The Role of Households' Collateralized Debt in Macroeconomic Stabilization

Jeffrey R. Campbell* Zvi Hercowitz†

September 2004

Abstract

This paper presents a macroeconomic model combining heterogeneity in time preference with the imposition of collateral constraints on households. The question analyzed is to what degree the financial reforms in the early 1980s, which lead to the relaxation of these constraints in the United States, can explain the subsequent decline in aggregate volatility. The model predicts a large fraction of the volatility decline in hours worked, output, household debt, and household durable goods purchases.

1 Introduction

This paper presents a macroeconomic model featuring collateral constraints on households. The purpose is to assess the implications of the financial reforms in the early 1980's, which relaxed these constraints, for aggregate volatility. The model combines trade between a patient *saver* and an impatient *borrower* with realistic features of most household loan contracts in the U.S.—such as a required downpayment and a rapid amortization. In equilibrium, the borrower household has no financial assets. Hence, when expanding purchases of home capital goods, it must borrow as well as increase labor supply to finance downpayments. Expanded labor supply persists because of debt repayment. Relaxing the collateral constraints—by reducing

*Federal Reserve Bank of Chicago and NBER e-mail: jcampbell@frbchi.org
†Tel Aviv University. e-mail: zvih@post.tau.ac.il

the downpayment rate or extending the term of the loans—weakens the link between durable purchases, debt, and labor, and results in lower variability of output.

The financial market reforms embodied in the Monetary Control Act of 1980 and the Garn-St. Germain Act of 1982 expanded households' options in mortgage markets. Among the new possibilities were refinancing and home equity loans with dramatically lower transactions costs. Practically, these new possibilities relaxed households' collateral constraints.[1]

The broad-based decline in macroeconomic volatility occurred a short time after these financial reforms. Because the decline was particularly dramatic in residential investment, Stock and Watson (2002, 2003) suggest the possibility of causality between these two phenomena. Examination of the behavior of household debt, reported below, supports the existence of such a link. Debt starts to accelerate at about the same time that macroeconomic volatility declines, and its volatility goes down along with the other variables'. Additionally, debt is strongly correlated with hours worked until the early 1980s, and much less so afterwards.

Our analysis of these issues builds on general equilibrium models with macroeconomic fluctuations driven by technology shocks. We stress the role of collateral constraints by first considering a version of the model with standard preferences and production possibilities. In this version, output volatility depends primarily on the variance of the technology shocks, as in the basic RBC model, given that the variation of inputs is relatively small. Hence, relaxation of the collateral constraints reduces output's volatility modestly, in spite of a large proportional reduction in that of hours worked. Following King and Rebelo (2000), we then introduce preferences and production possibilities that enhance the contribution of labor fluctuations to output. This version of the model predicts that relaxing collateral constraints does substantially reduce macroeconomic volatility.

The remainder of this paper proceeds as follows. In the next section, we discuss the history of household loan markets and their reforms. In Section 3 we present evidence on the cyclical behavior of household debt and its association with the decline of macroeconomic volatility. Section 4 presents a *borrower-saver* model, and in Section 5 the model's steady state is used to analyze long-run responses to financial market reforms. Section 6 builds

[1] For a detailed chronology of events leading to financial market deregulation, see Florida (1986), and the articles contained therein.

intuition by analyzing the borrower's labor supply decisions in partial equilibrium. The quantitative results from calibrated versions of the model are reported in Section 7. Section 8 contains a discussion of the links between this paper and the previous literature and Section 9 concludes.

2 A Long-Run Perspective on Household Debt Markets

Prior to the Great Depression, the typical mortgage offered by savings and loans institutions was mainly of the interest-only type, with the principal being refinanced every few years. Semer et. al. (1986) report that first mortgages had extremely low loan-to-value ratios, but second and third mortgages with higher interest rates were common. For other household durables, a multitude of finance companies provided installment credit through retailers for the purchases of automobiles, appliances and other durable goods during the 1920's. (Olney (1991)).

The Great Depression and its aftermath affected these two segments of the household lending market quite differently. Federal involvement in the mortgage market became massive, while consumer credit was regulated to a much smaller extent. Deflation during the depression period eroded housing values without affecting nominal balances due at maturity, so many borrowers were unable to find lenders to refinance their principles. The resulting defaults motivated the Hoover and Roosevelt administrations to exercise greater federal control over mortgage lending.

The Federal Home Loan Bank Act of 1932 and the Home Owners' Loan Act of 1933 established a new regulatory environment for savings and loans institutions. This regulation can be described as based on three elements: 1. Insulation of the mortgage market from the capital market, constraining savings and loans to raise funds mainly by short-term deposits, 2. The Federal Government became the lender of last resort for savings and loans institutions, and 3. Long-term *amortized* mortgages replaced the previous interest-only, periodically refinanced mortgages. The third implied a tightening of the collateral constraint on home lending, given that the previous mortgage didn't require amortization.

The maturity imbalance between savings and loans' long-term assets and short-term liabilities was enhanced in 1966 by the extension of Regulation Q to these institutions. This imbalance posed no challenge in a stable monetary environment, but the volatile financial markets of the late 1960's and 1970's pushed many savings and loans into insolvency. By 1980, Volker's monetary policy made the existing environment for savings and loans unsustainable, and compelled the federal government to abandon the New Deal financial system.

Restrictions on savings and loans were eased by Congress in the Monetary Control Act of 1980. Nevertheless, thrifts still remained unable to offer variable-rate mortgages or freely borrow in capital markets. The Garn-St. Germain Act of October 1982 eliminated these and other remaining restrictions, and at the same time opened mortgage lending to a wide variety of financial institutions. Mortgage lending was reintegrated with the capital market.

Figure 1 illustrates the implications of the developments of 1982, as well as the preceding financial distress, by presenting the ratio of mortgage debt to households' real estate, and the ratio of households' total debt to their real estate and other durable goods. From 1966 to the end of 1982, these ratios have a declining trend, while in early 1983 they start a dramatic increase. This surge reflects the emergence of the subprime mortgage lending market and households' greater use of home equity loans and mortgage refinancing to cash-out previously accumulated home equity. After 1995, the ratio of mortgage debt to households' real estate slowed down significantly. A possible interpretation of this stabilization is the convergence of the mortgage market to the new environment.

Although only the mortgage market underwent dramatic regulatory changes, also the automobile loan market was subject to long-run important evolution—probably due in part to the diffusion of information technology, such as credit scoring, that improved the terms of installment loans. For the 1920's, Olney (1991) reports typical terms of car loans of 1/3 down and a repayment period of 12-18 months. During the 1972-1982 period, the average figures are 13% down and repayment period of 40 months, while in the 1995-2003 period, the corresponding averages are 8% down and repayment period of 54 months.[2] Hence, credit markets finance a much larger fraction of households' stocks of collateralizable durable goods in the recent past than prior to 1983.

[2] The source of these observations is Federal Reserve Statistical Release G-19, Consumer Credit.

3 The Cyclical Behavior of Household Debt

The financial developments at the end of 1982 were followed not only by a fast increase in household debt—as suggested by the debt/stocks ratios in Figure 1—but also by a dramatic change in its cyclical behavior. The decline in macroeconomic volatility in the early 1980s, stressed in the literature, extends to household debt. Figures 2 and 3 show the cyclical behavior of household debt—total debt and mortgage debt, respectively—and its comovement with hours worked. Nominal debt is deflated by the GDP price index, and hours worked is an index of total private weekly hours. The three variables are logged and HP-filtered. The graphs show two remarkable phenomena regarding the cyclical behavior of household debt. First, debt's volatility declines dramatically in the early to mid 1980s—around the same time overall macroeconomic volatility declines as documented in the literature. Second, debt and hours worked comove strongly until the early 1980's, while afterwards, their movements became much less synchronized.

Tables 1 and 2 summarize these two phenomena quantitatively. Three periods are considered: (1) From the beginning of the sample in 1964:I through 1982:IV—the quarter corresponding to the Garn-St. Germain Act, (2) From 1983:I onwards, and (3) From 1995:I onwards. The latter period was interpreted in Section 2 as corresponding to the convergence of the mortgage market to the reforms of 1982. Clearly, we do not precisely identify this date.

Table 1 reports the volatility of total household debt and mortgage debt, along with those of other key macroeconomic variables, in these three periods. The standard deviation of total debt declines from 3% in the period through 1982:IV, to 0.7% from 1995:I onwards. The corresponding figures for mortgage debt are 2.5% and 1%, respectively. Table 1 also illustrates the decline in general macroeconomic volatility reported in the literature. The standard deviation of hours worked goes down from 2.2% to 0.9%. Stock and Watson (2002, 2003) stress that the decline in investment's volatility reflects primarily residential investment. Its standard deviation falls from 13.6% to 2.5%, while the standard deviation of nonresidential investment drops from 5.3% to 3.6%. The behavior of the remaining variables is consistent with prior results in the literature. The standard deviations of durable consumption expenditures, nondurable consumption expenditures, and GDP all fall substantially following 1983; and they are lower still in the post 1994 period.

