time of) the default decision (ex-post data).” Also on p. 351 they state that “researchers relied on the use of proxy measures, such as occupation for income variability, to capture the effect of factors believed to affect a household’s ability to pay and its equity position.”

Unemployment rate alone used outright as trigger for default has mixed results since unemployment rates mostly leads to delinquency and not foreclosure. Further, Danis

and Pennington-Cross (2005) and Pennington-Cross and Chomsisengphet (2007) found that delinquency marginally increases prepayments more than defaults. This provides the motivation for using both unemployment and health indicators as trigger proxies. In addition to the unemployment and health proxies, this chapter introduces the capability proxy. The capability proxy shows the relationship between the income and expenditure of the households. In this model, based on the data set, we derive these proxies to be as close to their macro-economic values. We calculate unemployment based on the number of weeks worked by the household in the reference year and the current Employment Insurance (EI) benefit indicator. We take into consideration cases where the reference person is single and also where the spouse of the reference person may be employed. The survey (Statistics Canada SHS, 2005) defines the household reference person as the member of the household who is mainly responsible for financial maintenance (*e.g.*, pays the rent, mortgage, property taxes, and electricity). Where the partner of the reference person works, we take the partner's total working weeks into the determination of the employability of the household. Because of the nature of the data set the computation of employability involves several factors. This includes taking into account non-response to working weeks of spouse, and the specification of zero working weeks. We consider the household to be unemployed if the total number of weeks worked is less than 50% of the number of potential weeks the household could be employed in addition to the current EI indicator.⁸ The potential number of weeks is 52 if the spouse is unemployed and 104 if otherwise. Our model assumes that households working less than 50% of the number of potential weeks and also currently receiving EI benefits are incapable of fulfilling their mortgage obligations optimally. At this point we do not assume that these set of households will default but that they are clearly in the set of potential defaulters

⁸In using EI benefit indicator, we assume that household is still receiving EI benefit and is still unemployed.

in the model. The basic benefit rate of EI benefit is 55% of the average insured earnings up to a yearly maximum insurable amount of \$43,200. This means one can receive a maximum payment of \$457 per week. In addition, EI payment is a taxable income, thus federal, provincial or territorial jurisdiction may deduct taxes from the benefit.⁹

A household is considered to have serious medical problems that impact their finances if that household spends 10% or more of its annual income from all sources on medical bills. In this model, such a household is considered to have *health problem*. The medical expenditure includes direct (out-of-pocket) costs and expenditures on insurance premiums. Since Canada has a provincial publicly funded health care plan, these expenses are the premiums on the publicly funded health care plus privately used health services. Canada spends approximately 10% of GDP on health care. This translates to total health spending per capita of \$3,953.¹⁰ The 10% calibration value for the health indicator is chosen to match the percentage of GDP spent on health care in Canada.

The *capability* trigger is computed from the total income of the household from all sources and the total expenditure of the household. We consider a household to be capable — that is the household is in a position to make a prepayment — if the total amount of income from all sources is at least 30% more than total expenditure.¹¹ Obviously such a household has more income to prepay mortgage loans. Once again, we do not assume such a household will make a prepayment but that the household is capable of doing so.

Equations 3.1, 3.2 and 3.3, specify the trigger proxies in summary as described above. The variables appearing in the equations are itemized below and are further discussed in section 3.4.

- EIFLAG is the employment insurance benefit indicator,

⁹For more details on EI benefit see: http://www.servicecanada.gc.ca/eng/ei/faq/faq_general.shtml.

¹⁰Data for 2007 adjusted for purchasing power parity, 'OECD Health Data 2009: How Does Canada Compare?' Available at: <http://www.oecd.org/dataoecd/46/33/38979719.pdf>.

¹¹Or conversely if the total expenditure the household incurs is less than 77% of the total income of the household.

- HHWEEKTOT is the total number of weeks worked by the primary respondent and the spouse,
- POTNL is the number of potential weeks the household could work when employed full-time,
- HHINCTOT is total household income from all sources,¹²
- L101 is the total health care cost incurred by the household,¹³ and
- TOTEXPEN is the total expenditure of the household for all goods and services.¹⁴

$$Unemployed_Indicator = \begin{cases} 1 & \text{if } (EIFLAG == 1) \text{ AND} \\ & (HHWEEKTOT < 0.50 * POTNL) \\ 0 & \text{otherwise} \end{cases} \quad (3.1)$$

$$Sick_Indicator = \begin{cases} 1 & \text{if } (L101 > 0.10 * HHINCTOT) \\ 0 & \text{otherwise} \end{cases} \quad (3.2)$$

$$Capable_Indicator = \begin{cases} 1 & \text{if } (HHINCTOT > 1.3 * TOTEXPEN) \\ 0 & \text{otherwise} \end{cases} \quad (3.3)$$

The trigger indicator proxies are used to define the repayment options of the model as follows: If a household has the sick or unemployed indicator set, the repayment option

¹²Includes income from wages and salaries, self-employment, net rentals, interest and dividends, all pensions, workers' compensation and employment insurance benefits, social assistance and income supplements, child tax benefits, goods and services tax credits, harmonized sales tax credits, provincial tax credits and miscellaneous regular income receipts.

