ESSAYS IN MACROECONOMICS

by

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ABSTRACT

We investigate three topics in this dissertation. In Chapter 1 we investigate a matter related to Chapter 7 non-business bankruptcy in the United States. We find that state homestead exemptions tend to have a positive effect on state-level Chapter 7 non-commercial bankruptcy filing rates and tend generally to be statistically significant at the five-percent level or lower. Additionally, consistent with existing literature, we tend to find a positive and marginally statistically significant effect of past divorce rates on current filing rates. Moreover, our results suggest that unemployment has a positive effect on filing rates, while home prices have a negative effect. We use a balanced panel data set of U.S. states from the beginning of 2006 until the end of 2008. Homestead exemptions are chosen as a proxy for total asset exemptions. In Chapter 2 we investigate total U.S. household-sector debt and its relationship to several other variables using a vector error correction model and vector autoregression models. We find that per-capita household debt levels appear to be reduced by positive shocks to intermediate- and long-term interest rates. In addition, the permanent income hypothesis is corroborated in up to two areas. First, in some specifications consumption shocks, representing permanent income shocks, have a modest positive effect on debt levels. Second, shocks to home prices increase borrowing. Error variance decompositions suggest that current debt levels have a large portion of the predictive power for future debt levels. In Chapter 3 we investigate U.S. consumer revolving credit unsecured by real estate and its relationships to several other variables using vector autoregressions. We make several findings. For example, we find evidence that an increase in the average interest rate faced by credit card holders has no discernible downward
effect on debt levels but that an increase in the federal funds rate does have a downward effect. Increases in the unemployment rate also seem to reduce credit use, probably due to supply constraints. Increases in permanent income, represented by consumption, and in asset prices have positive effects on credit use.
DEDICATION

This dissertation is dedicated to my parents, Fred and Deborah Patterson, without whose guidance I would not have had the vision and motivation to complete a doctoral degree.
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<td>FD</td>
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<td>FRED</td>
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<td>Vector Error Correction Model</td>
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CHAPTER 1

DO STATE BANKRUPTCY HOMESTEAD EXEMPTIONS AFFECT FILING RATES? A LOOK AT U.S. NON-COMMERCIAL CHAPTER 7 FILINGS

The United States is known for being one of the world’s most debtor-friendly nations (White 2007). Since rational economic agents respond to incentives, friendliness toward bankrupts may have increased the propensities of Americans to file for bankruptcy. One of the most obtainable measures of debtor-friendliness consists of the sizes of asset exemptions applied to debtors in bankruptcy. While exemptions can apply to insurance policies, retirement assets and other holdings, the main asset exemption is arguably that of the homestead. This chapter provides both a theoretical and an empirical argument suggesting that more generous homestead exemptions may lead to higher filing rates.

Corporations and individuals are subject to separate bankruptcy procedures. In this chapter we are concerned with bankruptcy law as it affects individuals, a section of the law known as personal bankruptcy law. Personal bankruptcy proceedings are divided into Chapter 7 and Chapter 13 proceedings. In Chapter 7, debtors are required to liquidate certain assets to pay off a portion of their debts. After this partial repayment, however, their incomes and all of their future assets are exempt from being seized by creditors. In Chapter 13, debtors do not have to liquidate any assets but enter a three-to-five-year payment plan in which a portion of their wages is garnished to repay their debts. Personal bankruptcy can occur because of debts incurred as a consumer, as a business owner, or both. In this chapter we address only consumer bankruptcies,
leaving business bankruptcies for further research. The chapter is organized as follows. Section 1.1 provides a brief review of some relevant existing literature. Section 1.2 establishes a theoretical model. Section 1.3 describes our data and methodology. Section 1.4 discusses results. Section 1.5 concludes.

1.1 Existing Literature

We now turn to a brief review of the literature as it pertains to this question. Much of this review makes use of White (2005), who provides an excellent overview of much of the economic literature concerning bankruptcy law.

1.1.1 Theoretical Literature

The theoretical literature on incentives for Chapter 7 bankruptcy is not uniform concerning the effects of asset exemptions on filing rates. However, most of this theoretical literature concludes that higher asset exemptions will increase filing rates.

White (1998a and 1998b) uses the 1992 Survey of Consumer Finances (SCF) to calculate the value of the financial gain of filing for bankruptcy for each household in the SCF sample. Households can follow some relatively simple strategies in order to increase the financial benefits of bankruptcy. For example, a portion of one’s home value is generally exempt from seizure. Debtors can convert assets from non-exempt status to exempt status by using non-exempt assets to pay down their mortgages. White finds that by following one or more of such strategies, “61% of all U.S. households could benefit by filing for bankruptcy.” This represents a clear financial incentive to file and may have caused filing rates to be higher than they otherwise would be.

In another paper, White (2005) sets up a simple model that allows for either Chapter 7 or Chapter 13 bankruptcy. She finds that higher exemptions of either assets in Chapter 7 or
earnings in Chapter 13 will increase the number of total bankruptcies. Likewise, Athreya (2006) creates a model in which secured and unsecured debts both exist and are treated differently in bankruptcy proceedings. He finds that exemptions have a positive association with filing rates.

In contrast, Li and Sarte (2005) conclude that lowering Chapter 7 asset exemptions will, counterintuitively, increase Chapter 7 filing rates. They develop a theoretical model and examine, among other things, the effects of lowering asset exemptions for Chapter 7 bankruptcy. They find that this action lowers default rates and thus lowers lenders’ default risk premiums, causing consumers to borrow more when offered lower interest rates. Since Chapter 13 wage garnishments are proportional to the amount owed, this in turn lowers the attractiveness of Chapter 13 bankruptcy and hence raises the relative attractiveness of Chapter 7 bankruptcy. Thus, lowering asset exemptions paradoxically raises Chapter 7 filings by lowering Chapter 13 filings. However, lowering asset exemptions also lowers the total number of defaults.

1.1.2 Empirical Literature

Some empirical work has also been done on the connection between the generosity of exemptions and filing frequencies. In 1978 Congress made some changes to federal bankruptcy laws. Among these changes was a decision to give the states the right to set their own wealth exemption levels. Early research concluded that the changes caused aggregate bankruptcy filing rates to increase nationally, but it is not clear which provisions of the legislation caused this increase. White (1987) finds a positive, significant relationship between wealth exemption levels and filing rates using aggregate county-level data. On the other hand, Buckley and Brinig (1998) use a panel of aggregate state data from the 1980s, employing state dummy variables, and find no significant relationship.
Additional research has been done using household-level, rather than aggregate, data. Domowitz and Sartain (1997) find that people are less likely to file for bankruptcy if they own a home. This may be due to the fact that they stand to lose some home equity in the process. In contrast, in what is referred to by White (2005) as the sociological model of bankruptcy, Sullivan, Warren and Westbrook (1989) argue that debtors never plan strategically for bankruptcy. They conclude that debtors only embrace bankruptcy when their incomes fall or when other adverse events occur such as job loss, illness or divorce.

White (2005) discusses what she calls the economic model of bankruptcy, which implies that consumers are more likely to file for bankruptcy when the financial benefit from doing so rises. Fay, Hurst and White (2002) use the Panel Survey of Income Dynamics to test the economic and sociological models. They find that if the financial benefit of filing increases by $1,000 for all households, then the bankruptcy filing rate will increase by seven percent in the following year. Additionally, they find no connection between filing and an illness or job loss of the head of household, or the head of household’s spouse, in the previous year. However, in support of the sociological model they also find that households with higher incomes are significantly less likely to file for bankruptcy and that a divorce in the previous year is marginally statistically significant. Thus the results of Fay, Hurst and White (2002) support the economic model of bankruptcy, as well as the sociological model of bankruptcy to a lesser extent.

1.2 Theoretical Model

Assume a concave utility function $u$, an asset (including future income) $a$, a payoff $g$ from a good outcome, a payoff $b$ from a bad outcome, an amount of debt $d$, an interest amount $r$, a probability $p \in (0,1)$ of the bad outcome for all effort levels $e > 0$, and a utility cost of effort $c$. 
Let \( p' < 0, \ c' > 0, \) and \( p'', \ c'' > 0. \) A consumer can borrow \( d \) for consumption purposes and in the course of living receive \( g \) or \( b. \) These two outcomes can be thought of as results of uncertain aspects of life such as health, marriage success and employment. Without the option of bankruptcy, the agent’s expected utility given \( e \) is

\[
Eu(e) = (1 - p(e))u(a + g - d - r) + p(e)u(a + b - d - r) - c(e). \tag{1.1}
\]

Assume \( g > d > 0 > b \), and that \( a + b \geq d + r. \) Thus if circumstances are good, the agent can use part of his benefit \( (g) \) to pay off the loan \( (d). \) If circumstances are bad, the agent can liquidate part of his asset \( (a) \) to pay off the loan. So the loan is always paid back. Assume that the lending market is perfectly competitive and hence that lenders make zero profit \( (r = 0). \) Let \( \bar{e} \) maximize \( Eu(e). \) To investigate the circumstances in which the bankruptcy option benefits consumers, we assume that the prospect of borrowing is not attractive under these circumstances, i.e., \( Eu(\bar{e}) < u(a). \)

Now assume that the law allows for bankruptcy. Assume also that the government can observe the outcome of each consumer’s life and provide an exemption level \( x. \) If it is the case that \( x \geq a + b - d - r, \) then

\[
Eu(e; x) = (1 - p(e))u(a + g - d - r) + p(e)u(\min\{x, a + b\}) - c(e). \tag{1.2}
\]

The lender expects to lose \( \delta = \min\{x, a + b\} - (a + b - d) \geq 0 \) of the loan principle (i.e., the default amount) with probability \( p(e). \) Under perfect competition in the lending market, the lender’s interest income to cover this expected loss is \( r = p(e)\delta. \) If \( x \in [a + b - d - r, a + b], \) equation (1.2) can be written as

\[
Eu(e; x) = (1 - p(e))u(a + g - d - p(e)\delta) + p(e)u(x) - c(e). \tag{1.3}
\]

To find \( e_p \) that maximizes \( Eu(e; x), \) we use the first-order necessary condition, \( 0 = \varphi(e,x) = -p'(e)[u(a + g - d - p(e)\delta) - u(x)] + \delta(1 - p(e))u'(a + g - d - p(e)\delta) - c'(e). \tag{1.4} \)
We then check the second-order sufficient condition. We find
\[
\frac{\partial \phi(e,x)}{\partial \rho} = -p''(e) + \delta p'(e)^2[2u'(a + g - d - p(e)\delta) + \delta(1 - p(e))u''(a + g - d - p(e)\delta)] - c''(e).
\]
(1.5)

Note that the first and last terms are negative. The second term is negative if
\[
\frac{u''(a+g-d-p(e)\delta)}{u'(a+g-d-p(e)\delta)} > \frac{2}{\delta(1-p(e))}
\]
(1.6)

We assume that the utility function is risk-averse enough so that the second-order sufficient condition holds. We also find that
\[
\frac{\partial \phi(e,x)}{\partial x} = p'(e)^2[u'(a + g - d - p(e)\delta) + \delta(1 - p(e))u''(a + g - d - p(e)\delta)] + p'(e)u'(x),
\]
(1.7)

which is negative if inequality (1.6) holds. Hence, \( \frac{d\phi}{dx} < 0 \).

By the Envelope Theorem, the effect of \( x \) on optimal \( Eu \) is positive. So the government can choose the level of exemption \( x^* \) so that \( Eu(e;x^*) = u(a) \) and the borrowing opportunity is attractive. However, as we show above, there is a moral hazard problem because the agent chooses a lower level of effort as a result of the exemption.

Note that \( x^* \) may not exist. Consider equation (1.2). If \( x > a + b \), then
\[
Eu(e|x > a + b) = (1 - p(e))u(a + g - d - r) + p(e)u(a + b) - c(e).
\]
(1.8)

Let \( \tilde{e} \) maximize equation (1.8). If \( Eu(\tilde{e}|x > a + b) < u(a) \), then no one will ever invest even though total debt is discharged. If this is the case, then \( x^* \) does not exist.

1.3 Data and Methodology

To test whether this theoretical result holds, we use a balanced panel dataset that spans the period from the first quarter of 2006 until the fourth quarter of 2008. We perform regressions in levels—namely, Fixed Effects (FE) and Random Effects (RE) regressions—in addition to
First Difference (FD) regressions. In regressions where we do not include divorce rates as an independent variable, cross-sectional observations include all 50 U.S. states and the District of Columbia. However, divorce rates are not published with a quarterly frequency by the states of California, Georgia, Hawaii, Indiana, Louisiana, and Minnesota. This leaves only 45 cross-sectional units to be observed when divorce rates are included as a regressor. In addition to the natural logarithm of divorce rates per thousand in the population, we include the following state-level variables in our analysis: the log of real homestead exemptions, the log of a real home price index, and unemployment rates. Our dependent variable is the log of per-capita Chapter 7 non-commercial bankruptcy filing rates per thousand. Please see Appendix A for our data sources.

We must correct for the peculiarity that some states (Arkansas, Florida, Iowa, Kansas, Oklahoma, South Dakota and Texas) and the District of Columbia have unlimited homestead exemptions. For each quarter, we assign to each of these entities the maximum real homestead exemption observed in the U.S. during that quarter. We then create a dummy variable to indicate whether each state has an unlimited homestead exemption.

Our balanced panel dataset lends itself to simple FE, RE and FD regressions. In each regression we use heteroskedasticity- and autocorrelation-robust standard errors. In the FE and RE regressions, we use time fixed effects to mitigate the effects of the non-stationary variables, such as home prices and homestead exemptions, and to correct for possible seasonality. In the FD regressions the data are likely to be stationary so we generally omit time fixed effects. However, as a robustness check we include time fixed effects in two FD specifications. All of our FE models are nested in the following prototype:

\[
f'_{it} = \beta_0 + \beta_1 x'_{it} + \beta_2 u'_{it} + \beta_3 u'_{it-1} + \beta_4 u'_{it-4} + \beta_5 u'_{it-8} + \beta_6 h'_{it} + \beta_7 d'_{it-1} + \beta_8 d'_{it-4} + \beta_9 d'_{it-8} + \beta_{10} l'_{it} + \sum_{j=2}^{T} y_j D'_{j} + e_{it}, \tag{1.9}
\]
where the asterisks indicate time-demeaned variables; $f_{it}$ is the log of Chapter 7 non-business bankruptcy filings per thousand in the population; $x_{it}$ is the log of the real homestead exemption; $u_{it}$ is the unemployment rate; $h_{it}$ is the log of the real home price index; $d_{it}$ is the log of divorces per thousand in the population; $l_{it}$ is a dummy variable equaling one if the state has an unlimited homestead exemption and zero otherwise; and the $D_{j}$ are dummy variables capturing time fixed effects. Note that the dummy variable for the unlimited homestead exemption drops out of the FE regression.