Table 2 documents an even more dramatic change in the cyclical behavior of household debt and hours worked. Prior to 1983, the correlation coefficients of household debt with hours worked are 0.90 and 0.87 for total and mortgage debt, respectively. These correlations are substantially lower in the post-1982 sample, and they are nearly zero in the post-1994 sample. Thus, the link between hours worked and debt may have broken down sometime after 1982.

Finally, Figures 4 and 5 show the debt and hours worked in levels for the two definitions of the debt. The variables are expressed in per-capita terms, using the civilian noninstitutional population, 16 years and older. The debt corresponds to nominal values deflated by the GDP price index, base year 2000. The figures display a clear breaking point in the behavior in the debt in 1983:I, when it begins to grow at a faster rate. This is consistent with Figure 1 regarding the debt/durable goods ratios. Interestingly, hours worked seems to have a break point around the same time. From a modest declining trend prior to 1983, hours worked per-capita begin to trend up.

The evidence presented in this section indicates that the financial reforms of the early 1980's coincided with substantial macroeconomic changes. First, the levels of households' debt and hours worked increase. Second, the volatility of most macroeconomic time series declined. This is particularly the case for household debt, residential investment and hours worked. Third, the strong positive comovement between hours worked and debt largely diminished. The remainder of this paper develops a macroeconomic model in which most of these changes arise endogenously following an exogenous reduction of the ownership stake required for the consumption of housing and other durable goods.[3]

[3] Of course, other events of the early 1980's could account for these changes. For discussions of explanations focusing on other factors, see McConnell and Perez-Quiros (2000), Blanchard and Simon (2001), Kahn, McConnell and Perez-Quiros (2002), and Stock and Watson (2002, 2003).

Table 1 Volatility Statistics				
Percent Standard Deviations of HP-filtered Data – US 1964:1–2003:I				
	1964:I-1982:IV	1983:I-2003:I	1995:I-2003:I	1964:I-2003:I
Total Debt	3.01	2.02	0.72	2.56
Mortgage Debt	2.55	1.89	0.95	2.25
Hours Worked	2.23	1.45	0.88	1.87
Residential Investment	13.60	5.82	2.45	10.44
Non-Residential Inv.	5.27	4.27	3.57	4.78
Durable Consumption	5.70	3.31	2.11	4.66
Non-Dururable Cons.	1.40	0.83	0.64	1.14
GDP	1.97	1.11	0.92	1.59

Table 2 Comovement of Hours Worked with Household Debt				
Correlation Coefficients of HP-filtered Data – US 1964:I-2003:I				
	1964:I-1982:IV	1983:I-2003:I	1995:I-2003:I	1964:I-2003:I
Total Debt	0.90	0.56	−0.13	0.79
Mortgage Debt	0.87	0.39	0.17	0.70

4 The Borrower-Saver Model

The main feature of the model is the combination of heterogeneity in time preference and the imposition of collateral constraints on household borrowing. Household debt reflects intertemporal trade between two households, an impatient *borrower* and a patient *saver*. We denote their rates of time preference with ρ and ϱ, where $\rho > \varrho$. Debt collateralized by homes and vehicles accounted for 85 percent of total U.S. household debt in 1962 and for almost 90 percent in 2001.[4] In the model economy, durable goods collateralize all

[4]From the Survey of Financial Characteristics of Consumers, conducted in 1963, Projector and Weiss (1966), Table 14, report that homes and real estate secure 77% of household debt, and automobiles another 8%. Using data from the 2002 Survey of Consumer Finances, Aizcorbe, Kennickell, and Moore (2003) report that borrowing collateralized by residential property account for 81.5% of households' debt in 2001 (Table 10), and installment loans, which include both collateralized vehicle loans and unbacked education and other loans, amounts to an additional 12.3%. Credit card balances and other forms of debt account for the remainder. The reported uses of borrowed funds (Table 12) indicate that vehicle debt represents 7.8% of total household debt, and, hence, collateralized debt

consumer debt.

Without collateral constraints, the patient saver lends to the impatient borrower; and the debt increases over time. In the limit the borrower does not consume and works to only service debt. Consequently, such an economy possesses no steady state. Imposing collateral constraints limits the borrower's debt, so the economy possesses a (unique) steady state with positive consumption by both households. In general, the borrower's collateral constraint may bind only occasionally. However, it always binds if the economy remains close to its steady state; so standard log-linearization techniques can characterize its equilibrium for small disturbances. This is the path we follow below.

The remainder of this section proceeds to present the economy's primitives, discusses the borrower's and saver's optimization problems, and defines a competitive equilibrium.

4.1 Preferences

The borrower's preferences over random sequences of durable and nondurable consumption and leisure are

$$E\left[\sum_{t=0}^{\infty} e^{-\rho t}\left(\theta \ln \hat{S}_t + (1-\theta)\ln \hat{C}_t + \varphi \ln\left(1-\hat{N}_t\right)\right)\right], \qquad 0<\theta<1,\ \varphi>0, \tag{1}$$

where $\hat{S}_t$, $\hat{C}_t$ and $\hat{N}_t$ represent the borrower's consumption of the two goods and labor supply.

The saver's preferences differ from those of a borrower in two respects: the rate of time discount is strictly smaller, i.e., $\varrho < \rho$, and it does not involve labor supply. The latter is an approximation to a situation where the saver's accumulated wealth is large enough so that the labor supply decision is quantitatively unimportant, both for her problem and for the economy's equilibrium. The saver's preferences are given by

$$E\left[\sum_{t=0}^{\infty} e^{-\varrho t}\left(\theta \ln \tilde{S}_t + (1-\theta)\ln \tilde{C}_t\right)\right]. \tag{2}$$

(by homes and vehicles) represents almost 90% of total household debt in 2001.

In (2), $\tilde{S}_t$ and $\tilde{C}_t$ are the saver's consumption of durable and nondurable goods, respectively.

4.2 Technology

The aggregate production technology is represented by a Cobb-Douglas production function with constant returns to scale:

$$Y_t = K^{\alpha} \left(A_t N_t\right)^{1-\alpha}, \qquad 0 < \alpha < 1, \tag{3}$$

in which Y_t is output, K is the capital stock, assumed to be constant, N_t is labor input, and A_t is an index of productivity. The assumption that K is constant simplifies the analysis. It reduces the complexity of the model in an aspect that is marginal in the present context, which focuses on household's capital goods. Additionally, capital stock movements are slow and thus not important for output volatility.

Output can be costlessly transformed into nondurable consumption and durable goods purchases. That is,

$$Y_t = C_t + S_{t+1} - (1 - \delta) S_t,$$

where C_t and S_t are the aggregate nondurable consumption and durable goods stock, respectively, at time t. The durable good is accumulated using a standard perpetual-inventory technology with depreciation rate δ.

The productivity shock follows the AR(1) stochastic process

$$\ln A_t = \eta \ln A_{t-1} + u_t, \qquad 0 \leq \eta \leq 1, \tag{4}$$

where u_t is an *i.i.d.* disturbance with zero mean and constant variance. We abstract from growth in this paper.

4.3 Trade

A large number of firms rent the fixed capital stock from households, purchase households' labor services, and sell output in perfectly competitive markets. The price of the nondurable consumption good is normalized to one, and the rental rate of capital and the wage rate are denoted by H_t and W_t.

The collateralizable value of the durable goods stock is generally less than its replacement cost, and given by

$$V_{t+1} = (1 - \pi) \sum_{j=0}^{\infty} (1 - \phi)^j \left(S_{t-j+1} - (1 - \delta) S_{t-j}\right). \tag{5}$$

Here, π is the fraction of a new durable good that cannot serve as collateral, and ϕ is the rate at which a good's collateral value depreciates. We assume that $\phi \geq \delta$, so that the good's value to a creditor declines at least as rapidly as its value to its owner. Collateral limits household borrowing. That is,

$$\begin{aligned} \hat{B}_{t+1} &\leq \hat{V}_{t+1}, \\ \tilde{B}_{t+1} &\leq \tilde{V}_{t+1}, \end{aligned} \tag{6}$$

where $\hat{B}_{t+1}$ and $\tilde{B}_{t+1}$ are the outstanding debts of the two households at the end of period t, and $\hat{V}_{t+1}$ and $\tilde{V}_{t+1}$ are the collateral values of their durable goods stocks.

To complete the model's market structure, we assume that unbacked state-contingent claims are unenforceable. Consequentially, the only security traded is one-period collateralized debt. Within this environment, the two households choose asset holdings, consumption of the two goods, and (for the borrower) labor supply to maximize utility subject to the budget and the borrowing constraints. Firms choose their outputs and inputs to maximize their profits. We now turn to the characterization of each of these decision problems.