¹³Includes direct (out-of-pocket) costs and expenditures on insurance premiums.

¹⁴Includes total current consumption, personal taxes, personal insurance payments and pension contributions, and gifts of money and contributions.

of such a household is set to *default*. For the rest of the households, any of them with the capable indicator set has repayment option set to *prepay*. All other households not in any of the aforementioned classification are deemed to not have any mortgage financial problem or advantage and continue to pay their mortgages as usual. This is termed the (*normal*) option. Equation 3.4 summarizes the options classification. The frequency counts of the options after being applied to the data set are presented in table 3.2.

$$Option = \begin{cases} 2 & \text{if (Sick or Unemployed)} \\ 1 & \text{if (Capable)} \\ 0 & \text{otherwise} \end{cases} \quad (3.4)$$

Table 3.2: Distribution of options

Options	Frequency	Percent
normal	4,343	86.32
prepay	416	8.27
default	272	5.41
Total	5,031	100.00

Note: Classification of options given by equations 3.1 to 3.4

Source: Processed from Survey of Household Spending for 2005, Income Statistics Division of Statistics Canada.

The household has to make a single decision among the 3 alternative unordered options. This is synonymous to the choice among means of transportation to work — train, bus, car, bicycle or walking. Whereas the choice of a household to prepay is based on willingness, the choice to default may be triggered by harsh economic circumstances. Nevertheless, defaulting is a choice the household makes. There are other actions that can be undertaken to avoid defaulting. But households will default if defaulting leads

to an increase in their utility. We seek to explain and predict the probability that a household with certain set of characteristics chooses one of the alternatives. Suppose the household i chooses j out of J unordered choices then the utility of the choice is:

$$U_{ij} = z'_{ij}\theta + \varepsilon_{ij} \quad (3.5)$$

The z'_{ij} 's include aspects specific to the individual and to the choices as well. The choice of j implies that U_{ij} is maximum among the J utilities. Households consider separately the utility obtained from each of the mortgage repayment options, and choose the option with the maximum utility. That is:

$$Prob(U_{ij} > U_{ik}) \forall k \neq j \quad (3.6)$$

This choice model is made operational by a particular choice of distribution. Because of the need to evaluate multiple integrals of the normal distribution, the logit model is more suitable. The logit model allows the estimated coefficients to be interpreted in terms of their implications for the utility of each option, as well as their influence on the choice probabilities. Let Y_i be a random variable that indicates the choice made, then if the J distribution is independent and identically distributed we have the multinomial logit model defined in equation 3.7. The estimated probability equations provide the set of probabilities for the $J + 1$ choices for a decision maker with characteristics w_i (Greene, 2008). The multinomial logit model is the most suitable model in our circumstance since there are 3 unordered choices. Most housing models with household unordered choices analyze the models with multinomial logit.

$$Prob(Y_i = j|w_i) = P_{ij} = \frac{e^{(w'_i\alpha_j)}}{1 + \sum_{k=1}^J e^{(w'_i\alpha_k)}}, \quad j = 0, 1, \dots, J \text{ and } \alpha_0 = 0 \quad (3.7)$$

The parameters α_j 's are specific to the j th alternative. The α_j 's in the alternative are set to zero to solve the logit problem. As will be seen later, Stata¹⁵ chooses the most frequent alternative as the referent group. A unique feature of multinomial logit model is that there is a single explanatory variable that describes the individual and not the alternative facing the individual (Hill et al., 2008). In this model the individual chooses one, and only one option. Estimation is by seeking the values of α_j 's that maximizes the log-likelihood function.

In the next section we present the details of the data set used in this chapter. We will also present the various characteristics or exogenous variable, the w_i , on which the model will determine their influence on the decision of the household (i) in selecting one of the $J + 1$ options, namely NORMAL, PREPAY, and DEFAULT.

¹⁵A general-purpose statistical software package created by StataCorp (www.stata.com).

3.4 Empirical Analysis

The data used in this chapter is the Survey of Household Spending for 2005 which was collected via personal interviews conducted in the first quarter of 2006 using a paper questionnaire. The information was on Canadian households spending habits, housing characteristics and household equipment during 2005. The data covered private households in the 10 provinces and in the three northern territories of Canada. Detailed information was collected about expenditures for consumer goods and services, changes in assets, mortgages and other loans, and annual income. The survey was conducted by the Income Statistics Division of Statistics Canada.

They were 21,331 household eligible for the survey and a total of 15,222 household results were usable. This gives a national response rate of 71.40%. For the purpose of our study only households who own their homes and have mortgages are included. The cross-section of households surveyed who own their homes is 10,332 (or 67.88%). This is in-line with the national average of home ownership which is more than two-thirds (68.4%) in 2006.¹⁶ The number of households that own their homes is identified by the indicator TENURYRP which is defined in the data set as “Housing tenure.” Of the 10,332 home ownership households in the survey, 5,031 owners had mortgage for the entire reference year up to December 31st. These are the households of interest in this research. Table 3.3 is the distribution of the home owners with mortgage by province (and territory). Note that the three territories are grouped into one entry. The sample size of 5,031 is large enough for the regression and no resampling technique, such as bootstrap, is employed to improve the accuracy of estimates of the model.