Using the same variables, all of our RE models are nested in the following prototype:

$$
f_{it}^* = \beta_0^* + \beta_1 x_{it}^* + \beta_2 u_{it}^* + \beta_3 u_{it-1}^* + \beta_4 u_{it-4}^* + \beta_5 h_{it}^* + \beta_6 d_{it}^* + \beta_7 d_{it-1}^* + \beta_8 d_{it-4}^* + \beta_9 d_{it-8}^* + \beta_{10} l_{it}^* + \sum_{j=2}^{T} \gamma_{j} D_{j}^* + \{ \theta_1 \overline{x_i} + \theta_2 \overline{u_i} + \theta_3 \overline{h_i} + \theta_4 \overline{d_i} \} + e_{it}, \quad (1.10)$$

where the asterisks indicate quasi-demeaned data and the bars represent cross-sectional means as prescribed by Mundlak (1978).

Finally, using the same variables, all of our FD models are nested in the following prototype:

$$
f_{it} = \beta_1 \Delta x_{it} + \beta_2 \Delta u_{it} + \beta_3 \Delta u_{it-1} + \beta_4 \Delta u_{it-4} + \beta_5 \Delta h_{it} + \beta_6 \Delta d_{it-1} + \beta_7 \Delta d_{it-4} + \beta_9 \Delta d_{it-8} + \sum_{j=2}^{T} \gamma_{j} \Delta D_{j} + e_{it}. \quad (1.11)$$

Note that the dummy variable for the unlimited homestead exemption drops out of the FD estimation because no state changed from having a limited homestead exemption to having an unlimited homestead exemption, or vice versa, from 2006 to 2008.
1.4 Results

We find robust evidence that higher homestead exemptions tend to increase filing rates at the five-percent significance level or lower. Additionally, we find several other forces that appear to be at work on filing rates. First, lagged unemployment rates appear to have a positive and statistically significant effect. Second, lagged divorce rates seem to have a positive and marginally significant effect. Third, current home prices seem to have a negative and highly significant effect.

Our results regarding the effects of unemployment and divorce are stronger than those obtained by Bhandari and Weiss (1993), who find positive but statistically insignificant coefficients for these lagged variables. These authors use annual and not quarterly data, which may be the source of the differing results. Our unemployment results are also stronger than those obtained by Shepard (1984), who examines total bankruptcies and finds a positive but insignificant coefficient for a lagged unemployment rate using annual data. Our unemployment findings corroborate Sullivan, Warren and Westbrook (2000), who use survey data of bankruptcy filers to argue that 67% of bankruptcy filings were due to job loss. On the other hand, the 1996 Panel Survey of Income Dynamics asked a representative sample of filers their primary reason for filing and only 21% replied that it was job loss. Additionally, our work seems contrary to Fay, Hurst and White (2002), who use the Panel Survey of Income Dynamics and find that a job loss in the previous year does not have a significant effect on a household’s decision to file for bankruptcy. On the other hand, the divorce effect is consistent with Fay, Hurst and White (2002), who find that a divorce in the previous year has a positive and marginally statistically significant effect on a household’s probability of filing for bankruptcy. The home price effect that we find is consistent with, although not identical to, Domowitz and Sartain (1999). They
use choice-based sampling by combining a sample of households that filed for bankruptcy in the early 1980’s with the 1983 SCF as a more general sample of households. The data suggest that households are less likely to file for bankruptcy if they own a home. This is not surprising, as a higher amount of home equity means a lower financial benefit of filing for bankruptcy.

We present the results of our FE, RE and FD estimations in tables 1.1-1.6. Before considering the results, note a preliminary consideration. We believe it is most plausible for divorces and job losses to affect filing rates with a lag of more than one quarter. After losing a job, the household’s income earner may believe for some time, perhaps while searching for another job, that the situation can be rectified. The empirical results seem to make more sense if we follow this line of thinking. Additionally, the serious financial problems that commonly accompany divorce are not likely to present themselves immediately. For this reason we display results using lags of one quarter, four quarters and eight quarters on unemployment and divorce rates.

We attempt three data manipulation techniques to determine whether the results are informative. First, because of the cumulative effect of long-term unemployment, it may seem reasonable to use a moving average figure for the unemployment rate. A similar argument may be used for divorce rates and home prices. We try two- and three-quarter moving averages for these statistics and find that the results, which we do not present here, either are made more ambiguous or are unchanged. Moreover, using this method will introduce some undesirable autocorrelation in the averaged variables, so we have reservations about the results.

Second, we try including an interaction term between divorce rates and exemption levels under the hypothesis that higher exemption levels may make bankruptcy look particularly attractive to recent divorcees. The coefficient on this variable is not significant, and we do not
report the results. Third, we try including both nominal homestead exemptions and the price level as separate variables and do not find discernible results for these variables. We do not report these results either.

We first consider all U.S. states. Then, in order to explore the effects of divorce rates on bankruptcy filing rates, we consider those 44 states and the District of Columbia that report divorce statistics at least quarterly.

All states are considered in the results given in tables 1.1-1.3. In each table, p-values are in parentheses. First consider table 1.1, which reports three FE specifications. The second specification is the most plausible because it uses the unemployment rate lagged by four quarters, which probably is a long enough span to identify unemployed debtors who choose bankruptcy as a result of job loss and does not seem excessively long. In this specification the homestead exemption, the lagged unemployment rate, and home prices have the expected signs and are highly significant. Specifically, the homestead exemption has a positive coefficient since consumers respond rationally to more generous bankruptcy provisions; the lagged unemployment rate has a positive coefficient since job loss aggravates financial difficulties; and home prices have a negative coefficient since higher home equity levels mean that more wealth is forfeited in the event of bankruptcy. Lagging the unemployment rate by a full two years gives less pronounced results, possibly because debtors who file for bankruptcy due to unemployment tend to do so less than two years after losing their jobs.

Second, consider table 1.2, which includes some RE specifications. As mentioned above, we use Mundlak’s method to control for possible correlation between each state’s unobserved heterogeneity and the error term. Again, the second specification seems to make the most sense. The real homestead exemption, the lagged unemployment rate and home prices all have the
expected signs and are highly statistically significant. In the second specification, which is most reasonable, each coefficient has approximately the same magnitude as its counterpart in the FE estimation.

Third, consider table 1.3, which displays some FD specifications. It is particularly important here that robust standard errors be used here because an autocorrelation test of the residuals could not rule out autocorrelation. The homestead exemption has a positive and at least marginally significant coefficient in each specification shown. Oddly, the unemployment rate lagged eight quarters appears to have a significant negative effect, probably due to the fact that an eight-quarter lag is excessive. Home prices have a highly significant negative effect of roughly the same magnitude in each specification. Adding time fixed effects causes the results to appear more ambiguous and, for the reason explained above, we do not believe these parameters are necessary anyway.
<table>
<thead>
<tr>
<th>Regressor</th>
<th>Regression 1</th>
<th>Regression 2</th>
<th>Regression 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>exemption</td>
<td>0.0389 (0.021)**</td>
<td>0.0443 (0.009)**</td>
<td>0.0417 (0.013)**</td>
</tr>
<tr>
<td>unlimited dummy</td>
<td>(dropped)</td>
<td>(dropped)</td>
<td>(dropped)</td>
</tr>
<tr>
<td>unemployment rate</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>unemployment rate{1}</td>
<td>-0.0015 (0.821)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>unemployment rate{4}</td>
<td>N/A</td>
<td>0.0273 (0.006)**</td>
<td>N/A</td>
</tr>
<tr>
<td>unemployment rate{8}</td>
<td>N/A</td>
<td>N/A</td>
<td>0.0204 (0.057)*</td>
</tr>
<tr>
<td>home prices</td>
<td>-2.4458 (0.000)** ***</td>
<td>-2.3470 (0.000)** ***</td>
<td>-2.4245 (0.000)** ***</td>
</tr>
<tr>
<td>2006Q2</td>
<td>0.4054 (0.000)***</td>
<td>0.4074 (0.000)***</td>
<td>0.4062 (0.000)***</td>
</tr>
<tr>
<td>2006Q3</td>
<td>0.4631 (0.000)***</td>
<td>0.4601 (0.000)***</td>
<td>0.4654 (0.000)***</td>
</tr>
<tr>
<td>2006Q4</td>
<td>0.5283 (0.000)***</td>
<td>0.5329 (0.000)***</td>
<td>0.5320 (0.000)***</td>
</tr>
<tr>
<td>2007Q1</td>
<td>0.6531 (0.000)***</td>
<td>0.6651 (0.000)***</td>
<td>0.6593 (0.000)***</td>
</tr>
<tr>
<td>2007Q2</td>
<td>0.7697 (0.000)***</td>
<td>0.7810 (0.000)***</td>
<td>0.7778 (0.000)***</td>
</tr>
<tr>
<td>2007Q3</td>
<td>0.7263 (0.000)***</td>
<td>0.7395 (0.000)***</td>
<td>0.7312 (0.000)***</td>
</tr>
<tr>
<td>2007Q4</td>
<td>0.7283 (0.000)***</td>
<td>0.7461 (0.000)***</td>
<td>0.7398 (0.000)***</td>
</tr>
<tr>
<td>2008Q1</td>
<td>0.8250 (0.000)***</td>
<td>0.8465 (0.000)***</td>
<td>0.8412 (0.000)***</td>
</tr>
<tr>
<td>2008Q2</td>
<td>0.9138 (0.000)***</td>
<td>0.9348 (0.000)***</td>
<td>0.9302 (0.000)***</td>
</tr>
<tr>
<td>2008Q3</td>
<td>0.8816 (0.000)***</td>
<td>0.9014 (0.000)***</td>
<td>0.8990 (0.000)***</td>
</tr>
<tr>
<td>2008Q4</td>
<td>0.9944 (0.000)***</td>
<td>1.0087 (0.000)***</td>
<td>1.0131 (0.000)***</td>
</tr>
<tr>
<td>constant</td>
<td>9.8574 (0.000)***</td>
<td>9.1787 (0.000)***</td>
<td>9.6107 (0.000)***</td>
</tr>
</tbody>
</table>

*Significant at the ten-percent level.
**Significant at the five-percent level.
***Significant at the one-percent level.
Table 1.2. Random Effects results, all states included.

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Regression 1</th>
<th>Regression 2</th>
<th>Regression 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>exemption</td>
<td>0.0389 (0.035)**</td>
<td>0.0443 (0.016)**</td>
<td>0.0417 (0.024)**</td>
</tr>
<tr>
<td>unlimited dummy</td>
<td>-0.1684 (0.361)</td>
<td>-0.1813 (0.315)</td>
<td>-0.1857 (0.309)</td>
</tr>
<tr>
<td>unemployment rate</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>unemployment rate{1}</td>
<td>-0.0017 (0.787)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>unemployment rate{4}</td>
<td>N/A</td>
<td>0.0273 (0.016)**</td>
<td>N/A</td>
</tr>
<tr>
<td>unemployment rate{8}</td>
<td>N/A</td>
<td>N/A</td>
<td>0.0204 (0.082)*</td>
</tr>
<tr>
<td>home prices</td>
<td>-2.4468 (0.000)***</td>
<td>-2.3469 (0.000)***</td>
<td>-2.4245 (0.000)***</td>
</tr>
<tr>
<td>2006Q2</td>
<td>0.4052 (0.000)***</td>
<td>0.4074 (0.000)***</td>
<td>0.4062 (0.000)***</td>
</tr>
<tr>
<td>2006Q3</td>
<td>0.4629 (0.000)***</td>
<td>0.4601 (0.000)***</td>
<td>0.4654 (0.000)***</td>
</tr>
<tr>
<td>2006Q4</td>
<td>0.5281 (0.000)***</td>
<td>0.5329 (0.000)***</td>
<td>0.5320 (0.000)***</td>
</tr>
<tr>
<td>2007Q1</td>
<td>0.6529 (0.000)***</td>
<td>0.6651 (0.000)***</td>
<td>0.6593 (0.000)***</td>
</tr>
<tr>
<td>2007Q2</td>
<td>0.7694 (0.000)***</td>
<td>0.7810 (0.000)***</td>
<td>0.7778 (0.000)***</td>
</tr>
<tr>
<td>2007Q3</td>
<td>0.7260 (0.000)***</td>
<td>0.7395 (0.000)***</td>
<td>0.7311 (0.000)***</td>
</tr>
<tr>
<td>2007Q4</td>
<td>0.7280 (0.000)***</td>
<td>0.7461 (0.000)***</td>
<td>0.7398 (0.000)***</td>
</tr>
<tr>
<td>2008Q1</td>
<td>0.8247 (0.000)***</td>
<td>0.8465 (0.000)***</td>
<td>0.8418 (0.000)***</td>
</tr>
<tr>
<td>2008Q2</td>
<td>0.9136 (0.000)***</td>
<td>0.9348 (0.000)***</td>
<td>0.9302 (0.000)***</td>
</tr>
<tr>
<td>2008Q3</td>
<td>0.8814 (0.000)***</td>
<td>0.9014 (0.000)***</td>
<td>0.8990 (0.000)***</td>
</tr>
<tr>
<td>2008Q4</td>
<td>0.9943 (0.000)***</td>
<td>1.0087 (0.000)***</td>
<td>1.0131 (0.000)***</td>
</tr>
<tr>
<td>constant</td>
<td>-0.3019 (0.819)</td>
<td>-0.2583 (0.846)</td>
<td>-0.1275 (0.925)</td>
</tr>
</tbody>
</table>

*Significant at the ten-percent level.
**Significant at the five-percent level.
***Significant at the one-percent level.
Only those 45 entities publishing divorce statistics with a quarterly or higher frequency are considered in tables 1.4-1.6. Once again, p-values are in parentheses. First consider table 1.4, which contains some FE specifications. The results here are similar to the results obtained for all states. In the most reasonable specification, which includes the fourth lag of both the unemployment rate and the divorce rate, all coefficients have the expected signs and are at least marginally statistically significant. The coefficient on the divorce rate is positive since post-
divorce financial obligations often aggravate existing financial problems. This coefficient is significant at the ten-percent level. Note that using the fourth lag of the divorce rate imitates Fay, Hurst and White (2002) to some extent, since their research considers the effects of a divorce within the past year.