4.4 Utility Maximization

The two types of households differ only in their preferences. However, the condition that the market in collateralized debt must clear implies that the borrowing constraint in (6) will bind for at most one type of household. We conjecture that at the steady state, (6) binds for the borrower. We examine fluctuations that remain close enough to the steady state so that the borrowing constraint always binds for the borrower but not for the saver. After characterizing the model's competitive equilibrium in the steady state, verifying that our conjecture is correct is straightforward. We now turn to the analysis of the borrower's and saver's utility maximization problems.

4.4.1 Utility Maximization by the Borrower

Consider first the borrower's problem given the assumption that (6) always binds. This allows us to replace $\hat{V}_{t+1}$ with $\hat{B}_{t+1}$ in (5) and rewrite this as

$$\hat{B}_{t+1} = (1-\phi)\,\hat{B}_t + (1-\pi)\left(\hat{S}_{t+1} - (1-\delta)\,\hat{S}_t\right). \tag{7}$$

Given $\hat{B}_0$ and $\hat{S}_0$, the borrower chooses state-contingent sequences of $\hat{C}_t$, $\hat{S}_{t+1}$, $\hat{N}_t$, and $\hat{B}_{t+1}$ to maximize the utility function in (1) subject to the debt accumulation constraint in (7), and the sequence of budget constraints

$$\hat{C}_t + \hat{S}_{t+1} - (1-\delta)\,\hat{S}_t \leq W_t \hat{N}_t + \hat{B}_{t+1} - R_t \hat{B}_t, \tag{8}$$

where R_t is the gross (real) interest rate on debt issued at date $t-1$. With a perpetually binding borrowing constraint, this household will never purchase productive capital. Hence, we can omit capital income from the borrower's budget constraint.

Denote the current-value Lagrange multiplier on (8) with Ψ_t, which will always be positive. If we then express the Lagrange multiplier on (7) as $\Xi_t \Psi_t$, then Ξ_t measures the value in units of either consumption good of marginally relaxing the constraint on debt accumulation. In addition to the two binding constraints, the optimality conditions for this utility maximization problem are

$$\Psi_t = \frac{1-\theta}{\hat{C}_t}, \tag{9}$$

$$1 - \Xi_t (1-\pi) = e^{-\rho} E\left[\frac{\Psi_{t+1}}{\Psi_t}\left(\frac{\theta}{1-\theta}\frac{\hat{C}_{t+1}}{\hat{S}_{t+1}} + (1-\delta)\left(1 - \Xi_{t+1}(1-\pi)\right)\right)\right], \tag{10}$$

$$W_t = \frac{\varphi}{1-\theta}\frac{\hat{C}_t}{1-\hat{N}_t}, \tag{11}$$

$$\Xi_t = 1 - e^{-\rho} E\left[\frac{\Psi_{t+1}}{\Psi_t} R_{t+1}\right] + (1-\phi)\, e^{-\rho} E\left[\frac{\Psi_{t+1}}{\Psi_t}\Xi_{t+1}\right]. \tag{12}$$

A state-contingent sequence of $\hat{C}_t$, $\hat{S}_{t+1}$, $\hat{N}_t$, $\hat{B}_{t+1}$, Ψ_t and Ξ_t that satisfies these, the two constraints, and the transversality conditions

$$\lim_{t\to\infty} E\left[e^{-\rho t}\Psi_t\right] = \lim_{t\to\infty} E\left[e^{-\rho t}\Psi_t \Xi_t\right] = 0 \tag{13}$$

is a solution to the borrower's utility maximization problem.

Equation (11) is the familiar labor supply condition. It can be used to stress the key role that durable goods have for labor supply in this model. Suppose that $\theta = 0$, so that all consumption goods are nondurable. In this case, the impatient household is completely disconnected from the capital market and $\hat{C}_t = W_t \hat{N}_t$ always. Substituting this into (11) yields

$$1 = \varphi \frac{\hat{N}_t}{1 - \hat{N}_t}.$$

Hours of work are constant. The income and substitution effects of *any* wage change, regardless of its persistence, always exactly offset. Thus, eliminating opportunities for intertemporal substitution eliminates labor supply fluctuations. In this sense, the opportunity to accumulate durable goods and to borrow against them fundamentally shape this economy's aggregate dynamics.

Equation (9) looks familiar, but the collateral constraint changes its interpretation. For an unconstrained household, such as the saver, it defines the value of relaxing the intertemporal budget constraint. The borrower does not have an intertemporal budget constraint, so Ψ_t represents only the marginal value of additional *current* resources.

With unlimited borrowing, the household equates the marginal rate of substitution between durable and nondurable goods with the relative price of durable goods. This is the condition that arises if we artificially set Ξ_t and Ξ_{t+1} to zero in (10). If we define $1 - \Xi_t (1 - \pi)$ as the net relative price of a durable good—the actual price less the benefit from relaxing the borrowing constraint by purchasing one more unit—then this condition has a similar interpretation.

Similarly, setting Ξ_t and Ξ_{t+1} to zero reduces (12) to the standard Euler equation, which equates the marginal rate of intertemporal substitution to the interest rate. When the collateral constraint binds, Ξ_t in (12) can be interpreted as the price of an asset which equals the payoff to additional borrowing—the violation of the standard Euler equation—plus the asset's appropriately discounted expected resale value.

4.4.2 Utility Maximization by the Saver

The utility maximization problem of the saver is standard, but we describe the solution here for the sake of completeness. Because the borrower never owns part of the capital stock if his borrowing constraint binds at all times, the saver must own all the capital stock in equilibrium. Hence, we impose this ownership directly on the saver. Given the constant stock, $\tilde{K}$, and her initial durable goods and bonds, $\tilde{S}_0$ and $-\tilde{B}_0$, the saver chooses state-contingent sequences of $\tilde{C}_t$, $\tilde{S}_{t+1}$ and $\tilde{B}_{t+1}$ to maximize utility subject to the sequence of budget constraints

$$\tilde{C}_t + \tilde{S}_{t+1} - (1-\delta)\,\tilde{S}_t - \tilde{B}_{t+1} \leq H_t \tilde{K} - R_t \tilde{B}_t. \tag{14}$$

The right-hand side of (14) sums the sources of funds, capital rental payments, and principle and interest income on her bonds. The left-hand side includes the three uses of these funds: nondurable consumption, accumulation of the durable good, and saving.

We denote the current-value Lagrange multiplier on (14) with Υ_t. The first-order conditions for the saver's utility maximization problem are

$$\Upsilon_t = \frac{1-\theta}{\tilde{C}_t}, \tag{15}$$

$$1 = e^{-\varrho} E\left[\frac{\Upsilon_{t+1}}{\Upsilon_t}\left(\frac{\theta}{1-\theta}\frac{\tilde{C}_{t+1}}{\tilde{S}_{t+1}} + 1 - \delta\right)\right], \tag{16}$$

$$1 = e^{-\varrho} E\left[\frac{\Upsilon_{t+1}}{\Upsilon_t} R_{t+1}\right], \tag{17}$$

and the budget constraint. Equation (16) equates the marginal rate of substitution between durable and nondurable consumption to the relative price, and (17), associated with the choice of $\tilde{B}_{t+1}$, is the standard Euler equation.

4.5 Production and Equilibrium

The representative firm takes the input prices as given and choose a production plan to maximize profits. Letting N_t denote labor used by the firm, profit maximization implies that

$$W_t = (1-\alpha)\, A_t^{1-\alpha}\left(\frac{K}{N_t}\right)^{\alpha}, \tag{18}$$

$$H_t = \alpha A_t^{1-\alpha}\left(\frac{K}{N_t}\right)^{\alpha-1}. \tag{19}$$

With the economic agents' maximization problems specified, we consider their interactions in a competitive equilibrium. Given the two types of households' initial stocks of durable goods, $\hat{S}_0$ and $\tilde{S}_0$, the stock of outstanding debt issued by the borrower and held by the saver, $B_0 = \hat{B}_0 = -\tilde{B}_0$, and the initial value of the technology shock, a competitive equilibrium is a set of state contingent sequences for all prices, the borrower's choices, the saver's choices, and the representative firm's choices such that both households maximize their utility subject to the given constraints, the representative firm maximizes its profit, and

$$N_t = \hat{N}_t, \tag{20}$$

$$K = \tilde{K}$$

$$Y_t = \tilde{C}_t + \hat{C}_t + \tilde{S}_{t+1} + \hat{S}_{t+1} - (1-\delta)(\tilde{S}_t + \hat{S}_t), \tag{21}$$

$$B_{t+1} = \hat{B}_{t+1} = -\tilde{B}_{t+1}. \tag{22}$$

That is, input, product, and debt markets clear.

5 The Deterministic Steady State

We now proceed to characterize the economy's steady state. In light of the substantial long-run increase in the ratio of debt to durable goods and in hours worked after 1983, we are particularly interested here in the level effects of changing the parameters of the collateral constraint, π and ϕ.