¹⁶See <http://www.statcan.gc.ca/daily-quotidien/080604/dq080604a-eng.htm>.

Table 3.3: Mortgage owing home ownership by province

	Province	Frequency	Percent
1	Newfoundland and Labrador	399	7.93
2	Prince Edward Island	224	4.45
3	Nova Scotia	445	8.85
4	New Brunswick	440	8.75
5	Quebec	619	12.30
6	Ontario	632	12.56
7	Manitoba	493	9.80
8	Saskatchewan	423	8.41
9	Alberta	508	10.10
10	British Columbia	601	11.95
11	Yukon/Northwest Territories/Nunavut	247	4.91
	Total	5,031	100.00

Source: Processed from Survey of Household Spending for 2005. Income Statistics Division of Statistics Canada.

The data set, for the purposes of this chapter, lacks some important data elements. The most notable variables that could enhance this research include interest rate at which the household acquired mortgages, the LTV, credit score and occupation. However, the survey provides other important areas for investigating mortgage defaulting and prepayment influencing factors.

We use macro data to compute interest rates for the data set. The year the household moved into the dwelling is used as the base year the household obtained the mortgage. The data related to this variable, YRMOVEDP, is highly summarized into year grouping. This grouping degrades the granularity of the interest rate. The source of the interest rate is from the monthly (percent) Canada Mortgage and Housing Corporation conventional mortgage lending rate for 5-year term.¹⁷ For each year grouping, namely 1970–1979, 1980–1989, 1990–2004, and 2005, we average out the mortgage lending rate and apply

¹⁷CANSIM Summary of Table 027-0015. Data is from the period January 1, 1951 to May 1, 2009.

to all households in that group. Hence there is a 1-to-1 mapping of interest rate to YRMOVEDP. Table 3.4 is the macro data lending interest rate as applied to the data set. The data is negatively skewed (in frequency) for the obvious reason that earlier home owners have finished paying off their mortgages than the later owners.

Table 3.4: Mortgage lending rates per period

Year	Mtge Rate	Frequency	Percent
Before 1970	6.983	63	1.25
1970–1979	10.606	194	3.86
1980–1989	13.546	518	10.30
1990–2004	8.293	3,973	78.97
2005	5.479	283	5.63
Total		5,031	100.00

Source: Processed from Survey of Household Spending for 2005. CANSIM Summary of Table 027-0015. Statistics Canada.

Additional dummy variables are defined for various non-continuous and aggregated qualitative data items. This allows the incorporation of qualitative information into the regression analysis enabling the interpretation of the regression with respect to a particular individual entry within the group. A dummy variable is assigned the value one to indicate the presence of an effect or membership in a group and the value zero to indicate the absence of the effect. The use of dummy variables increases the likelihood of events and results in a generally more powerful and stable model. The dummy variables generated from the data set are category and grouping based. We therefore exclude one of the dummy variables in the category from the model. If all the dummy variables in a category are included in the model we will have a perfect multicollinearity problem since all the dummy variables will sum up to one at every observation, in which case the regression will not be able to identify properly the coefficients.¹⁸ The dropped variable is

¹⁸It is as if we had a single variable always equal to one as in the case of the intercept. This problem

the baseline and the other dummy variables coefficients are interpreted as the difference from the baseline (Greene, 2008; Wooldridge, 2009).

The dummy variables are defined in table 3.5. Column 1 is the name of the variable with its definition as in the data set; column 2 is the new dummy variables derived from the survey variable and the third column is the variable set in the baseline and omitted from the regression. The definitions of the dummy variables are not necessarily one-to-one for all the groupings. For example, the data set categorizes TYPDWELP (Type of dwelling) into Single detached (1), Semi-detached (2), Row or terrace (3), Duplex (4), Apartment (5), and Mobile home or other (6) but the dummy variables for TYPDWELP are only Single detached (1) and Others (2 to 6). Note that the Stata package’s multinomial logit regression command by default looks for multicollinearity in the explanatory variables before the start of maximum likelihood iteration. If Stata detects collinearity, it will programmatically choose and omit unnecessary (baseline) variables. To have baseline selection control one has to explicitly choose and omit them prior to the regression.

Table 3.5: Dummy Variables

Variable	Dummies	Omitted
RPAGEGRP:	AGE_25_LESS	AGE_25_LESS
Age group of reference person	AGE_30_34	
	AGE_35_39	
	AGE_40_44	
	AGE_45_49	
	AGE_50_54	
	AGE_55_59	
	AGE_60_64	
	AGE_65_69	
	AGE_70_OVER	

continued ...

is known as the *dummy variable trap*.