Second, consider table 1.5, which contains two RE specifications. With the best specification, each coefficient has the same sign and roughly the same magnitude and significance level as its counterpart in the FE specification. Again, note that exemption levels seem to have a distinct positive effect on filing rates. Additionally, the exemption coefficients displayed in tables 1.4 and 1.5 are of roughly the same magnitude as their counterparts in tables 1.1 and 1.2.

Third, consider table 1.6, which contains some FD specifications. As is true in table 1.3, adding time fixed effects makes the effects of other variables seem more ambiguous. In each specification in table 1.6 except that which includes time fixed effects, the coefficient on the differenced exemption level is positive and significant at the ten-percent level and the coefficient on the lagged divorce rate is positive and significant. However, the unemployment rate does not convey meaningful information, which is puzzling. Still, this paper has presented enough evidence that the unemployment rate is influential for us to believe that the unemployment rate does in fact have a positive effect on filing rates.
Table 1.4. Fixed Effects results, divorce-reporting states.

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Regression 1</th>
<th>Regression 2</th>
<th>Regression 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>exemption</td>
<td>0.0331 (0.057)*</td>
<td>0.0449 (0.010)***</td>
<td>0.0391 (0.023)**</td>
</tr>
<tr>
<td>unlimited dummy</td>
<td>(dropped)</td>
<td>(dropped)</td>
<td>(dropped)</td>
</tr>
<tr>
<td>unemployment rate</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>unemployment rate{1}</td>
<td>-0.0037 (0.584)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>unemployment rate{4}</td>
<td>N/A</td>
<td>0.0384 (0.007)***</td>
<td>N/A</td>
</tr>
<tr>
<td>unemployment rate{8}</td>
<td>N/A</td>
<td>N/A</td>
<td>0.0318 (0.019)***</td>
</tr>
<tr>
<td>home prices</td>
<td>-2.4851 (0.000)***</td>
<td>-2.3581 (0.000)***</td>
<td>-2.4308 (0.000)***</td>
</tr>
<tr>
<td>divorce{1}</td>
<td>-0.0524 (0.130)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>divorce{4}</td>
<td>N/A</td>
<td>0.0660 (0.088)*</td>
<td>N/A</td>
</tr>
<tr>
<td>divorce{8}</td>
<td>N/A</td>
<td>N/A</td>
<td>0.0008 (0.982)</td>
</tr>
<tr>
<td>2006Q2</td>
<td>0.4081 (0.000)***</td>
<td>0.4063 (0.000)***</td>
<td>0.4108 (0.000)***</td>
</tr>
<tr>
<td>2006Q3</td>
<td>0.4702 (0.000)***</td>
<td>0.4627 (0.000)***</td>
<td>0.4710 (0.000)***</td>
</tr>
<tr>
<td>2006Q4</td>
<td>0.5342 (0.000)***</td>
<td>0.5397 (0.000)***</td>
<td>0.5392 (0.000)***</td>
</tr>
<tr>
<td>2007Q1</td>
<td>0.6538 (0.000)***</td>
<td>0.6704 (0.000)***</td>
<td>0.6637 (0.000)***</td>
</tr>
<tr>
<td>2007Q2</td>
<td>0.7722 (0.000)***</td>
<td>0.7833 (0.000)***</td>
<td>0.7863 (0.000)***</td>
</tr>
<tr>
<td>2007Q3</td>
<td>0.7341 (0.000)***</td>
<td>0.7447 (0.000)***</td>
<td>0.7417 (0.000)***</td>
</tr>
<tr>
<td>2007Q4</td>
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<td>0.7493 (0.000)***</td>
</tr>
<tr>
<td>2008Q1</td>
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<td>0.8494 (0.000)***</td>
</tr>
<tr>
<td>2008Q2</td>
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<td>0.9463 (0.000)***</td>
</tr>
<tr>
<td>2008Q3</td>
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<td>0.9106 (0.000)***</td>
<td>0.9133 (0.000)***</td>
</tr>
<tr>
<td>2008Q4</td>
<td>1.0017 (0.000)***</td>
<td>1.0180 (0.000)***</td>
<td>1.0304 (0.000)***</td>
</tr>
<tr>
<td>constant</td>
<td>10.0805 (0.000)***</td>
<td>9.1500 (0.000)***</td>
<td>9.5762 (0.000)***</td>
</tr>
</tbody>
</table>

*Significant at the ten-percent level.
**Significant at the five-percent level.
***Significant at the one-percent level.
Table 1.5. Random Effects results, divorce-reporting states.

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Regression 1</th>
<th>Regression 2</th>
<th>Regression 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>exemption</td>
<td>0.03308 (0.080)*</td>
<td>0.0449 (0.016)**</td>
<td>0.0391 (0.036)**</td>
</tr>
<tr>
<td>unlimited dummy</td>
<td>-0.1344 (0.438)</td>
<td>-0.1337 (0.444)</td>
<td>-0.1394 (0.422)</td>
</tr>
<tr>
<td>unemployment rate</td>
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<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>unemployment rate{1}</td>
<td>-0.0039 (0.548)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>unemployment rate{4}</td>
<td>N/A</td>
<td>0.0385 (0.006)**</td>
<td>N/A</td>
</tr>
<tr>
<td>unemployment rate{8}</td>
<td>N/A</td>
<td>N/A</td>
<td>0.0317 (0.016)**</td>
</tr>
<tr>
<td>home prices</td>
<td>-2.4868 (0.000)*****</td>
<td>-2.3581 (0.000)*****</td>
<td>-2.4308 (0.000)*****</td>
</tr>
<tr>
<td>divorce{1}</td>
<td>-0.0527 (0.133)</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>divorce{4}</td>
<td>N/A</td>
<td>0.0660 (0.089)*</td>
<td>N/A</td>
</tr>
<tr>
<td>divorce{8}</td>
<td>N/A</td>
<td>N/A</td>
<td>0.0008 (0.983)</td>
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<tr>
<td>2006Q2</td>
<td>0.4078 (0.000)*****</td>
<td>0.4063 (0.000)*****</td>
<td>0.4108 (0.000)*****</td>
</tr>
<tr>
<td>2006Q3</td>
<td>0.4699 (0.000)*****</td>
<td>0.4627 (0.000)*****</td>
<td>0.4710 (0.000)*****</td>
</tr>
<tr>
<td>2006Q4</td>
<td>0.5338 (0.000)*****</td>
<td>0.5397 (0.000)*****</td>
<td>0.5392 (0.000)*****</td>
</tr>
<tr>
<td>2007Q1</td>
<td>0.6534 (0.000)*****</td>
<td>0.6704 (0.000)*****</td>
<td>0.6637 (0.000)*****</td>
</tr>
<tr>
<td>2007Q2</td>
<td>0.7718 (0.000)*****</td>
<td>0.7833 (0.000)*****</td>
<td>0.7863 (0.000)*****</td>
</tr>
<tr>
<td>2007Q3</td>
<td>0.7337 (0.000)*****</td>
<td>0.7447 (0.000)*****</td>
<td>0.7417 (0.000)*****</td>
</tr>
<tr>
<td>2007Q4</td>
<td>0.7285 (0.000)*****</td>
<td>0.7523 (0.000)*****</td>
<td>0.7493 (0.000)*****</td>
</tr>
<tr>
<td>2008Q1</td>
<td>0.8218 (0.000)*****</td>
<td>0.8521 (0.000)*****</td>
<td>0.8494 (0.000)*****</td>
</tr>
<tr>
<td>2008Q2</td>
<td>0.9169 (0.000)*****</td>
<td>0.9417 (0.000)*****</td>
<td>0.9463 (0.000)*****</td>
</tr>
<tr>
<td>2008Q3</td>
<td>0.8850 (0.000)*****</td>
<td>0.9106 (0.000)*****</td>
<td>0.9133 (0.000)*****</td>
</tr>
<tr>
<td>2008Q4</td>
<td>1.0015 (0.000)*****</td>
<td>1.0180 (0.000)*****</td>
<td>1.0304 (0.000)*****</td>
</tr>
<tr>
<td>constant</td>
<td>-1.4394 (0.305)</td>
<td>-1.3959 (0.321)</td>
<td>-1.3536 (0.331)</td>
</tr>
</tbody>
</table>

*Significant at the ten-percent level.
**Significant at the five-percent level.
***Significant at the one-percent level.
Table 1.6. First Difference results, divorce-reporting states.

<table>
<thead>
<tr>
<th>Regressor</th>
<th>Regression 1</th>
<th>Regression 2</th>
<th>Regression 3</th>
<th>Regression 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Δexemption</td>
<td>0.0877 (0.064)*</td>
<td>0.0951 (0.077)*</td>
<td>0.0855 (0.098)*</td>
<td>0.0584 (0.205)</td>
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<tr>
<td>Δunemployment rate</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Δunemployment rate{1}</td>
<td>-0.0865 (0.000)***</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
</tr>
<tr>
<td>Δunemployment rate{4}</td>
<td>N/A</td>
<td>-0.0488 (0.216)</td>
<td>N/A</td>
<td>0.0460 (0.002)***</td>
</tr>
<tr>
<td>Δunemployment rate{8}</td>
<td>N/A</td>
<td>N/A</td>
<td>-0.1033 (0.022)**</td>
<td>N/A</td>
</tr>
<tr>
<td>Δhome prices</td>
<td>-1.8256 (0.000)***</td>
<td>-1.5944 (0.000)***</td>
<td>-1.5285 (0.000)***</td>
<td>-1.9096 (0.000)***</td>
</tr>
<tr>
<td>Δdivorce{1}</td>
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<td>N/A</td>
<td>N/A</td>
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<td>N/A</td>
<td>0.0294 (0.291)</td>
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<tr>
<td>Δdivorce{8}</td>
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<tr>
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<td>N/A</td>
<td>N/A</td>
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</tr>
<tr>
<td>2006Q3</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>0.0514 (0.000)***</td>
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<tr>
<td>2006Q4</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>0.0701 (0.000)***</td>
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<tr>
<td>2007Q1</td>
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<td>N/A</td>
<td>N/A</td>
<td>0.1332 (0.000)***</td>
</tr>
<tr>
<td>2007Q2</td>
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<td>N/A</td>
<td>N/A</td>
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<tr>
<td>2007Q3</td>
<td>N/A</td>
<td>N/A</td>
<td>N/A</td>
<td>-0.0364 (0.013)**</td>
</tr>
<tr>
<td>2007Q4</td>
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<td>N/A</td>
<td>N/A</td>
<td>0.0142 (0.237)</td>
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<tr>
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<td>N/A</td>
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<td>N/A</td>
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<td>N/A</td>
<td>N/A</td>
<td>0.881 (0.000)***</td>
</tr>
</tbody>
</table>

*Significant at the ten-percent level.
**Significant at the five-percent level.
***Significant at the one-percent level.
1.5 **Conclusions**

Consistent with the results of our theoretical model, there appears to be strong evidence that more generous homestead exemptions encourage Chapter 7 consumer bankruptcy filings. In terms of the theoretical model, an increase in the exemption level, \( x \), induces a decline in the effort level exerted to avoid default, \( e \), and hence causes an increase in defaults. Additionally, past unemployment rates appear to have a positive and statistically significant effect on bankruptcy filing rates. The loss of one’s job is likely to be a catalyst for bankruptcy sometime later. Further, higher home prices have a strong negative effect on filing rates. This may occur because higher home values enable consumers to expand their home equity loans to pay off pressing unsecured debts, and also because they make homeowners dread the loss of home equity if they file for bankruptcy. Finally, there is some evidence that lagged divorce rates have at least a marginally statistically significant positive effect on filing rates.

These findings together present evidence that, after accounting for other variables, there exists a downward-sloping demand curve for Chapter 7 consumer bankruptcy. In this respect our research supports the economic model of bankruptcy: the higher the financial benefit of filing, the more likely a household is to file for bankruptcy. This downward-sloping demand curve for consumer bankruptcy is borne out in two variables. First, a higher homestead exemption represents a higher financial benefit of bankruptcy and is associated with higher filing rates. Second, a lower home value represents a lower financial cost of bankruptcy and so, too, is associated with higher filing rates. Our conclusion regarding the homestead exemption implies that the exemption creates a moral hazard problem. One policy implication is that state legislatures should be conscious that homestead exemptions affect not only the welfare of bankrupts, but also the number of bankrupts.
Additionally, the upward influences of unemployment and divorce rates on filing rates support the sociological model of bankruptcy in some respects. Bankruptcy, then, does not seem to be only a matter of opportunism. One policy implication of this fact is that if states desire to reduce the bankruptcy rate, they may be able to do so by enacting policies that lower their unemployment and divorce rates. We consider this analysis to be a useful addition to the bankruptcy literature.
CHAPTER 2

HOUSEHOLD DEBT AND THE MACROECONOMY: A VECM ANALYSIS

Household debt has generally been steadily rising in the United States as a percentage of disposable income since the early 1980s and has become a burden for increasing numbers of households. This debt takes many forms, including amortizing mortgage debt and consumer installment loans, as well as non-amortizing sources of credit such as home equity loans and credit cards. This chapter investigates the relationships of household debt levels to various factors including home prices, interest rates, consumption, disposable income and unemployment.

Figure 2.1 illustrates the trajectory of the ratio of household-sector debt to disposable income in the U.S. from 1987 to 2009. This figure trended almost monotonically upward from 1987 to 2007, changing from about 0.85 in 1987 to nearly 1.3 in 2007. Figure 2.2 illustrates the path of the log of real per-capita household debt from 1987 to 2009. This figure also trended almost monotonically upward from 1987 until about 2007, representing about $18,500 in 1980 (in 2005 dollars) and reaching about $42,000 in 2007. Bean (2003) notes that according to the 1998 SCF, home-secured debt accounted for 71.9 percent of all household debt. The second largest portion was installment loans, which accounted for 12.8 percent of household debt.
Figure 2.1. Ratio of household-sector debt to disposable income, 1987-2009.

Figure 2.2. Log of real per-capita household debt, 1987-2009.
There are several reasons why the level of household debt is an important macroeconomic issue. One reason is that as households’ debt-to-income ratios rise, their sensitivity to changes in interest rates rises as well. This level of sensitivity is most severe when a large portion of a household’s debt is in variable-rate instruments such as credit cards. A second reason for the importance of current household debt levels is that they may be unsustainable in the long term. If so, there must eventually be changes in the U.S. economy to reverse the trend of rising debt, such as a depreciation of the dollar and an increase in the size of the tradable goods sector (Obstfeldt and Rogoff 2007).