In the steady state, the saver's Euler equation immediately determines the interest rate, $R = e^{\varrho}$. The calculation of the remaining steady-state quantities and prices proceeds by computing first the borrower's hours worked. Because the borrower's preferences satisfy the balanced growth requirements of King, Plosser, and Rebelo (1988), this choice does not depend on W, the steady-state real wage. Given the borrower's hours worked and the fixed capital stock, the rental prices H and W follow immediately from the representative firm's optimality conditions.

We begin with the borrower's variables. With R in hand, the borrower's Euler equation immediately implies that

$$\Xi = \frac{1 - e^{-\rho}R}{1 - e^{-\rho}(1-\phi)} = \frac{1 - e^{\varrho-\rho}}{1 - e^{-\rho}(1-\phi)} > 0. \tag{23}$$

Hence, the collateral constraint on the borrower binds at the steady state, as conjectured in Section 4.4.[5] From (10), the borrower's ratio of durable to

[5]From (23), Ξ can be interpreted as the present discounted value of the violation of the standard Euler equation.

nondurable consumption is

$$\frac{\hat{S}}{\hat{C}} = \frac{\theta}{1-\theta} \frac{e^{-\rho}}{\left(1 - \Xi\left(1-\pi\right)\right)\left(1 - e^{-\rho}\left(1-\delta\right)\right)}. \tag{24}$$

As usual, this ratio depends negatively on the relative price of durable goods, which corresponds here to $1 - \Xi\left(1-\pi\right)$.[6] Using (23), $\hat{S}/\hat{C}$ can be expressed as function of the primitive parameters.

The collateral constraint in (7) immediately yields $B/\hat{S}$. Using this, $\hat{S}/\hat{C}$ from (24), the borrower's budget constraint (8), and the optimal labor supply condition (11), yields $\hat{C}$ as a linear function of W.

$$\hat{C} = W / \left[1 + (R-1)\frac{B}{\hat{S}}\frac{\hat{S}}{\hat{C}} + \delta\frac{\hat{S}}{\hat{C}} + \frac{\varphi}{1-\theta}\right]. \tag{25}$$

Given $\hat{C}/W$, the optimal labor supply condition (11) determines $\hat{N}$. Obtaining W, H, and all of the borrower's steady-state choices is then straightforward. The steady-state capital rental rate, outstanding consumer debt, and the steady-state versions of (14) and (16) then determine the saver's variables $\tilde{C}$ and $\tilde{S}$.

The steady state can be used to examine the long-run implications of changes in the collateral requirements. Lowering the downpayment rate, π, has no impact on Ξ and directly increases $\hat{S}/\hat{C}$ and $B/\hat{S}$. Hence, $\hat{C}/W$ decreases from (25), and N increases according to (11). Intuitively, lowering the downpayment rate reduces the net cost of durable goods to the borrower, inducing a shift towards durable goods and away from both nondurable consumption and leisure. Also, the ratio of household debt to the aggregate stock of durables, $B/\left(\hat{S}+\tilde{S}\right)$, the model's counterpart to the ratio plotted in Figure 1, increases as the downpayment rate declines.[7]

Lowering the rate of debt repayment, ϕ, has the same qualitative implications as reducing π. In this case, the effect in (24) on the net cost of durables works through Ξ. Thus, the changes in the model's steady state following a reduction in downpayment and repayment rates qualitatively replicates

[6]Note that (24) implies that a household facing a binding collateral constraint will direct its consumption more heavily towards durable goods than a household without such constraint, given that the net purchase price of durables is lower than 1 when $\Xi > 0$.

[7]The ratio $\tilde{S}/B$ declines along with $\hat{S}/B$. The effect on $\tilde{S}/B$ can be shown using the budget constraints of the two households, and $HK = \frac{\alpha}{(1-\alpha)}NW$.

the long-run changes in hours worked and debt observed in the U.S. economy after 1983. In Section 7, we evaluate quantitatively how these parameter changes affect the steady-state levels of these variables and the model's cyclical dynamics.

6 The Borrower's Labor Supply Decision

To develop intuition that will be useful to interpret the next section's results, we focus here on the borrower's response to wage changes in partial equilibrium. This discussion is simplified by assuming that $\phi = \delta$, i.e., there is no accelerated repayment. The downpayment is still required.

With $\phi = \delta$, it follows from the borrowing constraint in (7) that if the borrower starts off with no assets and no durables, that is, $\hat{B}_0 = \hat{S}_0 = 0$, then $\hat{B}_t = (1 - \pi)\hat{S}_t$ for all $t \geq 1$. Replacing $\hat{B}_{t+1}$ and $\hat{B}_t$ with $(1 - \pi)\hat{S}_{t+1}$ and $(1 - \pi)\hat{S}_t$, the budget constraint in (8) can be expressed as

$$\hat{C}_t + \pi \hat{S}_{t+1} \leq W_t \hat{N}_t + R_t \left[\pi - \frac{R_t - 1 + \delta}{R_t}\right] \hat{S}_t. \tag{26}$$

In this form of the constraint, the uses of the borrower's funds appear as nondurable consumption and downpayments on the desired stock of durable goods, and the sources of funds are labor income, $W_t \hat{N}_t$, and the value of the depreciated durable goods net of the current debt.

The first-order conditions can be combined to yield

$$e^{-\rho} \frac{\theta}{\hat{S}_{t+1}} = \frac{\varphi \pi}{W_t \left(1 - \hat{N}_t\right)} - \varphi e^{-\rho} E \left[\frac{R_{t+1}\left(\pi - \frac{R_{t+1} - 1 + \delta}{R_{t+1}}\right)}{W_{t+1}\left(1 - \hat{N}_{t+1}\right)}\right]. \tag{27}$$

Here, the marginal utility of durable goods consumption is equated with the utility cost of working to acquire the downpayment, less the expected utility in the following period from the leisure equivalent of accumulated equity, $(1 - \delta) - (1 - \pi) R_{t+1}$—which can be written as $R_{t+1}\left(\pi - (R_{t+1} - 1 + \delta)/R_{t+1}\right)$.

A key term in both equations is $\pi - (R_t - 1 + \delta)/R_t$—the difference between the downpayment rate and the conventionally defined user cost of durable goods. When the downpayment is higher than the user cost, the borrowing constraint forces the borrower household to acquire some ownership of its durable goods stock. We focus next on two cases regarding this term.

6.1 Full Collateral

A benchmark case consists of setting R_t equal to a constant, R, and setting the downpayment rate to $\pi = (R - 1 + \delta)/R$. This downpayment covers only the user cost, so we call this the case of *full collateral.* In the repayment period, the values of the outstanding debt and the depreciated durable goods stock are equal.

Consider the effects of changes in W_t. Because the last terms in both (26) and (27) are now equal to zero, these equations and the first order condition for $\hat{N}_t$ are satisfied only by an immediate and full adjustment of $\hat{C}_t$ and $\hat{S}_{t+1}$ to the wage change, while $\hat{N}_t$ remains constant. If the wage change is permanent, then these choices correspond exactly to those of a household facing no borrowing constraints. Here, however, this result holds regardless as to whether the change is permanent or transitory. An unconstrained household borrows to finance leisure when the wage falls temporarily, but this option is unavailable to the present household because borrowing must be backed by purchases of durable goods. Therefore, full collateral eliminates completely the variation of hours worked following wage changes.

6.2 Partial Collateral

When $\pi > (R - 1 + \delta)/R$, the borrowing constraint forces the borrower household to accumulate equity on its durable goods stock. Correspondingly, only a fraction of the durable stock can serve as collateral, and thus we label this case as one of *partial collateral*.

Here, when W_t changes, the choice of immediate proportional adjustment in $\hat{C}_t$ and $\hat{S}_{t+1}$ leaving $\hat{N}_t$ unchanged violates the budget constraint in (26)— given that the last term on the right is now positive. Hence, the adjustment of $\hat{C}_t$ and $\hat{S}_{t+1}$ is less than proportional to the wage. The optimal labor supply condition (11) and the decline of $\hat{C}_t/W_t$ imply that $\hat{N}_t$ is higher than its long-run level. This occurs for both permanent and transitory changes in wages.

The main conclusion in this section is that partial collateral generates variability in hours worked to wage changes while full collateral does not.

7 Quantitative Results

To assess the quantitative implications of this framework for macroeconomic volatility, we solve the model and simulate the impact of empirically relevant changes in household loan markets.[8] We consider first a regime of high collateral requirements, for which the parameters π and ϕ are matched to observations from the period 1964:I through 1982:IV. The effects of the financial market reforms in the early 1980s are then assessed by considering a regime of low collateral requirements, which is matched to observations from the period 1995:I–2003:I.