Table 3.5 – continued from previous page

Variable	Dummies	Omitted
PROVINCP: Province or Territory	PROV_NFLD PROV_PEI PROV_NVSC PROV_NBRW PROV_QUEB PROV_ONT PROV_MAN PROV_SASK PROV_ALB PROV_BC PROV_TERR	PROV_TERR
RPHighestEdP: Highest level of education attained by reference person	EDUC_NO_DIPL EDUC_HSCH EDUC_DIPL EDUC_DEG	EDUC_NO_DIPL
RPMARP: Marital status of reference person	MARR_MARRIED_CL MARR_MARRIED_NVR MARR_SEP_DIV_WID	MARR_MARRIED_NVR
URBRUR: Urban Rural location	URBAN_LOC RURAL_LOC	RURAL_LOC
TYPDWELP: Type of dwelling	DWEL_SINGLE DWEL_OTHER	DWEL_OTHER
RPSEX: Sex of reference person	SEX_MALE SEX_FEMALE	SEX_FEMALE

Source: Processed from Survey of Household Spending for 2005. Income Statistics Division of Statistics Canada.

Additionally, the dummy variable HAVE_CHDN is defined to be 1 for households with children from age 0 to 17 years old and 0 otherwise. Table 3.6 shows the basic statistics of the variables used as predictor variables in the regression analysis. We exclude all parameters in the list on page 134 that were used in building the *Options* dependent

object. They are naturally biased to the *Options* parameter. The mean (μ_d) of a dummy variable is between 0 and 1, and it represents the proportion of cases that have a value of 1. That is the probability that a 1 will be observed for that dummy variable. The dummy variable's standard deviation (σ) is simply $[\mu_d * (1 - \mu_d)]^{1/2}$.

Table 3.6: Summary of predictor variables

Variables	Maximum (Minimum)	Mean (Std Dev)	Units of Measure
1 ADRENALT: Improvements - additions, renovations and alterations	250000 (0)	2884.40 (9440.98)	Dollars spent
2 NUMFTP: Number of full-time earners	2 (0)	1.149 (0.707)	1: One, 2: 2 or more
3 G040: Regular mortgage payments	60000 (0)	9635.60 (6124.19)	Dollars
4 NUMBEDRP: Number of bedrooms	5 (1)	3.238 (0.896)	Num of bedrooms
5 G010: Property taxes	16000 (0)	1875.17 (1231.84)	Dollars
6 mIntRate: Mortgage lending rate	13.546 (5.479)	8.748 (1.819)	Rate
7 ESTHHL: Moved to establish own household	1 (0)	0.074 (0.262)	0: No, 1: Yes
8 RPDisability: Reference person has a disability	1 (0)	0.104 (0.305)	0: No, 1: Yes
9 HHSZTOTP: Total household size	6 (1)	3.010 (1.322)	Persons
10 HAVE_CHDN: Household has children 0 to 17 years old	1 (0)	0.510 (0.500)	0: No, 1: Yes
11 PROV_NFLD: Household in Newfoundland and Labrador	1 (0)	0.079 (0.270)	0: No, 1: Yes
12 PROV_PEI: Household in Prince Edward	1	0.045	0: No, 1: Yes

continued ...

Table 3.6 – continued from previous page

	Variables	Maximum (Minimum)	Mean (Std Dev)	Units of Measure
	Island	(0)	(0.206)	
13	PROV_NVSC: Household in Nova Scotia	1 (0)	0.089 (0.284)	0: No, 1: Yes
14	PROV_NBRW: Household in New Brunswick	1 (0)	0.089 (0.283)	0: No, 1: Yes
15	PROV_QUEB: Household in Quebec	1 (0)	0.123 (0.329)	0: No, 1: Yes
16	PROV_ONT: Household in Ontario	1 (0)	0.126 (0.332)	0: No, 1: Yes
17	PROV_MAN: Household in Manitoba	1 (0)	0.098 (0.297)	0: No, 1: Yes
18	PROV_SASK: Household in Saskatchewan	1 (0)	0.084 (0.278)	0: No, 1: Yes
19	PROV_ALB: Household in Alberta	1 (0)	0.101 (0.301)	0: No, 1: Yes
20	PROV_BC: Household in British Columbia	1 (0)	0.120 (0.324)	0: No, 1: Yes
21	AGE_25_29: Respondent age in 25-29	1 (0)	0.067 (0.249)	0: No, 1: Yes
22	AGE_30_34: Respondent age in 30-34	1 (0)	0.120 (0.324)	0: No, 1: Yes
23	AGE_35_39: Respondent age in 35-39	1 (0)	0.151 (0.358)	0: No, 1: Yes
24	AGE_40_44: Respondent age in 40-44	1 (0)	0.190 (0.393)	0: No, 1: Yes
25	AGE_45_49: Respondent age in 45-49	1 (0)	0.150 (0.357)	0: No, 1: Yes
26	AGE_50_54: Respondent age in 50-54	1 (0)	0.129 (0.335)	0: No, 1: Yes
27	AGE_55_59: Respondent age in 55-59	1	0.081	0: No, 1: Yes

continued ...