One important issue in this analysis is which measure of household debt is to be used. Broadly speaking, there are three alternative measures: (1) gross debt, which equals the total principal on the liabilities side of households’ balance sheets; (2) net debt, which equals households’ total assets minus their total liabilities; and (3) the debt service ratio, which equals the ratio of minimum periodic debt payments to disposable income. In a world without liquidity constraints, net debt would be a satisfactory measure of households’ financial positions. At any time of their choosing, households could sell perfectly liquid assets to pay their debts. However, in the real world households tend to face liquidity constraints: as a simple example, there are frictions involved in selling one’s house. Additionally, changes in interest rates may distort the picture painted by debt service ratios. Therefore this chapter will focus on gross household debt.

The rest of the chapter is organized as follows. Section 2.1 provides an outline of some existing literature on this topic. Section 2.2 provides a theoretical basis for our empirical work. Section 2.3 describes our data and estimation methodology. Section 2.4 provides our results. Section 2.5 discusses robustness checks. Section 2.6 concludes.
2.1 Existing Literature

Existing literature has studied various aspects of the dynamics of household debt but has not used vector autoregression (VAR) and error correction methods as they are used in this chapter. The existing literature tends to find a positive relationship between household debt and home prices. The literature tends to find a negative relationship between household debt and interest rates. The verdict of the existing literature is mixed on income levels and unemployment. First, consider home prices.

Many authors believe that rising home prices have had an important impact on rising household debt levels. Household indebtedness is believed to rise with home prices as homeowners become better able to borrow against their home values. Authors with this view include, for example, Mishkin (1996); Prinsloo (2002); Wolswijk (2005); and Dynan and Kohn (2007). Consistent with the permanent income hypothesis (PIH), Mishkin notes from a theoretical perspective that home prices are a form of household wealth and increases in household wealth increase total lifetime resources, thus boosting consumption. Prinsloo empirically examines the dynamics of household debt in South Africa and finds that the phenomenon of rising house prices contributing to higher borrowing holds true in that economy. Wolswijk examines the effects of government fiscal policies in the European Union on mortgage debt accumulation with house prices as a peripheral interest. He finds that house prices are also influential in affecting mortgage debt growth in the EU. Dynan and Kohn investigate the causes of the rise of U.S. household indebtedness and find that relative house prices have a positive and statistically significant effect on household debt levels. In corroboration of this finding, home mortgage debt has risen at a faster pace than other debt since 1980, and seemingly in tandem with the rise in home prices. Additionally, Maki and Palumbo (2001) find that the increases in
net worth of the 1990s were driven in part by capital gains rather than saving. Thus it is plausible that some of the increase in debt during the 1990s may have been motivated by the comfort of rising asset prices.

Interactions between financial innovation and home prices also may have been at work. Dynan and Kohn (2007) note that given the development of home equity lines of credit, rising home prices gave households an easy method of borrowing against their home values. They also point out that from the perspective of financial institutions, rising home prices increase the return to financial innovations that allow homeowners to borrow against home equity. Additionally, Ortalo-Magné and Rady (2006) use a theoretical model to investigate the influence of income shocks and credit constraints on home prices, noting that financial innovations allow families to buy homes with smaller down payments. This makes purchasing a house easier at any given price, thus driving up home prices.

Second, consider interest rates. It is generally accepted that higher interest rates put downward pressure on household borrowing. Higher interest rates have the potential indirectly to reduce debt levels as borrowers seek to avoid higher interest payments. Waldron and Zampolli (2010) use a calibrated overlapping generations model and find that falling interest rates “were particularly important” in the increase in household debt in the United Kingdom between 1987 and 2006. Bean (2003) looks at the monetary policy implications of strong asset price movements and financial imbalances. He uses a theoretical model to estimate the effect of an unexpected one-percentage-point increase in interest rates occurring in 1980 and lasting until 1995. He finds a reduction in the aggregate debt-to-income ratio of 13 percentage points in the 1980s but a rapid increase in the 1990s. Among other things, he concludes that higher interest rates will cause households to borrow less and for shorter periods of time. However, he also
notes that there are key distinctions between expected and unexpected interest rate shocks.

Tudela and Young (2005), investigating the determinants of household debt in Britain, reach similar conclusions about the negative relationship between interest rates and household debt using a theoretical model that is calibrated to fit historical data. Additionally, Gross and Souleles (2002) perform an empirical study specifically on credit card debt. They estimate a long run elasticity of credit card debt to interest rates of -1.3.

Debelle (2004) does an analysis of the implications of rising household debt. He notes that in countries with predominantly fixed mortgage rates, the policy interest rate should have only a small effect on mortgage rates. Instead, long-term interest rates should have a larger effect on mortgage rates. In countries with predominantly variable mortgage rates, the policy interest rate should have a larger effect on mortgage rates. These effects, in turn, should affect borrowing and spending levels more in countries with variable-rate mortgages than in countries with fixed-rate mortgages. Hence in a country like the U.S., where most mortgages are fixed-rate mortgages, the policy rate should be expected to have less of an effect on debt levels than a longer-term rate.

 Dynan and Kohn (2007) consider the reduction in the U.S. aggregate saving rate, shown in figure 2.3. They note that it fell from around ten percent in 1980 almost to zero percent in 2006. They conclude that in the six years prior to the publication of their paper, the net decline in real interest rates accounted for about two percentage points of the decline in the aggregate saving rate. Still, it is important to recognize that the reduction in the household saving rate, while probably correlated with increases in household debt, will not have a one-to-one relationship with the latter. A reduction in household saving could accompany increased borrowing to finance consumption and investments, but this does not have to occur.
Callen and Thimann (1997) do an empirical analysis of the determinants of household saving using data from Organization for Economic Cooperation and Development countries. They find that the theoretical effect of a change in interest rates is ambiguous due to the conflicting substitution and income effects. Empirically, they find that the real interest rate is significant in some specifications but not in others. They note that empirical difficulties in finding a significant relationship between interest rates and saving rates may be due to difficulties in finding the correct after-tax interest rate.

Third, consider personal income. The literature is mixed on the effects of increases in expected income on household borrowing. According to the PIH (Friedman 1957), consumption closely tracks permanent income, which is determined by both lifetime labor income and lifetime asset appreciation. According to the theory, if expected lifetime labor income rises, or if expected lifetime asset appreciation rises, consumption should rise. In addressing the threats posed to the financial health of U.S. households by high levels of debt, Maki (2002) finds
evidence that consumers seem to take on debt when they expect their incomes to rise in the future, which is consistent with the PIH. Maki further notes that rising debt levels based on expected increases in future earnings are only worrisome if those expectations turn out to be incorrect. An empirical analysis of the determinants of unsecured borrowing in Britain by Del-Rio and Young (2005) suggests that current income is the main variable explaining cross-sectional differences in unsecured borrowing. Since current income is an influential predictor of future income, the conclusion of Del-Rio and Young may corroborate that of Maki.

Moreover, Bean (2003) discusses the effects of expected income increases on consumption expenditures, with reference to the PIH. Using a theoretical model, he explores the predicted effects of a fall in income growth beginning in the 1980s and lasting until 1995. In accordance with intuition, he finds a reduction in the debt-to-income ratio that reaches 33 percentage points by 1995. Bean also presents SCF data which suggest strongly that income is positively correlated with debt levels.

In contrast, Dynan and Kohn (2007) conclude that in the six years preceding the publication of their 2007 paper, expected increases in incomes do not seem to be a significant factor in the increase in debt levels. Since 1992 the SCF has asked consumers whether they expected their incomes to rise more than prices in the coming year. They state that the percentage of respondents answering in the affirmative declined in the six years preceding the publication of their 2007 paper, and “shows little trend over the past few decades.” Nevertheless, this is a somewhat cursory method and not all factors are accounted for.

Fourth, consider unemployment. The PIH would predict that as long as consumers do not lose their financing sources when they become unemployed, higher unemployment should cause debt to rise since current income has fallen more than permanent income. Keese (2007) explores
the determinants of severe levels of household debt in Germany. Using the German Socio-
Economic Panel, he finds evidence that unemployment increases a household’s debt-to-income
ratio, although this is mainly because it causes a fall in income.

On the other hand, Debelle (2004) notes that a possible increase in distressed home selling
following large-scale defaults associated with unemployment may decrease homeowners’
abilities to borrow against their home values. Moreover, using Spanish data, Nieto (2007) finds
that unemployment is negatively related to household debt levels for both demand- and supply-
related reasons. On the demand side, obtaining a job increases one’s expected income and thus
tends to increase one’s demand for credit. On the supply side, obtaining a job tends to increase
the supply of credit available to an individual due to lenders’ reluctance to lend to the
unemployed. This effect should not be an issue for home-secured debt. Although large portions
of debt are secured by homes (about 70 percent in the case of the United States), total household-
sector debt includes unsecured credit sources as well and thus may yield a muted effect of
unemployment on debt levels.

The results of this paper are consistent with broad conclusions in the literature in at least two
respects. One respect is that an intermediate-term interest rate consistently seems to have a
negative effect on household debt levels across multiple specifications. The second respect is
that home prices consistently seem to have a positive effect on debt levels across multiple
specifications. On the other hand, at least two results fail to corroborate the PIH. Our results
concerning unemployment seem to be somewhat neutral, possibly because not all financing
sources are home-secured and thus not all financing sources are independent of one’s job. In
addition, our results concerning permanent income are also somewhat muted, in contrast with the
PIH.
2.2 Theoretical Model

Suppose that individuals are infinitely lived and face the budget constraint that the expected present value of lifetime consumption must equal the expected present value of lifetime income plus net debt in the current period. Lifetime income consists of both labor income and realized capital gains. That is,

\[
E_t \sum_{s=t}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} c_s = E_t \sum_{s=t}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} y_s + A_t - (1 + r)d_{t-1},
\]

where \(c_s\) represents consumption in period \(s\), \(y_s\) represents income in period \(s\), \(A_t\) is total assets—including realized capital gains—held at the beginning of period \(t\), \(r\) is a constant interest rate and \((1+r)d_{t-1}\) is compounded revolving credit inherited from period \(t-1\). If no assets are sold during period \(t\), individuals face the following evolution equation for debt:

\[
d_t = (1 + r)d_{t-1} + (c_t - y_t).
\]

Equation (2.2) states that the current period’s debt is the compounded value of the last period’s debt plus the amount by which current consumption exceeds current income. Extrapolating forward, we obtain

\[
E_t d_{t+1} = (1 + r)d_t + E_t(c_{t+1} - y_{t+1}).
\]

This can be rearranged as follows.

\[
E_t d_{t+1} - (1 + r)d_t = E_t(c_{t+1} - y_{t+1})
\]

\[
d_t - \frac{1}{1+r} E_t d_{t+1} = \frac{1}{1+r} E_t(y_{t+1} - c_{t+1})
\]

\[
\left(1 - \frac{1}{1+r} L^{-1}\right) d_t = \frac{1}{1+r} E_t(y_{t+1} - c_{t+1})
\]
\[
d_t = \frac{1}{1 - \frac{1}{1+r}} \frac{1}{1+r} E_t(y_{t+1} - c_{t+1}) \\
= \left[ 1 + \frac{1}{1+r} L^{-1} + \left( \frac{1}{1+r} \right)^2 L^{-2} + \cdots \right] \frac{1}{1+r} E_t(y_{t+1} - c_{t+1}).
\]

Therefore

\[
d_t = \sum_{i=0}^{\infty} \left( \frac{1}{1+r} \right)^{i+1} E_t(y_{t+i+1} - c_{t+i+1}). \tag{2.4}
\]

This expression implies that

\[
d_{t-1} = \sum_{i=0}^{\infty} \left( \frac{1}{1+r} \right)^{i+1} E_{t-1}(y_{t+i} - c_{t+i}), \tag{2.5}
\]

so that

\[
d_t - d_{t-1} = \Delta d_t = rd_{t-1} + E_{t-1}(y_t - c_t) \\
+ \sum_{i=0}^{\infty} \left( \frac{1}{1+r} \right)^{i+1} \left[ (E_t y_{t+i+1} - E_{t-1} y_{t+i}) - (E_t c_{t+i+1} - E_{t-1} c_{t+i}) \right]. \tag{2.6}
\]

Keeping in mind that the household does not wish to sell assets to finance consumption in the current period, equation (2.4) states that the household holds revolving credit only if the time pattern of expected future income differs from that of expected future consumption. The present value of future income must exceed that of future consumption if debt is owed in period \(t\).

Equation (2.6) shows that the amount of revolving credit owed changes only if there is new information about the time patterns of future income and consumption (as represented by the difference between the \(E_t\) and \(E_{t-1}\) terms). If debt held increases in period \(t\), then it is because the new information acquired during the period shows that the present value of future income has increased relative to that of future consumption.

Consider a household which suffers a spell of unemployment during period \(t\) that is expected to last only a few periods. Because consumption is smoothed, the values of the \(c_{t+i}\)'s in equation (2.6) all decrease in accordance with how much the present value of current and future income has increased.
income has declined, which will be less than the decline in current income. But this must mean that the present value of future income has increased relative to the present value of future consumption. Hence it is appropriate in this situation for the household to increase its debt, provided that credit is available. As noted previously, this is not a condition that necessarily applies to our data.

2.3 Data and Methodology

This chapter examines how macroeconomic variables determine households’ use of credit. The variables in our baseline model are \( lcsresids \), the log of the real Case-Shiller national home price index; \( ldpc \), the log of real per-capita household-sector debt; \( lcons \), the log of real per-capita personal consumption expenditures; \( lunemp \), the log of the unemployment rate; \( gs10 \), the ten-year constant-maturity Treasury rate; and \( fedfunds \), the federal funds rate. Additionally, in other specifications of our model we consider the influence of \( lsp500 \), the log of the real S&P 500 index.