7.1 Calibration

Consider the parameters π and ϕ, which are the only ones to be assumed to differ across the two regimes. For the sample of high collateral constraints, the average term of a first mortgage for a new home purchase is 98 quarters, and the average term of a new car loan over the period 1971-1982 is 13.4 quarters.[9] The corresponding quarterly linear repayment rates are 0.01 and 0.075, respectively. We assume here and throughout this section that non-automobile consumer credit has the same loan terms as automobile loans. Using the shares of mortgage debt and consumer credit during the sample—0.7 and 0.3 respectively—ϕ is set at the weighted average of the two linear repayment rates, 0.03.[10]

The average loan-to-value ratios for home and car loans from the sample with high collateral constraints are 0.27 and 0.13. We calibrate π as a weighted average of these two downpayment rates. Without observations of the flow of loans extended for the purchase of newly constructed homes, we compute the weights indirectly. In a steady state, loans extended in each category should equal the principle repayment rate multiplied by the category's steady-state debt. Given the repayment rates and debt shares used to calibrate ϕ, the implied shares of home and automobile loans in total credit

[8] The solution procedure is a standard log-linearization technique.

[9] Evidence on the terms of mortgages comes from Federal Housing Finance Board's Interest Rate Survey. Federal Reserve Statistical Release G.19 reports the terms of new automobile loans.

[10] The decomposition of household debt into mortgage debt and consumer credit is from *Banking and Historical Statistics: 1941-1970.*

extended are 0.24 and 0.76.[11] The value of π is set at the weighted average downpayment rate of 0.16.

The values of π and ϕ for the low collateral constraints regime are more difficult to calibrate, because the available data on loan-to-value ratios and other home loan terms cover only first mortgages. For the period prior to 1983, these data are representative of the collateral constraints in this market, given the scarcity of refinancing and home equity loans options. The financial reforms in the early 1980s substantially widened these options, so that the terms of first mortgages cease to represent actual collateral constraints. In automobile finance, however, refinancing and second loans have never been prominent features. Hence, the terms of new car loans continue to reflect actual collateral constraints. During the 1995-2003 period, the average downpayment rate for cars fell five percentage points, and the average term of car loans increased to 18 quarters.

Given that the post-1982 credit market liberalization affected mainly the mortgage market, we assume that a decline in the effective downpayment for homes of 5 percentage points—the decline for car loans—is a conservative estimate. Hence, we set $\pi = 0.11$ for this regime. We assume that refinancing makes it possible to avoid home equity accumulation altogether. In this case, the mortgage repayment rate equals residential structures' physical depreciation rate, 0.0018. An 18 quarter auto loan term implies a linear repayment rate of 0.055. The appropriately weighted average of these two repayment rates is $\phi = 0.015$.

The remaining parameters are held constant across the two regimes. The production function elasticity α equals 0.3, the standard value for capital's share of income. The parameters of the exogenous productivity shock process are set as follows. Using the value $\eta = 0.95$ from Hansen and Prescott (2001), σ_η is calibrated so that the model's standard deviation of output matches its actual counterpart in the 1964:I–1982:IV sample. The resulting value is 0.0087. The same values of η and σ_η are then used in the simulation of the second regime. Durable goods' depreciation rate equals its empirical analogue, constructed from the Bureau of Economic Analysis' *Fixed Tangible Reproducible Wealth*. The value of δ is 0.0115, which is the appropriately weighted average of 0.0018 for residential structures and 0.034 for other durable goods.[12]

[11] The weight for homes is computed as $0.01 \times 0.7/(0.01 \times 0.7 + 0.075 \times 0.3) = 0.237$.

[12] The sample period used to estimate the two depreciation rates is 1964 through 2001.

We chose ϱ so that the quarterly interest rate is one percent. Because the borrower's discount rate does not influence the interest rate, its calibration is more difficult. We set $\rho = 0.015$, i.e., half of a percentage point higher than the interest rate. This degree of impatience is similar in magnitude to that used by Krusell and Smith (1998). Using a model with 3 levels of time preference, they calibrate the differences between each type as 0.36%; or 0.72% between the two extremes. We have experimented with various values for this parameter with almost identical results to those reported below.

The model's remaining parameters are θ and φ. We chose these simultaneously to match an average share of hours worked of 0.3 and the share of durable goods expenditure in total households' expenditures in the 1964:I-1982:IV sample of 0.2.[13] Given the other parameters and the collateral requirements in this period, the unique values of θ and φ that replicate these observations are 0.34 and 2.03. Table 3 summarizes the calibrated parameter values.

Table 3
Parameter Values

	Collateral requirements	
	High 1964:I-1982:IV	Low 1995:I-2003:I
π	0.16	0.11
ϕ	0.03	0.015
α	0.3	
η	0.95	
σ_η	0.0087	
δ	0.0115	
ϱ	0.01	
ρ	0.015	
θ	0.34	
φ	2.03	

The weights used were 0.76 and 0.24, which are the shares of owner occupied residential stock and consumer durables' stock, respectively.

[13]To calculate this ratio, we adjusted the NIPA's nondurable personal consumption expenditures by removing the imputed service flow of housing. This concept is matched to the model's $\hat{C} + \tilde{C}$. We then added residential investment to personal consumption expenditures on durable goods. This represents $(\hat{S}_{t+1} + \tilde{S}_{t+1}) - (1 - \delta)(\hat{S}_t + \tilde{S}_t)$.

7.2 Household Borrowing and Aggregate Dynamics

To illustrate how the model works, and in particular the dynamic behavior of household debt, we consider first the evolution of the two households' decisions in general equilibrium, with the model calibrated to the high collateral regime. Figure 6 plots impulse responses of the two households' nondurable and durable consumption, the borrower's hours worked and debt to a positive productivity shock of $1/(1-\alpha)$ percent. All the variables are expressed as percent deviations from their steady-state values.

The price responses are not shown since they are similar to those in the standard model. The technology shock directly shifts up labor demand, so the wage sharply rises and falls slowly to its steady-state level. The interest rate response has a similar shape, given the increased demand for consumption by both households, but it is very small given high interest sensitivity of both households.

The individual households' responses to the technology shock strongly reflect the intertemporal exchange between them. Although the technology shock increases the rental price of capital and thereby the saver's income, her durable purchases and nondurable consumption reflect the higher interest rate: durable consumption declines and nondurable consumption trends upwards. The saver's main reaction to the interest rate is to save by purchasing household debt. Thereby, she helps to finance a surge in the borrower's consumption. As in the partial equilibrium discussion in Section 6, the increase in hours worked by the borrower reflects partial collateral: Labor supply has to increase to finance durable purchases.

A peculiar characteristic of the borrower's behavior is that temporarily higher income induces the borrower to *increase* his debt—in sharp contrast with the response of a household in a standard model, or the saver in this model. The reason for this behavior is that impatience is assumed to be important enough for the collateral constraint to bind at all times. Hence, borrowing cannot be a vehicle for consumption smoothing. It is a component of the transaction of purchasing a durable good.

7.3 Collateral Requirements and Aggregate Volatility

Now we turn to the main issue in the paper: How important is the relaxation of the collateral constraints for aggregate dynamics? Figure 7 compares the impulse responses of the aggregate variables under the two regimes, high and low collateral constraints, to the same $1/(1-\alpha)$ percent increase in A_t.

In the low collateral regime, the responses of hours worked and the debt are of about half the magnitude of the responses in the high collateral regime. The response of hours worked reflects the mechanism discussed in Section 6: Moving closer to full collateral reduces the labor supply reaction to wage changes. The change in the response of the debt reflects mainly the decline in the repayment rate ϕ. When $\phi > \delta$, a young durable good has more collateral value than an old good. Given that the borrower fully exploits this collateral value, a positive shock that raises durable purchases increases the debt even more. Over time, as the average age of the durable goods returns to the steady-state, the debt converges to its long-run value. This overshooting is eliminated when $\phi = \delta$, because age is irrelevant for the collateral value of a durable good. Lowering the collateral constraint makes ϕ much closer to δ, and thus the overshooting of the debt is greatly reduced. The response of durable expenditures declines.

The large proportional decline in the response of hours worked, however, is translated into a small decline in the response of output, as shown in Figure 7. The reason is that given the standard utility and production functions, the response of hours worked is small, and hence output dynamics are dictated primarily by the exogenous productivity shock. In the next subsection we follow King and Rebelo (2000) and introduce preferences and production possibilities that enhance the contribution of labor fluctuations to output, and thereby reduce the exogenous variation of the shocks that is necessary to match the volatility of output to the data.

7.4 Collateral Requirements and Aggregate Volatility in a High-Substitution Economy

Here we adopt both Hansen's (1985) utility function and a production function with variable capital utilization. The borrower's utility function is now

$$E\left[\sum_{t=0}^{\infty} e^{-\rho t}\left(\theta \ln \hat{S}_t + (1-\theta)\ln \hat{C}_t + \gamma(1-\hat{N}_t)\right)\right],$$

where $0 < \theta < 1$ and $\gamma > 0$.[14] For the saver, there is no labor supply decision, so that the utility function remains the same.