Table 3.6 – continued from previous page

Variables		Maximum (Minimum)	Mean (Std Dev)	Units of Measure
		(0)	(0.272)	
28	AGE_60_64: Respondent age in 60-64	1 (0)	0.049 (0.217)	0: No, 1: Yes
29	AGE_65_69: Respondent age in 65-69	1 (0)	0.0213 (0.144)	0: No, 1: Yes
30	AGE_70_OVER: Respondent age in 70 plus	1 (0)	0.025 (0.157)	0: No, 1: Yes
31	EDUC_HSCH: Secondary (high) school diploma or equivalent	1 (0)	0.255 (0.436)	0: No, 1: Yes
32	EDUC_DIPL: Pre-university certificates or diplomas	1 (0)	0.345 (0.475)	0: No, 1: Yes
33	EDUC_DEG: University certificates or diplomas or degree	1 (0)	0.299 (0.458)	0: No, 1: Yes
34	MARR_MARRIED_CL: Married or common law	1 (0)	0.768 (0.422)	0: No, 1: Yes
35	MARR_SEP_DIV_WID: Separated, divorced, or widowed	1 (0)	0.144 (0.351)	0: No, 1: Yes
36	URBAN_LOC: Urban location	1 (0)	0.808 (0.394)	0: No, 1: Yes
37	DWEL_SINGLE: Single detached house	1 (0)	0.808 (0.394)	0: No, 1: Yes
38	SEX_MALE: Gender=Male	1 (0)	0.492 (0.500)	0: Female, 1: Male

Source: Processed from Survey of Household Spending for 2005. Income Statistics Division of Statistics Canada.

Table 3.7 shows the results from the regression from the multinomial logit execution. The entries represent the degree of influence that each independent variable has on the probability of default and prepayment relative to normal mortgage repayment. The values in the parentheses are the corresponding standard deviations. There are 5031

observations in this regression analysis. The regression is performed using Stata. Stata chooses the most frequently occurring group as the referent group. Following the values from table 3.2, Stata chooses the *normal* option as the referent group. The log likelihood of the fitted model is -2134.997 . This is used in the Likelihood Ratio Chi-Square test of whether all exogenous regression coefficients in the model are simultaneously zero. The goodness of fit Chi-Squared statistic is 668.39 with 76 degrees of freedom. Likelihood Ratio Chi-Square tests both equations of the models — namely, *default* relative to *normal* and *prepayment* relative to *normal*.

The null hypothesis is that all of the regression coefficients across both models are simultaneously equal to zero. In the solution of the model, the probability of getting a Likelihood Ratio test statistic as extreme as or more than the observed statistic under the null hypothesis is 0.0000 (the p-value). The small p-value from the Likelihood Ratio test, less than 0.00001, leads to a conclusion that at least one of the regression coefficients in the model is not equal to zero.

Table 3.7: Multinomial logit regression results

Variable: Description		Prepay Coefficient (Std Err)	Default Coefficient (Std Err)
1	ADRENALT: Improvements - additions, renovations and alterations	0.00000906** (0.00000414)	0.00000657 (0.00000686)
2	NUMFTP: Number of full-time earners	0.380*** (0.0927)	-1.839*** (0.133)
3	G040: Regular mortgage payments	-0.0000251** (0.0000113)	-0.000000187 (0.0000177)
4	NUMBEDRP: Number of bedrooms	-0.101 (0.0718)	0.0237 (0.0876)
5	G010: Property taxes	0.000170*** (0.0000528)	-0.000108 (0.0000972)

continued ...

Table 3.7 – continued from previous page

	Variable: Description	Prepay Coefficient (Std Err)	Default Coefficient (Std Err)
6	mIntRate: Mortgage lending rate	0.0429 (0.0314)	0.0523 (0.0351)
7	ESTHHL: Moved to establish own household	0.00639 (0.209)	−0.439 (0.338)
8	RPDisability: Reference person has a disability	−0.489** (0.220)	0.235 (0.179)
9	HHSZTOTP: Total household size	−0.225*** (0.0753)	0.119 (0.0915)
10	HAVE_CHDN: Household has children 0 to 17 years old	−0.0871 (0.174)	−0.0746 (0.242)
11	PROV_NFLD: Household in Newfoundland and Labrador	−1.0252*** (0.275)	0.749 (0.557)
12	PROV_PEI: Household in Prince Edward Island	−0.716** (0.350)	1.341** (0.592)
13	PROV_NVSC: Household in Nova Scotia	−1.128*** (0.263)	−0.136 (0.591)
14	PROV_NBRW: Household in New Brunswick	−1.0106*** (0.270)	0.902 (0.557)
15	PROV_QUEB: Household in Quebec	−1.280*** (0.251)	0.220 (0.571)
16	PROV_ONT: Household in Ontario	−1.137*** (0.240)	0.0154 (0.593)
17	PROV_MAN: Household in Manitoba	−1.415*** (0.275)	−0.134 (0.613)
18	PROV_SASK: Household in Saskatchewan	−0.885*** (0.257)	0.483 (0.590)
19	PROV_ALB: Household in Alberta	−0.336 (0.223)	0.861 (0.563)
20	PROV_BC: Household in British Columbia	−0.885***	0.578

continued ...