We test for error correction based on the possibility that there is at least one cointegrating relationship between \( lcsresids \), \( ldpc \), \( lcons \), and \( gs10 \). Knowing that the long-term relationship between three upward-trending variables and an interest rate might be somewhat weak, we also test for cointegration among only \( lcsresids \), \( ldpc \), and \( lcons \). Specifically, we hypothesize a VECM of the form

\[
\Delta x_t = \gamma + \pi x_{t-1} + \sum_{i=1}^l \pi_i \Delta x_{t-i} + \epsilon_t, \tag{2.7}
\]

where \( \gamma \) is a constant, the \( \pi \) terms are parameters to be estimated, \( \pi = \alpha \beta' \), and both \( \alpha \) and \( \beta \) are \( n*r \) matrices, \( n \) being the number of endogenous variables in the model and \( r \) being the rank of \( \pi \) or, equivalently, the number of cointegrating vectors. The matrix \( \alpha \) is considered the speed-of-adjustment matrix and the matrix \( \beta \) is the set of cointegrating vectors. The model is estimated
with a constant both inside the cointegrating space (i.e., inside $\beta$) and outside the cointegrating space in order to avoid unnecessarily restricting the model. Since we use quarterly data, we test between four and eight lags using the Schwarz-Bayesian Criterion (SBC). We calculate the SBC as

$$SBC = T \ln |\Sigma| + N k \ln(T),$$

where $T$ is the number of observations, $N$ is the number of equations in the system, $k$ is the number of regressors in each equation and $\Sigma$ is the variance-covariance matrix of the residuals. Using eight lags (with the appropriate cointegrating relations under an eight-lag estimation) yields an SBC of $-2518$, whereas using four lags (with the appropriate cointegrating relations under a four-lag estimation) yields an SBC of $-2897$. Therefore we let $l = 4$ in our tests for cointegration. As alluded to above, in our baseline model,

$$x_t = [\text{lunemp}_t \ \text{lcons}_t \ \text{ldpc}_t \ \text{lcsresids}_t \ \text{gs10}_t \ \text{fedfunds}_t]' .$$

Note that either two or three rows of $\pi$ are populated by zeros, depending on whether $gs10$ is included in the cointegrating space.

We use quarterly data from 1987:I to 2009:IV because the national Case-Shiller index did not become available until 1987:I. Please see Appendix B for our data sources. We intend for consumption expenditures to serve as a proxy for permanent income. Lettau and Ludvigson (2001) show that the consumption-wealth ratio summarizes expected returns on aggregate wealth. Specifically, they find that consumption, asset holdings and labor income are cointegrated and that deviations from their long-term relationship imply expectations about future returns on aggregate wealth. This implies that consumption closely tracks the two components of permanent income—assets and labor income—and thus can be used to represent
permanent income. (However, as a robustness check we also include results in which we use
disposable personal income, denoted as $lpdi$, instead of consumption expenditures.)

We use a nominal ten-year interest rate rather than a real interest rate for two reasons. First,
estimating an expected real rate is difficult over a ten-year period. Second, shocks to this
nominal rate tend to be driven by expected future inflation and other conditions rather than by
current inflation. Thus, shocks to this nominal rate roughly represent shocks to real interest
rates. We are interested in a ten-year interest rate because we want to avoid the possible errors
of using only a short-term rate (the federal funds rate), as well as the possible errors of using a
very long-term rate. A portion of household debt is intermediate-term debt rather than long-term
debt, and most of household debt is not very short-term debt. Hence we use an intermediate-
term interest rate to take the middle ground between very long maturities and very short
maturities. Nevertheless, as a robustness check we also employ a specification using a 30-year
mortgage rate instead of the ten-year Treasury rate and find that the impulse response results are
not meaningfully changed.

In the event that cointegration does not appear to be present, a simpler model becomes
appropriate, taking the form of

$$
\Delta x_t = \gamma + \sum_{i=1}^{l} \pi_i \Delta x_{t-i} + \varepsilon_t.
$$

Before testing for cointegration, we examine the time series properties of each variable to
determine the order of integration and to consider where cointegration might exist. Figures 2.4-
2.11 show the levels and first differences of each variable we have mentioned so far. As figures
2.4, 2.5, 2.6, 2.10 and 2.11 respectively show, income, household debt, home prices,
consumption and the S&P 500 appear to follow either a deterministic or a stochastic upward
trend. In contrast, the unemployment rate seems to be a random walk process without drift and
the ten-year rate and federal funds rate seem to be random walk processes with possible
downward stochastic trends.

Figure 2.4. Log of real per-capita personal income, in levels (*top*) and in differences (*bottom*).
Figure 2.5. Log of real per-capita household-sector debt, in levels (top) and in differences (bottom).
Figure 2.6. Log of the real Case-Shiller home price index, after using a seasonal adjustment method, in levels (top) and in differences (bottom).
Figure 2.7. Log of the unemployment rate, in levels (top) and in differences (bottom).
Figure 2.8. Ten-year constant-maturity Treasury rate, in levels (top) and in differences (bottom).
Figure 2.9. Federal funds rate, in levels (top) and in differences (bottom).
Figure 2.10. Log of real per-capita personal consumption expenditures, in levels (*top*) and in differences (*bottom*).
Figure 2.11. Log of real S&P 500, in levels (top) and in differences (bottom).

We also display the autocorrelation functions (ACFs) and partial autocorrelation functions (PACFs) of each variable in levels and in differences, out to 25 quarters, in figures
2.12-2.19. With the exceptions of the unemployment and federal funds rates, the ACFs are quite persistent for each variable, strongly suggesting that they are I(1).
Figure 2.12. ACFs and PACFs of unemployment in levels (top) and in differences (bottom).
Figure 2.13. ACFs and PACFs of consumption in levels (top) and in differences (bottom).
Figure 2.14. ACFs and PACFs of debt in levels (top) and in differences (bottom).
Figure 2.15. ACFs and PACFs of home prices in levels (top) and in differences (bottom).
Figure 2.16. ACFs and PACFs of the ten-year Treasury rate in levels (*top*) and in differences (*bottom*).
Figure 2.17. ACFs and PACFs of the federal funds rate in levels (*top*) and in differences (*bottom*).
Figure 2.18. ACFs and PACFs of disposable income in levels (top) and in differences (bottom).
To find further evidence concerning the variables’ levels of integration, we perform augmented Dickey-Fuller tests with four lags, as well as KPSS tests. Tables 2.1-2.4 show the critical values and our test statistics for these tests. The null hypothesis for the Dickey-Fuller
tests, whose results are shown in table 2.2, is that a given variable is non-stationary. Excepting home prices, the null hypothesis for each variable cannot be rejected either with or without a trend. Home prices show some evidence of being trend-stationary, allowing us to reject the null hypothesis at the five-percent level in our augmented Dickey-Fuller test that includes a trend; however, KPSS tests find a contrary result. The null hypothesis for the KPSS tests, whose results are shown in table 2.4, is that a given variable is stationary. For each variable except unemployment the null hypothesis can be rejected at highly significant levels, whether or not a trend is imposed.

Table 2.1. Dickey-Fuller critical values for the sample.

<table>
<thead>
<tr>
<th>Significance level</th>
<th>Constant, no time trend</th>
<th>Constant with time trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>-2.58</td>
<td>-3.16</td>
</tr>
<tr>
<td>5%</td>
<td>-2.89</td>
<td>-3.46</td>
</tr>
<tr>
<td>1%</td>
<td>-3.51</td>
<td>-4.07</td>
</tr>
</tbody>
</table>

Table 2.2. Dickey-Fuller tests of variables, four lags on the differences.

<table>
<thead>
<tr>
<th>Variable</th>
<th>t-statistic, with constant but no trend</th>
<th>t-statistic, with constant and trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>gs10</td>
<td>-1.18</td>
<td>N/A</td>
</tr>
<tr>
<td>lcsresids</td>
<td>-2.21</td>
<td>-3.65**</td>
</tr>
<tr>
<td>lsp500</td>
<td>-1.90</td>
<td>-1.73</td>
</tr>
<tr>
<td>ldpc</td>
<td>-1.58</td>
<td>-2.36</td>
</tr>
<tr>
<td>lcons</td>
<td>-0.84</td>
<td>-1.80</td>
</tr>
<tr>
<td>fedfunds</td>
<td>-2.02</td>
<td>N/A</td>
</tr>
<tr>
<td>lunemp</td>
<td>-2.38</td>
<td>N/A</td>
</tr>
<tr>
<td>lphdi</td>
<td>-0.65</td>
<td>-1.20</td>
</tr>
</tbody>
</table>

*Significant at the ten-percent level.
**Significant at the five-percent level.
***Significant at the one-percent level.
Table 2.3. KPSS critical values for the sample.

<table>
<thead>
<tr>
<th>Significance level</th>
<th>Critical value, no trend</th>
<th>Critical value with trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>0.35</td>
<td>0.12</td>
</tr>
<tr>
<td>5%</td>
<td>0.46</td>
<td>0.15</td>
</tr>
<tr>
<td>1%</td>
<td>0.74</td>
<td>0.22</td>
</tr>
</tbody>
</table>

Table 2.4. KPSS test results.

<table>
<thead>
<tr>
<th>Variable</th>
<th>KPSS statistic, no trend</th>
<th>KPSS statistic with trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>gs10</td>
<td>1.74***</td>
<td>N/A</td>
</tr>
<tr>
<td>lcsresids</td>
<td>1.18***</td>
<td>0.25***</td>
</tr>
<tr>
<td>lsp500</td>
<td>1.38***</td>
<td>0.31***</td>
</tr>
<tr>
<td>ldpc</td>
<td>1.87***</td>
<td>0.39***</td>
</tr>
<tr>
<td>lcons</td>
<td>1.92***</td>
<td>0.20**</td>
</tr>
<tr>
<td>fedfunds</td>
<td>1.00***</td>
<td>N/A</td>
</tr>
<tr>
<td>lunemp</td>
<td>0.23</td>
<td>N/A</td>
</tr>
<tr>
<td>lpdii</td>
<td>1.93***</td>
<td>0.22***</td>
</tr>
</tbody>
</table>

*Significant at the ten-percent level.
**Significant at the five-percent level.
***Significant at the one-percent level.

Since interest rates, asset prices and GDP generally have unit roots, it is unsurprising to find that the gs10, lcons, lcsresids, lsp500, fedfunds and lpdii series seem to be I(1). Since debt levels seem loosely to track income, it also seems unsurprising that the ldpc series is I(1) as well. Although the literature generally treats unemployment as regime-wise stationary (see, for example, Papell, Murray and Ghiblawi 2000), some evidence suggests that here it should be treated as a random walk. A Dickey-Fuller test cannot reject the null hypothesis of non-stationarity at any meaningful significance level. Thus all of our variables are treated as I(1). However, when unemployment is treated as I(0) as a robustness check, the impulse responses are not materially changed.

We convert the model to a moving average representation in order to analyze impulse response functions. Converting to a moving average representation requires identifying restrictions. We use a Choleski decomposition, for which causal ordering is significant.
We place the unemployment rate first since it has necessarily has a contemporaneous impact on current income. Current income is a determinant of permanent income, which is represented by consumption. Consumption is second, followed by debt levels since consumption strongly influences debt levels. Asset prices—represented by home prices in our baseline model and by stock prices in an alternative specification—are placed fourth on the view that permanent income may influence demand for assets. The ten-year rate is placed fifth. Since the Federal Reserve attempts to take into account many contemporary macroeconomic variables in its feedback rule (Christiano, Eichenbaum and Evans 1996b), we place the federal funds rate last in our decomposition.

2.4 Results

We arrive at a number of conclusions that seem robust to different model specifications. First, a shock to debt levels has a persistent, significant positive effect on debt levels themselves. Second, a shock to home prices has a significant and increasing positive effect on debt levels. Third, a positive shock to the ten-year rate has a marginally significant negative effect on debt levels. Fourth, debt shocks account for potentially the vast majority of the forecast error variance in debt. Counterintuitively, do not find a consistent positive effect of consumption on debt levels, although there is some modest evidence of such an effect.

Our initial, unrestricted VECM obtains the cointegrating relations shown in table 2.5. We first test for cointegration among lcsresids, lcons, ldpc and gs10, and then test for cointegration among only lcsresids, lcons, and ldpc. (We use home prices as our measure of debt in our baseline model since about 70 percent of household debt is secured by a home.) Tables 2.6 and 2.7 show rank test statistics for these two models using a VECM with four lags on the differenced variables. In both of these tables, the last column—labeled “P-Value*”—represents
the marginal significance of the small-sample-corrected trace statistic, given in the middle column as “Trace*”. The second-to-last column gives the ninety-five-percent critical value of the trace statistic. The top-row entry is a test of the null hypothesis that there are no cointegrating relationships against the alternative hypothesis that there is at least one relationship. The second-row entry is a test of the null hypothesis that there exists no more than one cointegrating relationship against the alternative that there exist two or more. Tables 2.6 and 2.7 both proceed in this manner. In table 2.6, which tests for cointegration between all four variables, the first small-sample-corrected trace statistic is 47.802 and the p-value is 0.162. For each test of fewer cointegrating relationships against more relationships in table 2.6, we must accept the null hypothesis of fewer relationships. Hence we conclude that there are no cointegrating relationships between these variables. Observing the respective paths of the variables in figures 2.5, 2.6, 2.8 and 2.10 adds some intuition to this finding: the interest rate is much more volatile than the other three variables and does not seem to be strongly influenced by them.

**Table 2.5.** \( \beta' \), unrestricted VECM model.

<table>
<thead>
<tr>
<th></th>
<th>lcsresids</th>
<th>lcons</th>
<th>ldpc</th>
<th>constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \beta_1 )</td>
<td>-15.058</td>
<td>-31.145</td>
<td>24.055</td>
<td>68.817</td>
</tr>
<tr>
<td>( \beta_2 )</td>
<td>0.161</td>
<td>24.024</td>
<td>13.213</td>
<td>105.619</td>
</tr>
<tr>
<td>( \beta_3 )</td>
<td>-3.060</td>
<td>-39.444</td>
<td>24.243</td>
<td>153.479</td>
</tr>
</tbody>
</table>

**Table 2.6.** Rank test statistics: interest rate, consumption, home prices, and debt.

<table>
<thead>
<tr>
<th>Rank of ( \pi )</th>
<th>Eigenvalue</th>
<th>Trace*</th>
<th>95% critical value</th>
<th>P-Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.352</td>
<td>47.802</td>
<td>53.945</td>
<td>0.162</td>
</tr>
<tr>
<td>1</td>
<td>0.212</td>
<td>27.230</td>
<td>35.070</td>
<td>0.281</td>
</tr>
<tr>
<td>2</td>
<td>0.153</td>
<td>12.864</td>
<td>20.164</td>
<td>0.383</td>
</tr>
<tr>
<td>3</td>
<td>0.115</td>
<td>5.139</td>
<td>9.142</td>
<td>0.278</td>
</tr>
</tbody>
</table>
In table 2.7, which tests for cointegration among \textit{lcsresids}, \textit{lcons} and \textit{ldpc}, the first small-sample-corrected trace statistic is 38.919 and the p-value is 0.017. Therefore we reject the null hypothesis that there are no cointegrating relationships in favor of the alternative that there exists at least one. The second trace statistic is 18.311 and the second p-value is 0.090. At the conventional five-percent significance level, we therefore accept the null hypothesis that there exists no more than one relationship. The final row of table 2.7 does not give any reason to question this judgment, causing us to accept the null hypothesis that there are fewer than three relationships over the alternative that there are at least three. Therefore we conclude that there exists one cointegrating relationship between \textit{lcsresids}, \textit{lcons}, and \textit{ldpc}. Hence we restrict the rank of the $\pi$ to equal one in the VECM that we will consider our baseline model, resulting in the $\alpha$ and $\beta$ matrices shown in tables 2.8 and 2.9, respectively.