The production structure is changed so as to increase the elasticity of output with respect to labor without changing the income shares of borrowers and savers. Assume that the production function is

$$Y_t = (M_t K)^{\alpha} (A_t N_t)^{1-\alpha}, \quad 0 < \alpha < 1,$$

where M_t is the composite

$$M_t = \left(\int_0^1 M(i)_t^{\zeta} di \right)^{1/\zeta}, \quad 0 < \zeta < 1,$$

of intermediate materials required for capital utilization. Each of these materials is purchased from a profit-maximizing monopoly that produces at the constant marginal cost. Savers own all the shares in these monopolies.

It can be shown that the optimal level of capital utilization is proportional to output, and thus the production function, solved for capital utilization, can then be expressed as

$$Y_t = \kappa A_t N_t,$$

where κ is a constant depending on K, α and the marginal cost of producing M. The elasticity of output with respect to labor is now unity, and thus there is no return to the ownership of K. However, labor's share in income is not one because the saver receives monopoly profits. These profits are the difference between total payments to the monopolies and their production costs. It can be shown that the share of savers and borrowers in income are, respectively, $\nu = \alpha(1-\alpha)/(1-\alpha^2)$ and $1 - \nu = (1-\alpha)/(1-\alpha^2)$.

Given that in this economy the capital share is ν, we now calibrate this parameter, and not α, as 0.3. Also the parameter σ_η is recalibrated. As for the basic economy, the criterion is that the simulated standard deviation of output in the high collateral regime equals the standard deviation of output in the 1964:I-1982:4 period. Given the high-substitution nature of this economy, this parameter is now reduced from 0.0087 in the baseline economy to 0.0038.

Figure 8 shows the impulse responses for the two regimes in this economy. Here, the difference between the high and the low collateral regimes are much

[14]For computational purposes, we actually use the form $\theta \ln \hat{S}_t + (1-\theta) \ln \hat{C}_t + \gamma \frac{(1-\hat{N}_t)^{1-\chi}}{1-\chi}$, with a very small value for χ.

more pronounced on impact than for the baseline economy, and somewhat larger later on.

Table 4 presents the standard deviations of HP-filtered data from both economies. The standard deviations for the baseline economy reflect the impulse response functions in Figure 7: The decline in volatility is not broad based. It is concentrated in debt and hours.

The results are substantially different for the high-substitution economy, on which we focus from now on. For labor, the ratio of the standard deviation in the low-collateral regime to its high-collateral counterpart is 0.41. This is close to the ratio of standard deviations from the periods 1995:I-2003:I and 1964:I-1982:IV in Table 1, 0.39. For output, the corresponding ratios from the model and data are 0.69 and 0.47. Hence, the mechanism we study can reproduce a large part of the decline in output's volatility. The same holds for the volatility of the debt: the standard-deviation ratio in the model is 0.38 and in the data is 0.24.

The model does less well in accounting for the behavior of durable goods. The ratio of standard deviations from the low- and high-collateral regimes is 0.56. The actual ratios for residential investment and durable consumption purchases are 0.18 and 0.37. The model's most counterfactual result is the small decline in the volatility of nondurable consumption—the standard deviation ratio is 0.92. The actual volatility ratio is 0.46.

The decline in the correlation of hours worked with the debt, which is very strong in the data—as shown in Table 2—is much weaker in the model. Here, the responses of both variables to shocks are weaker in the low collateral regime, but not very different in shape than in the high collateral regime. The reason for this result is that the present framework has only one shock. If other unrelated disturbances were also included—which do not generate a positive comovement of hours with the debt—weakening the strength of the present mechanism would lead to a weaker correlation of hours and the debt.

Table 4 Model Second Moments				
Percent Standard Deviations of HP-Filtered Data				
	Baseline Economy		High-Substitution Economy	
	High Collateral	Low Collateral	High Collateral	Low Collateral
Debt	2.08	0.95	1.94	0.73
Hours Worked	0.56	0.28	1.16	0.47
Nondurable Consumption	0.90	0.95	0.73	0.67
Durable Purchases	6.31	4.93	7.30	4.11
Output	1.97	1.77	1.97	1.36

7.5 Comparison of Level Changes

Figures 1, 4 and 5 indicate that the increase in the debt/durable stock ratio following the reforms in the early 1980s seems to coincide with the trend change in hours worked per capita. The analysis in Section 5 predicts qualitatively that both hours worked and the debt/durable stock ratio should increase following a relaxation of the collateral constraints. Here, using the parameter values and the model's steady state, we can evaluate quantitatively these changes and compare them to the actual changes of the averages in the period 1964:I-1982:IV to the averages in the 1995:I-2003:I period.

The actual percentage increase in hours per-capita across these two periods is 11.1%. In the baseline economy, the steady state increase from the high to the low collateral regime is 5.3%, and in the high-substitution economy it is 7.7%. Regarding the debt/durable stock ratio, the average ratio for the period 1964:I-1982:IV is 0.35. For 1995:I-2003:I it is 0.47. In the two model economies, the ratio from the high collateral regime is 0.21. Changing to the low collateral regime raises this to 0.42.

8 Links with the Literature

This paper follows Krusell and Smith (1998) in studying the cyclical interaction of agents having heterogeneous thrift attitudes in an environment with borrowing constraints. Krusell and Smith stress in particular the role of constraints on non-collateralized borrowing for the cyclical behavior of saving and investment. They use a setup where the rate of time preference is stochastic, although persistent, so that "borrowers" and "savers" interchange at some point. Beyond the different modelling strategy, the main departure of our analysis from theirs is the introduction of household durables and collateralized debt, and the interaction with labor supply. The key role of durables in this context was stressed in Section 6: If all consumption goods are nondurable, the agents who supply labor may not vary hours worked over the business cycle at all.

The different rates of time preference in a two-agents setup as the present one are endogenous in Gomme and Greenwood (1995), as negative functions of wealth accumulation. Possibly, adopting that specification could generate a setup similar to the current one as the limit of a process starting from identical agents and a one-time perturbation in income—that triggers increasingly different rates of time preference and wealth.

Microeconomic evidence supporting the notion that collateral constraints tie together labor supply and household debt include Fortin (1995) and Del Boca and Lusardi (2003). Using Canadian and Italian data, they found that labor participation of married women increases with their households' mortgage debt.

The possible implications of financial market innovations for the decline of macroeconomic volatility in the early 1980s were discussed by Blanchard and Simon (2001) and Stock and Watson (2002, 2003). Blanchard and Simon point out that an enhanced ability of smoothing consumption due to financial innovations does not seem a promising route for explaining the greater macroeconomic stability: One would expect these developments both to reduce the volatility of nondurable consumption and services and to increase the volatility of durable purchases—due to easier adjustment to optimal stocks. However, in the early 1980s the volatility of the three components of consumption declines, and to a similar degree. Stock and Watson stress the innovations in the mortgage market in particular, and the observed drastic decline in the volatility of residential investment in the early 1980s, among one of the possible sources of the increased macroeconomic stability since then. This is the direction adopted in this paper.

Kiyotaki and Moore (1997) focused on the cyclical implications of collateral constraints on firms. In their analysis, productive capital serves a dual role, as collateral for loans and in production. In the present paper, durable goods play a dual role for households, as collateral for loans and in utility. Both setups generate endogenous transmission of shocks, but the mechanisms are very different. In Kiyotaki and Moore, an exogenous shock that increases investment of a credit-constrained firm is transmitted to further investment due to the additional collateral obtained. Here, an exogenous shock that increases income of a credit-constrained household is magnified by a labor supply effect, but only under *partial* collateral—with full collateral, the labor supply response disappears.

The cyclical interaction of home durables with hours worked was also addressed from a home production perspective, as, for example, in Rupert, Rogerson and Wright (2000) and Fisher (2001). In these models, which incorporate perfect capital markets, the interaction between the two variables depends on the technological role assigned to home capital. Rupert, Rogerson and Wright point out that home production by itself should not generate a link between home capital and labor supply under perfect capital markets. Fisher incorporates a mechanism by which home capital improves the effectiveness of hours worked in the market, and thus generates a positive comovement between household capital and labor supply. The long-run relationship between home durables and labor participation was analyzed by Greenwood, Seshadri and Yorukoglu (2003). In their model, the adoption of new home durables substitutes labor in home activities, and thus induces higher participation in market production.

9 Concluding Remarks

The present mechanism of relaxing the collateral constraints on households seems quantitatively important for explaining the decline in macroenomic volatility since the early 1980s. This framework is consistent with different aspects of actual behavior of household debt and other key macroeconomic variables, particularly labor and output. Aggregate volatility declines as the level of household debt and hours worked start to increase after the financial reforms of 1982.