Table 3.7 – continued from previous page

Variable: Description		Prepay Coefficient (Std Err)	Default Coefficient (Std Err)
		(0.233)	(0.559)
21	AGE_25_29: Respondent age in 25-29	−0.308 (0.491)	−0.735 (0.508)
22	AGE_35_39: Respondent age in 35-39	0.221 (0.464)	−1.118** (0.500)
23	AGE_40_44: Respondent age in 40-44	−0.0668 (0.465)	−0.835* (0.479)
24	AGE_45_49: Respondent age in 45-49	−0.172 (0.472)	−0.886* (0.494)
25	AGE_70_OVER: Respondent age in 70 plus	.682 (0.557)	−1.318** (0.561)
26	EDUC_HSCH: Secondary (high) school diploma or equivalent	−0.441** (0.214)	−0.336* (0.204)
27	EDUC_DIPL: Pre-university certificates or diplomas	−0.242 (0.203)	−0.366* (0.200)
28	EDUC_DEG: University certificates or diplomas or degree	0.0541 (0.204)	−0.377* (0.228)
29	MARR_MARRIED_CL: Married or common law	0.676*** (0.235)	0.439 (0.281)
30	MARR_SEP_DIV_WID: Separated, divorced, or widowed	0.0753 (0.265)	0.183 (0.3018)
31	URBAN_LOC: Urban location	0.0533 (0.181)	−0.237 (0.180)
32	DWEL_SINGLE: Single detached house	0.0325 (0.144)	−0.122 (0.184)
33	SEX_MALE: Gender=Male	−0.0721 (0.107)	0.056 (0.140)
34	Constant	−1.801*** (0.633)	−1.756** (0.820)

* Significant at the 10% level.

** Significant at the 5% level.

*** Significant at the 1% level.

Source: Processed from Survey of Household Spending for 2005. Income Statistics Division of Statistics Canada.

From the set of predictor variables selected for the regression analysis, 9 variables influence the *default* option relative to the *normal* option and 17 variables influence the likelihood of *prepayment* relative to the *normal* option. The standard interpretation of the multinomial logit is that for a unit change in the predictor variable, the logit of outcome of option default (or prepayment) relative to *normal* option is expected to change by its respective parameter estimate (which is in log-odds units) given the other variables in the model are held constant. For example if the number of full-time earners were to increase by one person, the multinomial log-odds for defaulting rather than staying on the normal payment of mortgage would be expected to decrease by 1.84 unit while holding all other variables in the model constant. The constant parameter (line 34 of table 3.7) is the multinomial logit estimate for default and prepayment relative to normal when the predictor variables (lines 1 to 33 of table 3.7) in the model are evaluated at zero. The constant term in this model is significant for both the default and prepayment options. This implies apart from the chosen parameter values there are other additional variables of the model that may influence the default and prepayment of mortgages relative to the normal mortgage payment.

The results show that as a household puts more value into the housing, the more likely that the household will make a prepayment on the house. The coefficient of the improvements (ADRENALT) which includes additions to the property, renovations and improvement, is very small but nevertheless significant. Households typically take out equity from their homes for renovation purposes. In Canada, 40% of households took equity in their homes, amounting to \$12 billion, for renovation or home repair in 2008.

Some households were motivated to do these renovations due to the Home Renovation Tax Credit and other incentives provided by the provincial and central governments (Dunning, 2009).

As expected the larger the number of full-time earners in the household, NUMFTP, the less the household will default on mortgage (NUMFTP has a negative sign in the default equation). In addition, households with more full-time earners will have more income at their disposal to make prepayments. The NUMFTP predictor is related to the income of the household. It is expected that the more individuals in the household who work full-time, the more income the household makes. With more household income comes the likelihood of making more prepayments. Such households are less likely to default on their mortgages. The existence of more full-time wage earners may also signal households with greater income constraints. Archer et al. (2002b) used these constraints as the reason why the two-wage earners households were not significant in determining the default rate in their research. Von Furstenberg and Green (1974) found that increasing family income lowers the expected delinquency rate. Generally households with large income will make more prepayment and will not likely default on their mortgages.

The result of marital status goes to reinforce the role of double income households in relation to the repayment equations. As in the case of the number of full-time earners in the household, the result shows that households with married or common law couples at 99% confidence level are significantly more likely to prepay. The married indicator is not significant in the default equation. The divorce marital indicator is not significant in the repayment equations. The results also show that disability does not influence the default equation. However, the model states households with the primary respondent having disability are not likely to prepay. The granting of mortgage loans by the banks examines eligibility. Banks will grant loans to disabled persons if they meet the mortgage's requirements.

The model correctly predicts the relationship between mortgage prepayment and the amount of regular mortgage payments made by the household. The predictor variable G040, regular mortgage payments, is 95% significant in determining mortgage prepayment. Households that make large regular mortgage payments, in relation to their income, are left with less income to make prepayments hence the negative relationship. Even though not significant in the model, the sign of G040 in relation to default is appropriate. Households that have continually made higher regular mortgage payments have put a larger equity into their real estate investment and are less likely to default on them. The mortgage payment and its counterpart mortgage payment-to-income ratio have been found not to be significant as a predictor of defaults in both Herzog and Earley (1970) and Sandor and Sosin (1975).