\textbf{Table 2.7.} Rank test statistics: consumption, home prices, and debt.

<table>
<thead>
<tr>
<th>Rank of $\pi$</th>
<th>Eigenvalue</th>
<th>Trace*</th>
<th>95% critical value</th>
<th>P-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.336</td>
<td>38.919</td>
<td>35.070</td>
<td>0.017</td>
</tr>
<tr>
<td>1</td>
<td>0.180</td>
<td>18.311</td>
<td>20.164</td>
<td>0.090</td>
</tr>
<tr>
<td>2</td>
<td>0.125</td>
<td>2.935</td>
<td>9.142</td>
<td>0.601</td>
</tr>
</tbody>
</table>

\textbf{Table 2.8.} $\beta'$ normalized by debt, baseline model (t-statistics in parentheses).

<table>
<thead>
<tr>
<th>$lcons$</th>
<th>$lcsresids$</th>
<th>$ldpc$</th>
<th>constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.295 (-16.383)</td>
<td>-0.626 (-9.979)</td>
<td>1.000 (N/A)</td>
<td>2.861 (3.595)</td>
</tr>
</tbody>
</table>
Table 2.9. \( \alpha \), baseline model (p-values in parentheses).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Delta \text{ldpc} )</td>
<td>.020 (0.386)</td>
</tr>
<tr>
<td>( \Delta \text{gs10} )</td>
<td>-2.487 (0.165)</td>
</tr>
<tr>
<td>( \Delta \text{lunemp} )</td>
<td>.267 (0.032)**</td>
</tr>
<tr>
<td>( \Delta \text{lcons} )</td>
<td>-.033 (0.007)***</td>
</tr>
<tr>
<td>( \Delta \text{lcsresids} )</td>
<td>-.139 (0.000)***</td>
</tr>
<tr>
<td>( \Delta \text{fedfunds} )</td>
<td>-1.252 (0.324)</td>
</tr>
</tbody>
</table>

*Significant at the ten-percent level.
**Significant at the five-percent level.
***Significant at the one-percent level.

In results that we do not report here, we do not find evidence that \( \text{lsp500} \) belongs in a cointegrating relationship with \( \text{ldpc} \) and \( \text{lcons} \). Therefore, in alternative specifications that use \( \text{lsp500} \) instead of \( \text{lcsresids} \) as a wealth measure, we do not include a cointegration concept.

Table 2.8 summarizes the following cointegrating relationship, with t-statistics indicating that each coefficient is highly significant:

\[
z_t = -2.861 + 1.295 c_t + 0.626 p_t.
\]

The mathematical relationship implies that per-capita debt levels have a long-term positive relationship with both home prices and consumption. Since both of these variables are closely related to permanent income, this relationship seems consistent with the PIH. It is interesting that the magnitude of the consumption coefficient is roughly twice that of the home price coefficient. Since consumption should move in an almost one-for-one fashion with permanent income and home prices are only a portion of permanent income, it is consistent with intuition that consumption should have a greater impact on debt levels than do home prices.

The speed-of-adjustment matrix \( \alpha \) has important implications as well. Note that table 2.9 identifies three variables as having significant speed-of-adjustment parameters: the unemployment rate, consumption and home prices. The unemployment rate has a positive and
significant speed-of-adjustment parameter. This implies that when the value of the cointegrating relationship,

$$z_t + 2.861 - 1.295c_t - 0.626p_t,$$  \hspace{1cm} (2.10)

rises, the unemployment rate rises. The value of the relationship rises if either consumption falls or home prices fall, which is consistent with intuition. Conversely, if the value of the relationship falls—often meaning that consumption has risen or home prices have risen—the unemployment rate falls. Additionally, table 2.9 shows that consumption and home prices have negative speed-of-adjustment parameters. This means, for example, that if home prices rise, consumption rises. It also means that if consumption rises, which means that permanent income has risen, then home prices also rise as the demand for homes rises.

With a single cointegrating relationship, performing weak exogeneity tests on the variables in table 2.9 is as simple as noting which variables have insignificant speed-of-adjustment parameters. A weakly exogenous variable does not respond immediately to disturbances in the cointegrating relationship. The variables with insignificant speed-of-adjustment parameters are debt, the ten-year rate and the federal funds rate. Thus for each of these three variables we cannot reject the null hypothesis of weak exogeneity. The conclusion that debt is weakly exogenous implies that debt is somewhat idiosyncratic in the short term. Households’ debt levels therefore seem to exercise a large degree of inertia over forces that work to change them.

Three caveats are important, however. First, the period from 2006 to 2009 was abnormal in many respects due to the housing market meltdown and accompanying financial crisis. Real housing prices peaked in 2006 and unemployment began rising at an increasing rate in 2007. Turmoil in the housing market and in the broader economy could plausibly have distorted some
otherwise long-term relationships between consumption, asset prices and debt. Such turmoil could also have made a long-term relationship appear to exist when in fact it did not. Therefore, omitting these years constitutes a healthy robustness check. Second, the S&P 500 might be a better measure of wealth than home prices because it contains more information about investors’ current assessments of the broader economy and about investors’ expectations for the future. Third, consumption is intended to represent permanent income, which is influenced significantly by wealth, and thus in some respects including a measure of wealth is redundant. Due to these considerations, we present impulse responses varying both the time window and our measure of wealth, or omission of such a measure. Cointegration rank tests, which we do not present here, suggest that a cointegrating relationship is not justified in any specifications besides our baseline specification. This casts some doubt on the legitimacy of cointegration in our baseline model, and therefore as a robustness check we include impulse response results for our baseline model assuming no cointegration.

We present the impulse responses for six specifications with a 16-quarter horizon in figures 2.20-2.25. These impulse responses are estimated in levels rather than in differences. The outer bands are 90-percent confidence bands, computed via Monte Carlo integration with 2500 replications. Thus the top and bottom confidence bands represent the estimated ninety-fifth percentile and fifth percentile of impulse response possibilities, respectively.

Figures 2.20 and 2.21 present impulse responses using home prices as the wealth measure. Figure 2.20 is the baseline specification and includes all data available from 1987:I to 2009:IV; figure 2.21 truncates the time window at 2005:IV. Figures 2.22 and 2.23 present impulse responses using the S&P 500 as the wealth measure. Figure 2.22 includes the full time window and figure 2.23 truncates the time window at 2005:IV. Figures 2.24 and 2.25 present impulse
responses omitting any wealth measure in order to attribute more influence to permanent income, which is represented by consumption. Figure 2.24 includes the full time window and figure 2.25 truncates the time window at 2005:IV.

**Figure 2.20.** Impulse responses for the baseline model, using the full time window.

<table>
<thead>
<tr>
<th>Impulse responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>LUNEMP</td>
</tr>
</tbody>
</table>

![Impulse Responses Graph](image-url)
Figure 2.21. Impulse responses including home prices, while truncating the time window at 2005:IV.
Figure 2.22. Impulse responses including the S&P 500, using the whole time window.
Figure 2.23. Impulse responses using the S&P 500, while truncating the time window at 2005:IV.
**Figure 2.24.** Impulse responses without any wealth measure, using the whole time window.
Figure 2.25. Impulse responses without any wealth measure, while truncating the time window at 2005:IV.

Across all specifications, a positive shock to the ten-year rate has a negative and at least marginally significant effect on debt levels. Furthermore, in both specifications that include home prices, home prices have a positive and significant effect on debt levels.

Figure 2.20 presents a few puzzles. First, a positive shock to the unemployment rate seems to have a positive effect on home prices. This effect is eliminated in figure 2.21 when we truncate the data window to isolate the bursting of the housing bubble. Additionally, the effect is eliminated when we use the S&P 500 as a wealth measure or remove a wealth measure from the model entirely. A positive shock to the unemployment rate is actually shown to reduce the S&P 500, as should be expected.
A second puzzle presented by figure 2.20 is that a positive consumption shock does not have a significant effect on household debt. This finding is generally true across specifications, although it has a slightly ambiguous positive effect in figures 2.22-2.25, where we use the S&P 500 as a wealth measure or use no wealth measure at all. The PIH suggests that a positive shock to permanent income should increase debt levels if current income has not risen in tandem. Hence the weak response of debt to consumption is puzzling.

A third puzzle presented by figure 2.20 is that a positive shock to either interest rate does not have a significant effect on the unemployment rate. This result is constant throughout all specifications, in spite of various papers with differing results (see, e.g., Christiano, Eichenbaum and Evans 1999).

Consider figures 2.22 and 2.23 as less controversial representations of the system. In both figures, consider first a shock to the unemployment rate. This shock has a persistent positive effect on unemployment itself. In addition to having a negative effect on consumption, it also has a negative effect both on the S&P 500 index, reflecting investors’ outlooks, and on the federal funds rate, reflecting the response of the Federal Reserve to worsened economic conditions.

Second, consider a shock to consumption. This shock has a negative effect on unemployment as higher spending increases the demand for labor. A positive effect can be seen both on consumption itself and potentially on debt levels as consumers perceive that their permanent incomes have risen. Additionally, this shock to consumption has a positive effect on the federal funds rate as the Federal Reserve acts to contain the effects of the consumption shock.

Third, consider a shock to debt itself. This shock has a positive and long-lasting effect on debt, reinforcing the view that the debt trajectory is not easily altered.
Fourth, consider a shock to the S&P 500 index. This has the effect of reducing the unemployment rate, probably reflecting improved outlooks on the part of employers. There is also a positive effect on consumption as consumers feel wealthier. The absence of a meaningful effect on debt levels may be due to the fact that a large portion of household debt consists of home mortgage debt and consumers make home-secured borrowing decisions based on their perceived home values rather than the stock market.

Fifth, consider a shock to the ten-year rate. This is associated with a clear downward movement in both consumption and debt levels. The negative effect on debt levels is consistent with the literature that we have cited above.

Sixth, consider a shock to the federal funds rate. Consistent with the logic of Debelle (2004), this shock has no discernible effect on household debt levels. A significant portion of U.S. household debt consists of fixed-rate amortizing mortgage debt, which is subject to long-term interest rates and therefore is not much affected by a change in a very short-term rate like the federal funds rate.

Tables 2.10-2.15 show forecast error variance decompositions for household debt, forecasting 24 quarters into the future. Although there is some degree of divergence between the results of the different models, each model attributes a sizable influence to debt itself. As tables 2.12-2.15 show, where home prices are not present, debt appears to account for at least 70 percent of the forecast error variance in debt. When home prices are included as in tables 2.10-2.11, debt still appears to account for at least 30 percent of the forecast error variance. In addition, with the exception of home prices, no other variable ever accounts for significantly more than 20 percent. The importance of debt shocks seems to suggest that debt holdings are somewhat idiosyncratic. Moreover, the apparent insignificance of the federal funds rate relative
to the ten-year rate suggests that consumers vary their borrowing more with long-term rates than with short-term rates, once again consistent with Debelle (2004).

**Table 2.10.** Error variance decompositions with a 24-quarter horizon, using home prices and full time window.

<table>
<thead>
<tr>
<th>% of variance in debt attributable to shocks in: debt</th>
<th>% of variance in debt attributable to shocks in: ten-year rate</th>
<th>% of variance in debt attributable to shocks in: unemployment</th>
<th>% of variance in debt attributable to shocks in: consumption</th>
<th>% of variance in debt attributable to shocks in: home prices</th>
<th>% of variance in debt attributable to shocks in: federal funds rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>33.117</td>
<td>7.659</td>
<td>20.940</td>
<td>8.051</td>
<td>28.590</td>
<td>1.642</td>
</tr>
</tbody>
</table>

**Table 2.11:** Error variance decompositions with a 24-quarter horizon, using home prices and truncating time window at 2005:IV.

<table>
<thead>
<tr>
<th>% of variance in debt attributable to shocks in: debt</th>
<th>% of variance in debt attributable to shocks in: ten-year rate</th>
<th>% of variance in debt attributable to shocks in: unemployment</th>
<th>% of variance in debt attributable to shocks in: consumption</th>
<th>% of variance in debt attributable to shocks in: home prices</th>
<th>% of variance in debt attributable to shocks in: federal funds rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>30.197</td>
<td>5.745</td>
<td>0.040</td>
<td>0.434</td>
<td>58.320</td>
<td>5.225</td>
</tr>
</tbody>
</table>

**Table 2.12.** Error variance decompositions with a 24-quarter horizon, using S&P 500 and full time window.

<table>
<thead>
<tr>
<th>% of variance in debt attributable to shocks in: debt</th>
<th>% of variance in debt attributable to shocks in: ten-year rate</th>
<th>% of variance in debt attributable to shocks in: unemployment</th>
<th>% of variance in debt attributable to shocks in: consumption</th>
<th>% of variance in debt attributable to shocks in: S&amp;P 500</th>
<th>% of variance in debt attributable to shocks in: federal funds rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>72.770</td>
<td>12.544</td>
<td>5.758</td>
<td>6.766</td>
<td>2.121</td>
<td>0.041</td>
</tr>
</tbody>
</table>
Table 2.13. Error variance decompositions with a 24-quarter horizon, using S&P 500 and truncating time window at 2005:IV.

<table>
<thead>
<tr>
<th>% of variance in debt attributable to shocks in: debt</th>
<th>% of variance in debt attributable to shocks in: ten-year rate</th>
<th>% of variance in debt attributable to shocks in: unemployment</th>
<th>% of variance in debt attributable to shocks in: consumption</th>
<th>% of variance in debt attributable to shocks in: S&amp;P 500</th>
<th>% of variance in debt attributable to shocks in: federal funds rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>57.621</td>
<td>20.905</td>
<td>3.691</td>
<td>12.487</td>
<td>3.391</td>
<td>1.905</td>
</tr>
</tbody>
</table>

Table 2.14. Error variance decompositions with a 24-quarter horizon, not using any wealth measure and using full time window.