The present analysis could be extended in different directions. One example is a cross-country comparison that exploits different features of the household credit markets. This model could also prove useful for the analysis of fiscal issues, such as the macroeconomic implications of mortgage interest deductions from income tax, or optimal taxation of capital and labor.

In general, the model presented here is a tractable alternative to the representative-agent framework for macroeconomic analysis, and it seems particularly appropriate for the analysis of issues involving the credit market.

References

[1] Aizcorbe, Ana M., Arthur B. Kennickell, and Kevin B. Moore, 2003, "Recent Changes in U.S. Family Finances: Evidence from the 1998 and 2001 Survey of Consumer Finances," *Federal Reserve Bulletin*, 89, 1-32.

[2] Blanchard, Olivier, and John Simon, 2001, "The Long and Large Decline in U.S. Output Volatility," *Brookings Papers on Economic Activity,* 135-164.

[3] Del Boca, Daniela, and Annamaria Lusardi, 2003, "Credit Market Constraints and Labor Market Decisions," *Labour Economics*, 681-703.

[4] Fisher, Jonas D. M., 2001, "A Real Explanation for Heterogenous Investment Dynamics," Federal Reserve Bank of Chicago working paper.

[5] Florida, Richard, L. 1986, "*Housing and the New Financial Markets*," Rutgers-The State University of New Jersey.

[6] Fortin, Nicole, M., 1995, "Allocation Inflexibilities, Female Labor Supply, and Housing Assets Accumulation: Are Women Working to Pay the Mortgage?," *Journal of Labor Economics*, 13, 524-557.

[7] Gomme, Paul, and Jeremy Greenwood, 1995, "On the Cyclical Allocation of Risk," *Journal of Economic Dynamics and Control*, 19, 91-124.

[8] Greenwood, Jeremy, Seshadri, Ananth and Mehmet Yorukoglu, 2003, "Engines of Liberation," forthcoming in the *Review of Economic Studies.*

[9] Hansen, Gary D, 1985, "Indivisible Labor and the Business Cycle," Journal of Monetary Economics, 16, 309-327.

[10] Hansen, Gary D., and Edward C. Prescott, 2001, "Capacity Constraints, Asymmetries, and the Business Cycle," manuscript.

[11] Kahn, James, Margaret M. McConnell, and Gabriel Perez-Quiros, 2002, "On the Causes of the Increased Stability of the U.S. Economy," *Federal Reserve Bank of New York Economic Policy Review*, 8, 183-202.

[12] King, Robert, G., Charles I. Plosser and Sergio T. Rebelo, 1988, "Production, Growth and Business Cycles I." *Journal of Monetary Economics,* 21, 195-232.

[13] King, Robert G., and Sergio T. Rebelo, 2000, "Resuscitating Real Business Cycles," in John Taylor and Michael Woodford (eds) *Handbook of Macroeconomics*, North Holland, 927-1007.

[14] Kiyotaki, Nobuhiro, and John Moore, 1997, "Credit Cycles," *Journal of Political Economy*, 105, 211-248.

[15] Krusell, Per, and Anthony A. Smith, Jr., 1998, "Income and Wealth Heterogeneity in the Macroeconomy," *Journal of Political Economy*, 106, 867-896.

[16] McConnell, Margaret. M., and Gabriel Perez-Quiros, 2000, "Output Fluctuations in the United States: What Has Changed Since the Early 1980s," *American Economic Review*, 90, 1464-1476.

[17] Olney, Martha, L., 1991, "*Buy Now Pay Later*," The University of North Carolina Press.

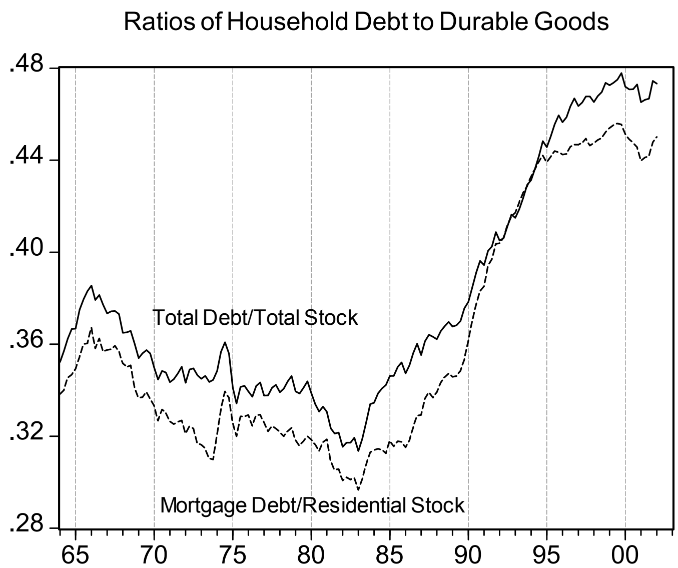
[18] Projector, Dorothy S., and Gertrude S. Weiss, 1966, "Survey of Financial Characteristics of Consumers," Federal Reserve Technical Papers, August.

[19] Rupert, Peter, Rogerson, Richard, and Randall Wright, 2000, "Homework in Labor Economics: Household Production and Intertemporal Substitution," *Journal of Monetary Economics*, 46, 557-579.

[20] Semer, Milton P., Julian H. Zimmerman, John M. Frantz and Ashley Ford, 1986, "Evolution of Federal Legislative Policy in Housing: Housing Credits," in Richard L. Florida (ed.) *Housing and the New Financial Markets,* Rutgers-The State University of New Jersey.

[21] Stock, James H., and Mark W. Watson, 2002, "Has the Business Cycle Changed and Why?," *NBER Macroeconomics Annual*, 159-218.

[22] Stock, James H., and Mark W. Watson, 2003, "Has the Business Cycle Changed? Evidence and Explanations," manuscript.



Ratios of Household Debt to Durable Goods
.48
.44
.40
.36
.32
.28
65
70
75
80
85
90
95
00
Total Debt/Total Stock
Mortgage Debt/Residential Stock