The amount of property taxes paid on the home (G010) is found to be insignificant in the default equation but significant in the prepayment equation. The property taxes variable has a positive sign but small value in the prepayment equation. This signifies a small increase in prepayment when the assessed value of the property increases. The expectation is rather to have a decrease in prepayment as property value increases. If income is held constant, then the households now paying higher property taxes will have less income leftover to prepay mortgages. Zorn and Lea (1989, p. 132) model of household's utility maximization includes the assumption that "property taxes do not affect mortgage repayment decisions." Property taxes are the main source of income for the local government and are generally based on the assessed property value. Unpaid property taxes supersede the rights of the lenders' lien to the properties. Banks therefore care about payment of property taxes.

The total household size (predictor variable HHSZTOTP) is significant in the prepayment equation but not in the default equation. The bigger the size of the household the less likely the household will make a prepayment. A bigger family size has more

expenses associated with their income and will therefore have less money left after expenses to make prepayments. Surprisingly, the dummy variable HAVE_CHDN, stating if the household has children, is not significant in the repayment equations. Income is correlated with the number of children. Children, especially young ones, may require one parent staying home, and the payment of children activities or education. All these reduces the households income (Morton, 1975).¹⁹

All provincial indicators with the exception of Alberta do influence the prepayment equation. The provincial indicators have a negative coefficient in the prepayment equation. Thus there is a low propensity for Canadians to make prepayments. Canadian banks charge a penalty for prepayments on closed mortgages if a household decides to pay off the mortgage before the mortgage term ends or pay an amount greater than the allowable prepayment privileges. Most banks calculate the penalty to be the greater of three months interest on the outstanding mortgage balance or Interest Rate Differential (IRD) amount.²⁰ Mortgage terms are set to discourage prepayments in Canada. Households therefore make little or no prepayments at all as indicated by the results of the model. The model could not predict the prepayment behaviour of households in Alberta. Households in Alberta have the second highest GDP per capita of all provinces and territories. They may be more susceptible of making prepayments than other households in Canada. Northwest Territories has the highest GDP per capita in Canada but with only a GDP of \$4.7 billion compared to Alberta's GDP of \$263.5 billion.²¹

Prince Edward Island (PEI) is the only province that showed significance in the default equation. Households in PEI have a higher tendency to default on their mortgages.

¹⁹The variables number of children 0 to 4 (CH04D31) and number of children 5 to 17 (CH517D31) from which HAVE_CHDN was derived, individually are also insignificant in the repayment equations.

²⁰The IRD amount is equivalent to the difference between your annual interest rate and the posted interest rate on a mortgage that is closest to the remainder of the term less any rate discount you received, multiplied by the amount being prepaid, and multiplied by the time that is remaining on the term.

²¹Statistics Canada, CANSIM, table 384-0002 (2010 values).

PEI has the lowest GDP per capita of all provinces and territories in Canada. In the reference year, 2005, PEI had a GDP per capita of \$30,492. In 2010, the value had increased to \$34,400 but still the lowest in Canada.²² PEI receives more in per capita equalization payments than any province or territory in Canada. Aside from having the lowest GDP per capita, there might also be cultural differences why default is more prevalent in PEI.

The age group the primary household respondent belongs to influences the default equation but insignificant for prepayment equation. For all age groups, except for the youngest group in 25-29, show a negative correlation to default. Following this result, banks should be worried in advancing mortgage loans to households with primary applicant less than 30 years old. Cunningham and Capone (1990) include the borrower's age into their regression and found the borrower's age to be positively related to the default option. In their sample, the age of the borrower was in the range 21 to 77 years with mean age of 38. The results in this model is more related to those in Zorn and Lea (1989), where the age of the borrower yielded a significant but negative effect on default and delinquency but insignificant for prepayment. The effect of age is not conclusive across studies.

The level of education indicators is significant in the default equation. The results show that all education levels have propensity not to default on their mortgages. The higher the level of education is, the lower the propensity to default. The coefficient of the households with the primary respondent with secondary level education is -0.336 . That of pre-university respondents is -0.366 ; and the university level is -0.377 . The results also show that households with high school diploma as the highest level of education are not likely to make prepayments. All the other levels of education are not significant in

²²Statistics Canada, Table A.34 Gross domestic product per capita, Canada, provinces and territories, 2005/2006 to 2009/2010 (in current dollars).

the prepayment equation. These results are expected since education is highly correlated with income. Quercia and Spader (2008) found education to significantly predict default, but not prepayment. They also found households with a high school level education to be significantly more likely to default and not more likely to prepay.