<table>
<thead>
<tr>
<th>% of variance in debt attributable to shocks in: debt</th>
<th>% of variance in debt attributable to shocks in: ten-year rate</th>
<th>% of variance in debt attributable to shocks in: unemployment</th>
<th>% of variance in debt attributable to shocks in: consumption</th>
<th>% of variance in debt attributable to shocks in: federal funds rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>76.825</td>
<td>8.762</td>
<td>3.477</td>
<td>10.658</td>
<td>0.278</td>
</tr>
</tbody>
</table>

Table 2.15. Error variance decompositions with a 24-quarter horizon, not using any wealth measure and truncating time window at 2005:IV.

<table>
<thead>
<tr>
<th>% of variance in debt attributable to shocks in: debt</th>
<th>% of variance in debt attributable to shocks in: ten-year rate</th>
<th>% of variance in debt attributable to shocks in: unemployment</th>
<th>% of variance in debt attributable to shocks in: consumption</th>
<th>% of variance in debt attributable to shocks in: federal funds rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>77.640</td>
<td>13.404</td>
<td>3.237</td>
<td>5.692</td>
<td>0.027</td>
</tr>
</tbody>
</table>

2.5 Robustness Checks

This section is concerned with verifying the robustness of our VECM model. We observe the ACFs and PACFs of the residual series, out to 25 quarters, and display them in figures 2.26-2.31. For each variable the residuals seem to resemble a white noise process, as evidenced by the fact that the ACFs and PACFs do not tend to register values beyond the black ninety-five-percent confidence bands.
Figure 2.26. ACFs and PACFs for residuals of $\Delta l_{unemp}$.

Figure 2.27. ACFs and PACFs for residuals of $\Delta l_{cons}$. 
Figure 2.28. ACFs and PACFs for residuals of $\Delta ldpc$.

Figure 2.29. ACFs and PACFs for residuals of $\Delta lcsresids$. 
Additionally, we report Ljung-Box Q-statistics with 20 lags in table 2.16, using our baseline specification. For this test the null hypothesis is that there is no autocorrelation among the residuals out to 20 quarters. For each variable except home prices we are unable to reject the null hypothesis of no autocorrelation at any meaningful significance level.
Table 2.16. Ljung-Box Q-statistics, 20 lags, baseline model.

<table>
<thead>
<tr>
<th>Equation</th>
<th>Q(20)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta z$</td>
<td>18.326</td>
<td>0.565960</td>
</tr>
<tr>
<td>$\Delta i$</td>
<td>23.216</td>
<td>0.278292</td>
</tr>
<tr>
<td>$\Delta u$</td>
<td>20.927</td>
<td>0.401427</td>
</tr>
<tr>
<td>$\Delta c$</td>
<td>26.403</td>
<td>0.152920</td>
</tr>
<tr>
<td>$\Delta p$</td>
<td>30.076</td>
<td>0.068626*</td>
</tr>
<tr>
<td>$\Delta f$</td>
<td>22.684</td>
<td>0.304558</td>
</tr>
</tbody>
</table>

*Significant at the ten-percent level.
**Significant at the five-percent level.
***Significant at the one-percent level.

We provide comments on our seasonal adjustment method for home prices in Appendix C. We also note in Appendix D that changing the lag length does not alter the basic nature of the estimated cointegrating relationship in the baseline model. Tables D.1-D.2 in Appendix D show the rank tests and estimated cointegrating relations using three lags. Tables D.3-D.4 do the same using five lags. This lends credibility to the idea that if there is in fact a long-run relationship at work, our estimated relationship captures its essence.

As noted previously, omitting the years 2006-2009 casts doubt on our cointegrating relationship. This is our main reason for performing a robustness check by displaying the impulse response results assuming no cointegration in the baseline model. Making this assumption does not materially change in the impulse responses; we present impulse responses under this framework in figure 2.32. Additionally, in figure 2.33 we include the impulse responses of a model that includes income instead of consumption. Once again the results are not meaningfully different. Finally, in results not presented here, we find that impulse response estimates are not meaningfully changed if we treat the unemployment rate as being $I(0)$ instead of $I(1)$. 

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Figure 2.32. Impulse responses including home prices and using the whole time window, assuming no cointegration.
Figure 2.33. Impulse responses using personal income instead of consumption, and using the whole time window.

We next test the null hypothesis that a given variable can be excluded from the long-run cointegrating relationship. We present the results in table 2.17, with p-values in parentheses.

The test statistic is distributed as a $\chi^2(r)$ random variable, where $r$ is the rank of the $\pi$ matrix.

Table 2.17 shows that with one cointegrating relationship, no variable except the constant can be omitted from the relationship at the one-percent significance level.

<table>
<thead>
<tr>
<th>Rank of $\pi$ ($r$)</th>
<th>5% critical value</th>
<th>lcsresids</th>
<th>icons</th>
<th>ldpc</th>
<th>constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>3.841</td>
<td>18.509 (0.000)</td>
<td>7.459 (0.006)</td>
<td>9.778 (0.002)</td>
<td>2.885 (0.089)</td>
</tr>
<tr>
<td>2</td>
<td>5.991</td>
<td>23.072 (0.000)</td>
<td>9.225 (0.010)</td>
<td>11.323 (0.003)</td>
<td>4.820 (0.090)</td>
</tr>
</tbody>
</table>

We also test whether the cointegrating relationship that we obtain in our baseline model is stationary. Tables 2.18 and 2.19 below show the critical values and results of KPSS and
augmented Dickey-Fuller tests with four lags, respectively. The KPSS test fails to reject the null hypothesis of stationarity, and the Dickey-Fuller test rejects the null hypothesis of a unit root at the five-percent significance level. However, figure 2.34 is a graph of the cointegrating relationship, which shows a large degree of persistence. In our view, given that the existence of a cointegrating relationship is not robust to the time window, it is wisest to consider the long-term relationship between these variables to be weak. Still, even if the standards for cointegration are not met, to think that there is no long-run relationship whatsoever between household debt, incomes and home prices would also be very implausible.

Table 2.18. Dickey-Fuller and KPSS test critical values for the sample.

<table>
<thead>
<tr>
<th>Significance level</th>
<th>Dickey-Fuller critical t-statistic (with intercept and 4 lags)</th>
<th>KPSS critical value</th>
</tr>
</thead>
<tbody>
<tr>
<td>1%</td>
<td>-3.504</td>
<td>0.739</td>
</tr>
<tr>
<td>5%</td>
<td>-2.894</td>
<td>0.463</td>
</tr>
<tr>
<td>10%</td>
<td>-2.584</td>
<td>0.347</td>
</tr>
</tbody>
</table>

Table 2.19. Dickey-Fuller and KPSS test results for the cointegrating relationship.

<table>
<thead>
<tr>
<th>Dickey-Fuller t-statistic (with intercept and 4 lags)</th>
<th>KPSS statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2.967**</td>
<td>0.264</td>
</tr>
</tbody>
</table>

*Significant at the ten-percent level.
**Significant at the five-percent level.
***Significant at the one-percent level.
Additionally, we perform a Bai-Perron test to see whether there may be a structural break in household debt levels. We include a constant in the test and allow for only one structural break since a graph of the household debt series (figure 2.5) does not seem to allow for more than one break. The test suggests a break beginning at 2006:IV, with a 90-percent confidence interval within the period from 1999:III to 2007:III. Including an exogenous dummy variable in our VECM for this break does not materially change the estimated impulse responses.

### 2.6 Conclusions

The primary motivation of this chapter is an analysis of the determinants of household debt levels. Our results corroborate conclusions in the literature concerning intermediate-term and long-term interest rates’ negative effects on household debt levels. They are also consistent with the PIH in that increases in home prices seem to increase borrowing because they raise permanent income relative to current income. There is also some modest evidence in some
specifications that debt levels respond positively to permanent income shocks as represented by consumption shocks. With respect to the unemployment rate and federal funds rate, debt levels seem not to be easily influenced in the short term. Moreover, we show evidence that much of the predictive power for future household debt levels—perhaps as much as 70 percent—is contained in exogenous shocks to household debt levels themselves.

There are several implications of these results. One implication is that the PIH is corroborated with respect to the effects of home prices on debt, and to some degree with respect to the effects of permanent income on debt. Secondly, we corroborate the literature in finding that consumers take interest rates into account in their borrowing decisions. However, while consumers do respond to the basic variables that influence demand for credit—interest rates, lifetime incomes and past credit demand—they do not change their behavior very easily in the very short term. These diverse results are benefits of using the VECM methodologies set.
Revolving consumer credit in the United States has evolved from very humble beginnings (Mandell 1990) to rise substantially since the 1970s. During 1980 the average outstanding balance per person (in 2009 dollars) was about $810, whereas in 2009 it was about $3,860. White (2007) points out that credit card debt was 3.2 percent of the U.S. median family income in 1980 and had increased to 12.5 percent in 2004, arguing that the explosion of credit card debt is the main explanation of the five-fold increase in bankruptcy filings from 1980 to 2004. Since revolving credit is typically an unsecured form of credit with high interest rates, the instrument can cause hardships for consumers. In this chapter we use a VAR model to explore the effects of various macroeconomic variables on consumer revolving credit.

The chapter is organized as follows. Section 3.1 provides a brief review of some relevant existing literature. Section 3.2 presents a theoretical basis for our results. Section 3.3 describes our data and estimation methodology. Section 3.4 provides estimation results. Section 3.5 concludes.

3.1 Existing Literature

This chapter is motivated by consumers’ demand for revolving credit unsecured by real estate, exemplified by but not limited to that provided by credit cards. As we discuss below,
previous literature tends to find that expected future income and wealth are positively associated with both consumer spending and the amount of outstanding revolving consumer debt. The literature takes a more nuanced form regarding the relationships of current income and interest rates to revolving consumer credit. Finally, the literature does not provide unanimous results on the relationship of consumer credit to unemployment.

First, one would expect consumption and therefore revolving credit to increase with both wealth and expected future income if the PIH holds. The PIH states that consumption is based on lifetime income rather than on current income (Friedman 1957). An increase in asset prices is one way in which lifetime income can increase. Using survey data, Davies and Lea (1995) find that college students’ credit card balances are positively associated with their level of tolerance for debt, but they argue that this tolerance for debt is in turn proportional to their expectations of future income. In contrast, Kim and DeVaney (2001) use 1998 SCF data to find that income expectations are not significantly associated with outstanding credit card balances.

Secondly, if one accepts the PIH, then whether an increase in current income leads to an increase in credit depends on whether the increase in current income is viewed as temporary or permanent (or as a signal of even higher incomes in the future). As our theoretical model makes clear below, if an increase in current income is viewed as temporary, revolving credit declines. If an increase in current income corresponds to an equal increase in permanent income, there is no reason for revolving credit to change. Finally, if the increase in current income is less than the corresponding increase in permanent income, revolving credit increases. Slocum and Matthews (1970) use a survey to find that higher income brackets are associated with more positive views of credit card use. Additionally, Zhu and Meeks (1994) use SCF data from 1986 and find that two of the significant factors influencing a household’s credit balance were the
household head’s employment status and age, two factors that are highly correlated with income. Calem and Mester (1995) find that income is significantly positively related to credit card balances at middle and lower income levels but that the effect is approximately zero at the highest income level of the sample (perhaps because those with the highest incomes are more likely to have a current income that is on par with their permanent income). Calem and Mester (1995) point out that the higher balances associated with higher incomes may be due to either to an increase in demand or an increase in credit availability.

Kim and DeVaney (2001) provide insights that may shed light on the distinction between credit demand and credit availability. They use survey data and find that current income is negatively and significantly related to the likelihood of revolving one’s credit card balance. The PIH might suggest that this is the case because those with low incomes are more likely to have current incomes below their permanent incomes. On the other hand, among those with outstanding credit card balances, current income is positively and significantly related to those balances, possibly reflecting income-based supply constraints. Interestingly, Lea, Webley and Walker (1995) use survey data of people who owed money to a public utilities company. Since this debt can be classified as revolving credit, it is of interest to this chapter. They find that, among other characteristics, the debtors had lower incomes than those who did not owe money. This finding points to the possibility that lesser use of revolving credit among lower income earners may be due to a lack of supply rather than a lack of demand.

Thirdly, it is not completely clear how a change in interest rates affects revolving credit. As Deaton (1992) notes, purely from a theoretical perspective, in the short run a positive shock to interest rates can have either a positive or a negative effect on consumption depending on both consumer preferences and the consumer’s financial position. Since consumption is closely
related to debt levels, this suggests that the short-run effect of interest rates on debt levels could be either positive or negative. Regarding the long-run effect of interest rates, Gross and Souleles (2006) empirically estimate the long-run elasticity of credit card debt with respect to interest rates to be -1.3.