Figure 1

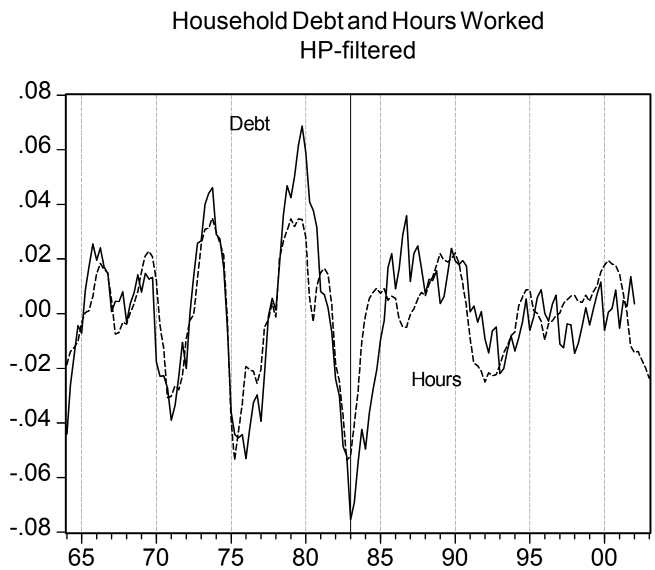


Figure 2

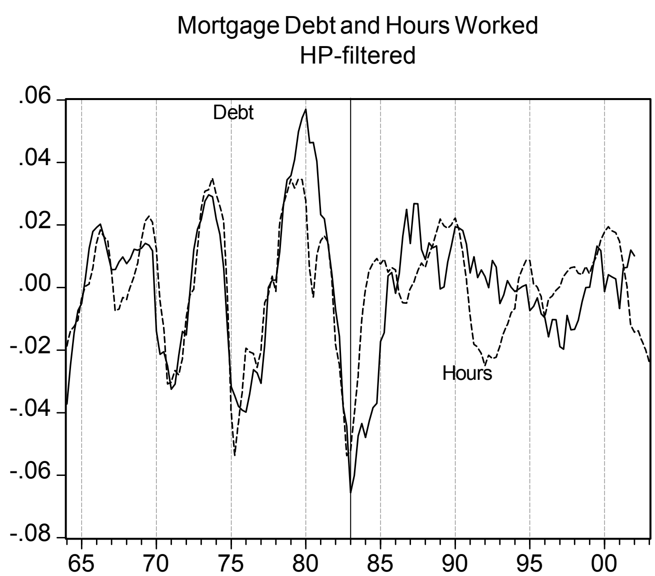


Figure 3

Figure 4

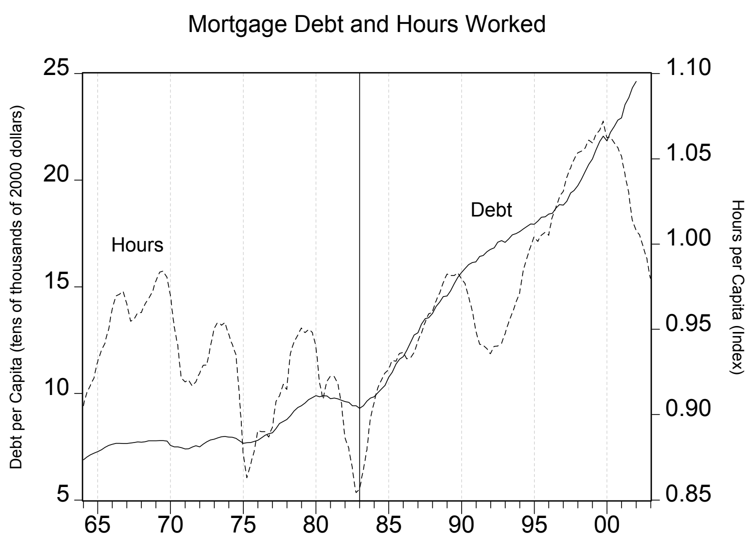


Figure 5

Figure 6, Impulse Response Functions

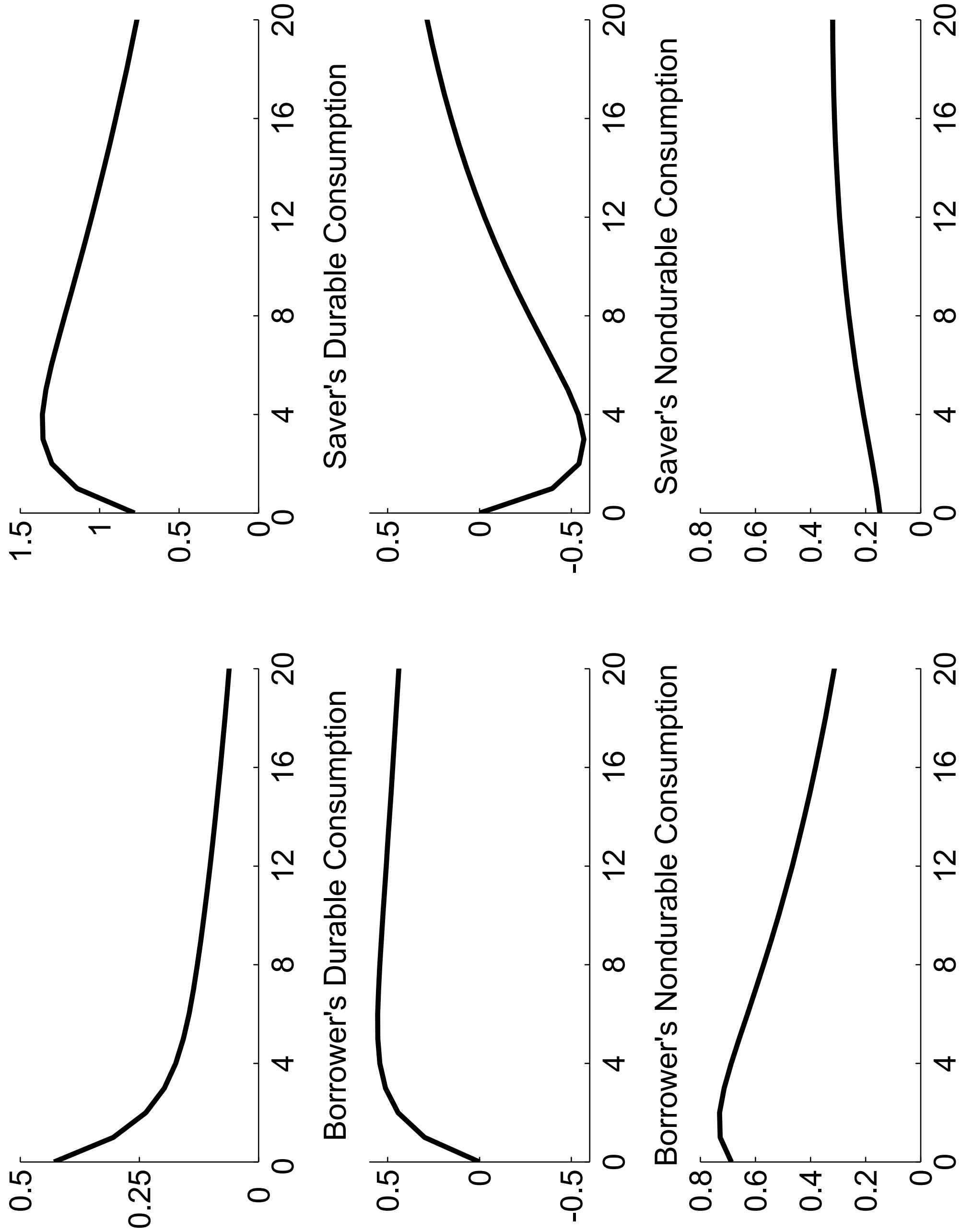


Figure 7: Dynamics in the High and Low Collateral Regimes

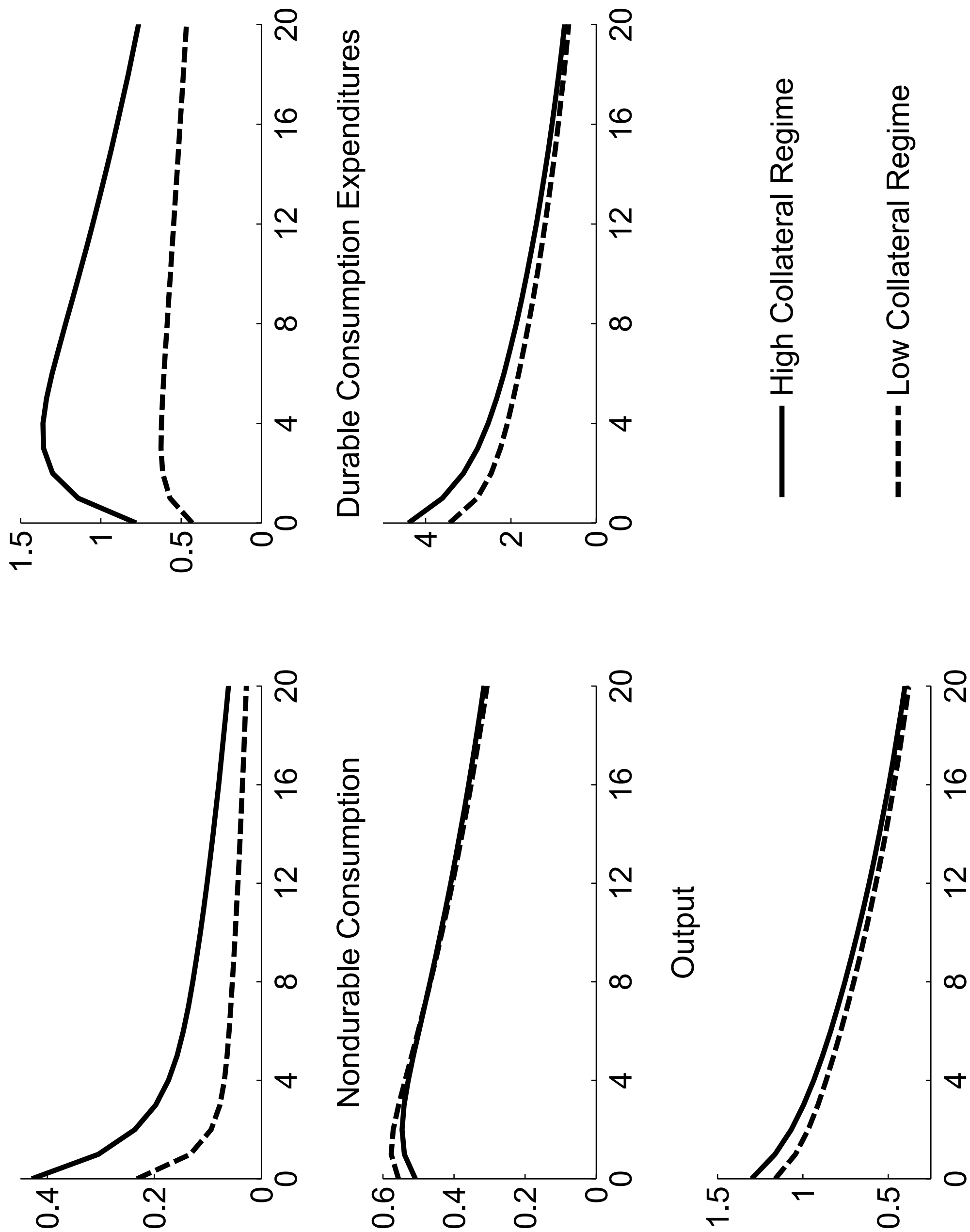


Figure 8: The High-Substitution Economy