A mortgage repayment predictor that has been found to be significant in other mortgage researches but not in this chapter is the mortgage lending rate (`mIntRate`). However not too many studies have use interest rate as a predictor for mortgage repayment. This is surprising given that the sub-prime crisis to a large extent is attributed to interest rates. Nevertheless, when used as a predictor, the lending rate has been found to be an important determinant of mortgage repayment. Our result may be due to the way in which the mortgage lending rates are calculated — a macro data that is further averaged for households based on the year the household moved into their dwellings. The derivation of the mortgage lending rate is discussed on page 140. In a mortgage valuation model which includes the potential for early prepayment and for default, Sharp et al. (2008) determined house prices and interest rates as the major determinants of mortgage repayment options. In their study, Igan and Pinheiro (2010) demonstrated interest rates and income as the major determinants of delinquency. Rising mortgage interest rates lead to an increase in delinquencies as more borrowers find it harder to make their payments. Jackson and Kaserman (1980) also found loan-to-value ratios and mortgage interest rates to be positively related to default in both the net equity and cash flow optimization models. Although the lending rates in this chapter are insignificant in the repayment equations, they do have the correct signs. An increase in interest rate will induce more defaults since it becomes burdensome to households when they renew their mortgages. Similarly, a lower mortgage rate implies that households having to pay less in mortgage loans thus increasing the possibility of them making more prepayments with the extra income.

3.5 Conclusion

This chapter investigated the determinants of housing mortgage repayment in Canada. The repayment options in this study are default, prepayment and normal. Most housing repayment studies use US based data set. This chapter uses the Canadian Survey of Household Spending for 2005 data set to determine the statistical significant predictors of default and prepayment relative to the normal mortgage payment option. The research is also enhanced with the definition of several dummy variables for qualitative variables in the survey. The empirical results establish that the traditional mortgage related predictor variables for repayment are statistically significant with the expected signs. We have been able to reproduce the results of studies that use a mortgage specific data set with data based on a general survey on household spending.²³

The research defined a dependent variable *Options* indirectly from existing independent variables of the data set. These variables are employment insurance benefit indicator, the total number of weeks the household worked, total household income and expenditure and the total health care cost incurred by the household. The aforementioned independent variables are used to compute the proxy indicators Unemployed_Indicator, Sick_Indicator and Capable_Indicator. The values of the *Options* dependent variable are derived from the proxy indicators. All the parameters used to compute dependent variable *Options* are excluded from the logit regression.

The general household spending survey micro data set has several predictors of repayment to choose from. Apart from the traditional variables, new and interesting potential

²³In general getting mortgage data, which is primarily held by financial institutions, is a difficult task. Mortgage research, and indeed other research, that require financial data can be carried out using publicly available data as proven by this study.

determinants are also examined. These new predictors include the province or territory where the household own their home, home improvements including additions and renovations done on the home, the amount of regular mortgage payments, property taxes, and the highest educational level of the primary respondent.

The results show that any predictor that goes to boost the income of the household increases the likelihood of the household making prepayment and simultaneously decreases the likelihood of the household defaulting on their loan obligations. The results infer that households in Canada generally do not like to make prepayments. This was significant in all provinces except Alberta — the highest per capita GDP province in Canada. The lowest per capita GDP province in Canada, PEI, is the only province identified in the data set to have households who are more likely to default on their mortgages.

Of the insignificant predictors the outcome of the mortgage lending rate was the most perplexing. Nevertheless some researchers have also found the lending rate not to be significant. Having children has the potential of being income affecting but the independent variable relating to having children in the household is found not to be significant in the regression.

There are limits to our empirical approach that need to be mentioned. The technique of defining the repayment options used existing macro results which are both observable and well researched. It would have been more desirable if these indicators the options are based on were directly collected during the survey. In addition, the calculation of new variables such as the mortgage lending rate relied upon an existing variable in the survey. All these definitions of variables can potentially lead to multicollinearity problems. We relied on the Stata package to solve the multicollinearity problem in the model. Problem collinearity variables are excluded from the regression. The insignificance of the mortgage lending rate may be due to the way in which it was computed, as explained on page 155. The availability of micro data related to the mortgage lending rate would have solved

this potential problem. Similarly, if the age of the respondents (primary and secondary) were not aggregated in groups during the survey, the true repayment behaviour on raw age would have been determined. Thus this research is limited by the necessity of using aggregate values to update borrower-specific variables. This compromises the empirical results. Notwithstanding, the empirical results presented in this chapter offer several insights into the household's repayment behaviour.

The survey data set is collected at the national level. This gives an opportunity of further work to compare how households in the various provinces react to the individual predictors. The comparison can be between the provinces or between a province and the national result. The survey used here was conducted before the subprime mortgage crisis. Using a more recent data could reveal new predictors. It is anticipated that the use of a newer data set will have little impact on the results attained here since the subprime mortgage crisis originated in the US housing sector. The crisis which led to mortgage delinquencies and defaults in the US however triggered adverse consequences to the Canadian financial sector and it would be of interest to examine the impact on a newer Canadian data set.

3.A Terms

AREUEA	American Real Estate and Urban Economics Association
ARM	Adjustable Rate Mortgage
CANSIM	Canadian Socio-Economic Information Management System (Statistics Canada)
CMHC	Canada Mortgage and Housing Corporation
EI	Employment Insurance
FHA	US Federal Housing Administration
FRM	Fixed Rate Mortgage
GDP	Gross Domestic Product
LTV	Loan-to-value ratio
OECD	Organization for Economic Co-operation and Development

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