Fourthly, if a worker becomes unemployed and expects the period of unemployment to be relatively brief, his current income is likely to be less than his permanent income, so one would expect his revolving debt to increase. Sullivan (2002) presents evidence consistent with this position. He finds evidence that during unemployed spells households with some initial wealth borrow on average about 10 cents in unsecured debt for each dollar of lost income. This implies that these households increase their debt as a result of unemployment. In contrast, households with low initial wealth do not use unsecured credit during these periods. This is likely to be because creditors are reluctant to lend to an unemployed worker who has little or no wealth. Keese (2009) explores the determinants of severe levels of household debt, broadly defined, in Germany. Using the German Socio-Economic Panel, he finds evidence that unemployment increases a household’s debt-to-income ratio, but this does not provide strong support for the prediction that debt increases during spells of unemployment because he notes that the increase in the ratio appears to be mainly due to the fall in income while unemployed. Using Spanish data, Nieto (2007) presents evidence that total debt does not increase during unemployment. He attributes this in part to desired debt being a function of income: the higher (lower) the level of income, the higher (lower) the level of desired debt. He also attributes it in part to a reluctance of creditors to lend to the unemployed. The literature cited above on current income—particularly Lea, Webley and Walker (1995)—is consistent with Nieto’s work.
3.2 Theoretical Model

Suppose that individuals are infinitely lived and face the budget constraint that the expected present value of lifetime consumption must equal the expected present value of lifetime income plus net debt in the current period. Lifetime income consists of both labor income and realized capital gains. That is,

\[ E_t \sum_{s=t}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} c_s = E_t \sum_{s=t}^{\infty} \left( \frac{1}{1+r} \right)^{s-t} y_s + A_t - (1 + r)d_{t-1}. \]  

(3.1)

where \( c_s \) represents consumption in period \( s \), \( y_s \) represents income in period \( s \), \( A_t \) is total assets—including realized capital gains—held at the beginning of period \( t \), \( r \) is a constant interest rate and \((1+r)d_{t-1}\) is compounded revolving credit inherited from period \( t-1 \). If no assets are sold during period \( t \), individuals face the following evolution equation for debt:

\[ d_t = (1 + r)d_{t-1} + (c_t - y_t). \]  

(3.2)

Equation (3.2) states that the current period’s debt is the compounded value of the last period’s debt plus the amount by which current consumption exceeds current income. Extrapolating forward, we obtain

\[ E_t d_{t+1} = (1 + r)d_t + E_t(c_{t+1} - y_{t+1}). \]  

(3.3)

This can be rearranged as follows.

\[ E_t d_{t+1} - (1 + r)d_t = E_t(c_{t+1} - y_{t+1}) \]
\[ d_t - \frac{1}{1+r}E_t d_{t+1} = \frac{1}{1+r}E_t(y_{t+1} - c_{t+1}) \]
\[ \left( 1 - \frac{1}{1+r}L^{-1} \right) d_t = \frac{1}{1+r}E_t(y_{t+1} - c_{t+1}) \]
\[ d_t = \frac{1}{1 - \frac{1}{1 + r} L^{-1}} \frac{1}{1 + r} E_t (y_{t+1} - c_{t+1}) \]
\[ = \left[ 1 + \frac{1}{1 + r} L^{-1} + \left( \frac{1}{1 + r} \right)^2 L^{-2} + \cdots \right] \frac{1}{1 + r} E_t (y_{t+1} - c_{t+1}). \]

Therefore

\[ d_t = \sum_{i=0}^{\infty} \left( \frac{1}{1 + r} \right)^{i+1} E_t (y_{t+i+1} - c_{t+i+1}). \]  \hspace{1cm} (3.4)

This expression implies that

\[ d_{t-1} = \sum_{i=0}^{\infty} \left( \frac{1}{1 + r} \right)^{i+1} E_{t-1} (y_{t+i} - c_{t+i}), \]  \hspace{1cm} (3.5)

so that

\[ d_t - d_{t-1} = \Delta d_t = rd_{t-1} + E_{t-1} (y_t - c_t) \]
\[ + \sum_{i=0}^{\infty} \left( \frac{1}{1 + r} \right)^{i+1} [(E_t y_{t+i+1} - E_{t-1} y_{t+i}) - (E_t c_{t+i+1} - E_{t-1} c_{t+i})]. \]  \hspace{1cm} (3.6)

Keeping in mind that the household does not wish to sell assets to finance consumption in the current period, equation (3.4) states that the household holds revolving credit only if the time pattern of expected future income differs from that of expected future consumption. The present value of future income must exceed that of future consumption if debt is owed in period \( t \).

Equation (3.6) shows that the amount of revolving credit owed changes only if there is new information about the time patterns of future income and consumption (as represented by the difference between the \( E_t \) and \( E_{t-1} \) terms). If debt held increases in period \( t \), then it is because the new information acquired during the period shows that the present value of future income has increased relative to that of future consumption.

Consider a household which suffers a spell of unemployment during period \( t \) that is expected to last only a few periods. Because consumption is smoothed, the values of the \( c_{t+i+j} \)'s in equation (3.6) all decrease in accordance with how much the present value of current and future
income has declined, which will be less than the decline in current income. But this must mean that the present value of future income has increased relative to the present value of future consumption. Hence it is appropriate in this situation for the household to increase its debt, provided that credit is available. As noted previously, this is not a condition that necessarily applies to our data.

3.3 Data and Methodology

This chapter examines what variables determine the level of revolving consumer credit via a VAR model. The basic variables in the system are ccrate, the average nominal interest rate on credit card accounts; lsp500, the log of the real S&P 500 index; lcons, the log of real per-capita personal consumption expenditures; lrevdebt, the log of real per-capita revolving consumer debt; fedfunds, the nominal federal funds rate; and lunemp, the log of the unemployment rate. We intend for consumption expenditures to be a proxy for permanent income. Lettau and Ludvigson (2001) show that the consumption-wealth ratio summarizes expected returns on aggregate wealth. Specifically, they find that consumption, asset holdings and labor income are cointegrated and that deviations from their long-term relationship imply expectations about future returns on aggregate wealth. This implies that consumption closely tracks the two components of permanent income—assets and labor income—and thus can be used to represent permanent income. However, as a robustness check we also estimate a model in which we use disposable personal income instead of personal consumption expenditures. Since the impulse response results are essentially unchanged, we do not report them. We use quarterly data from 1977:I to 2009:IV to avoid a data discontinuity in revolving credit that occurs just before 1977:I. Please see Appendix E for our data sources.
Before estimating the model, we examine the time series properties of each variable to determine its order of integration and to consider where cointegration might exist. Figures 3.1-3.7 show the levels and first differences of each variable throughout the period of interest. As figures 3.1, 3.3, 3.5 and 3.7 show, there are upward trends throughout part of most of the sample for debt, disposable income, the S&P 500 index and personal consumption expenditures. There is something of a downward trend in the credit card and federal funds rates (figures 3.2 and 3.6) and the unemployment rate fluctuates with overall business conditions (figure 3.4), suggesting that it is not stationary in our sample.
Figure 3.1. Log of real per-capita revolving credit, in levels (top) and in differences (bottom).
Figure 3.2. Average credit card rate, in levels (top) and in differences (bottom).
Figure 3.3. Log of real per-capita disposable income, in levels (top) and in differences (bottom).
Figure 3.4. Log of the unemployment rate, in levels (top) and in differences (bottom).
Figure 3.5. Log of the real S&P 500 index, in levels (top) and in differences (bottom).
Figure 3.6. Federal funds rate, in levels (top) and in differences (bottom).
Figure 3.7. Log of real per-capita consumption expenditures, in levels (top) and in differences (bottom).
In figures 3.8-3.14 we examine the ACFs and PACFs of each variable in levels and in differences. For each variable in levels except the unemployment rate, the ACFs show extreme persistence, suggesting that the variables are I(1). On the other hand, for each variable in differences the ACFs decay quite quickly, suggesting that the differences do not have a unit root.

**Figure 3.8.** ACFs and PACFs of revolving consumer credit, in levels (*top*) and in differences (*bottom*).
Figure 3.9. ACFs and PACFs of unemployment, in levels (top) and in differences (bottom).
Figure 3.10. ACFs and PACFs of disposable income, in levels (top) and in differences (bottom).
Figure 3.11. ACFs and PACFs of the S&P 500, in levels (top) and in differences (bottom).
Figure 3.12. ACFs and PACFs of the average credit card rate, in levels (*top*) and in differences (*bottom*).
Figure 3.13. ACFs and PACFs of the federal funds rate, in levels (top) and in differences (bottom).
Figure 3.14. ACFs and PACFs of consumption, in levels (top) and in differences (bottom).

We test this judgment about the variables using augmented Dickey-Fuller tests with four lags and supplement these tests with KPSS tests since the Dickey-Fuller test has low power. Tables 3.1-3.4 show the critical values and our test statistics for these tests. For the Dickey-Fuller test the null hypothesis is that the series has a unit root. Table 3.2 shows that this hypothesis is accepted for all variables. For the KPSS test the null hypothesis is that the series is stationary; table 3.4 shows that this hypothesis is rejected for each variable, with the exception of consumption when a trend is introduced. We nevertheless assume consumption is non-stationary in order to capture its effects on other variables in a possible cointegrating relationship. Since
interest rates, asset prices and GDP generally follow random walk processes, it is unsurprising to
conclude that the Dickey-Fuller and KPSS tests support the existence of a unit root for the
ccrate, lcons, lpdi, lsp500 and fedfunds series. Although the literature generally treats
unemployment as regime-wise stationary (see, e.g., Papell, Murray and Ghiblawi 2000), we treat
it as a random walk here because of the results of our tests and because almost any series with a
unit root can be modeled as being regime-wise stationary. Thus all of our variables are treated as
I(1) in our main model. However, as a robustness check we also estimate the model treating
unemployment as stationary. In finding the conditions for the stationarity of the U.S.
unemployment rate, Papell, Murray and Ghiblawi place the last break in the series in the early
1980s; however, in our robustness check we make our model more parsimonious by omitting the
structural break.

Table 3.1. Dickey-Fuller critical values for the sample.

<table>
<thead>
<tr>
<th>Significance Level</th>
<th>Constant, no time trend</th>
<th>Constant with time trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>-2.577</td>
<td>-3.145</td>
</tr>
<tr>
<td>5%</td>
<td>-2.881</td>
<td>-3.441</td>
</tr>
<tr>
<td>1%</td>
<td>-3.475</td>
<td>-4.022</td>
</tr>
</tbody>
</table>
Table 3.2. Dickey-Fuller tests of variables, four lags on the differences.

<table>
<thead>
<tr>
<th>Variable</th>
<th>t-statistic, with constant but no trend (four lags)</th>
<th>t-statistic, with constant and trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>ccrate</td>
<td>-0.53</td>
<td>N/A</td>
</tr>
<tr>
<td>lsp500</td>
<td>-1.28</td>
<td>-1.71</td>
</tr>
<tr>
<td>lrevdebt</td>
<td>-1.89</td>
<td>-0.49</td>
</tr>
<tr>
<td>lpdi</td>
<td>-0.77</td>
<td>-2.10</td>
</tr>
<tr>
<td>lcons</td>
<td>-0.89</td>
<td>-2.46</td>
</tr>
<tr>
<td>fedfunds</td>
<td>-1.23</td>
<td>N/A</td>
</tr>
<tr>
<td>lunemp</td>
<td>-2.38</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Significant at the ten-percent level.
**Significant at the five-percent level.
***Significant at the one-percent level.

Table 3.3. KPSS critical values for the sample.

<table>
<thead>
<tr>
<th>Significance Level</th>
<th>Critical value, no trend</th>
<th>Critical value, with trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>10%</td>
<td>0.347</td>
<td>0.119</td>
</tr>
<tr>
<td>5%</td>
<td>0.463</td>
<td>0.146</td>
</tr>
<tr>
<td>1%</td>
<td>0.739</td>
<td>0.216</td>
</tr>
</tbody>
</table>

Table 3.4. KPSS tests of variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>KPSS statistic, no trend</th>
<th>KPSS statistic, with trend</th>
</tr>
</thead>
<tbody>
<tr>
<td>ccrate</td>
<td>2.23***</td>
<td>N/A</td>
</tr>
<tr>
<td>lsp500</td>
<td>2.46***</td>
<td>0.267***</td>
</tr>
<tr>
<td>lrevdebt</td>
<td>2.63***</td>
<td>0.517***</td>
</tr>
<tr>
<td>lpdi</td>
<td>2.71***</td>
<td>0.125*</td>
</tr>
<tr>
<td>lcons</td>
<td>2.70***</td>
<td>0.108</td>
</tr>
<tr>
<td>fedfunds</td>
<td>1.80***</td>
<td>N/A</td>
</tr>
<tr>
<td>lunemp</td>
<td>0.91***</td>
<td>N/A</td>
</tr>
</tbody>
</table>

*Significant at the ten-percent level.
**Significant at the five-percent level.
***Significant at the one-percent level.

As part of our analysis, we use a Choleski decomposition and observe impulse responses.

Our causal ordering is as follows: unemployment, consumption, debt, asset prices, the credit card rate and the federal funds rate. We place the unemployment rate first since it has a contemporaneous effect on per-capita income, which is related to consumption. Consumption precedes debt since it strongly influences debt levels. Debt levels in turn influence spending and
hence stock prices, which in turn influence the credit card interest rate environment. The Federal Reserve then observes all of these variables in its interest rate decisions (Christiano, Eichenbaum and Evans 1996b) and hence can be said to be roughly contemporaneously influenced by all of them. Keeping the last three variables in their place, any of the six possible orderings of the first three variables does not meaningfully alter the impulse responses of debt.

3.4 Results

We find five general empirical results of interest. First, revolving debt levels fall when the federal funds rate rises. This may be because an increase in the federal funds rate means a higher interest rate environment and hence draws funds away from the revolving credit market, where interest rates are more rigid and hence the risk premium for lenders has fallen. Second, debt levels do not seem to respond to a shock in the credit card interest rate. This seems to point to rigid behavior on the part of revolving debt holders. Third, a shock to consumption, representing permanent income, has a statistically significant positive effect on revolving debt levels. This is consistent with the PIH in that spending should be in line with permanent income rather than current income. Fourth, a positive shock to the unemployment rate reduces debt holdings, possibly due to supply constraints that arise in higher unemployment environments. Fifth, asset price shocks seem to have positive effects on debt, a phenomenon that is also consistent with the PIH.

The first task for the empirical model is to determine whether any of the variables are cointegrated. The unit root tests discussed above suggest that all series are I(1), but only three appear to have long-term trends: \textit{lsp500}, \textit{lcons} and \textit{lrevdebt}. Since household demand for revolving credit is likely to be influenced by wealth, permanent income and the credit card rate, it is reasonable to test whether \textit{ccrate}, \textit{lsp500}, \textit{lcons} and \textit{lrevdebt} are cointegrated. In addition,
since consumers may not respond strongly to the credit card rate, it is also reasonable to test
whether a cointegrating relationship exists between only \textit{lsp500}, \textit{lcons} and \textit{lrevdebt}. We
hypothesize a VECM of the following form:

\[ \Delta x_t = \gamma + \pi x_{t-1} + \sum_{i=1}^{l} \pi_i \Delta x_{t-i} + \varepsilon_t, \]

(3.7)

where \( x_t = [lcons_t \ lsp500_t \ lrevdebt_t \ ccrate_t \ fedfunds_t \ lunemp_t]' \), \( \gamma \) is a
constant, \( \pi \) and \( \pi_i \) are coefficients to be estimated, and \( \varepsilon_t \) is a serially independent vector of
stochastic errors. The \( \pi \) matrix represents the cointegrating space. Constants are allowed both in
the cointegrating space and outside of it in order to avoid restrictions that could distort the
results. If we reject the hypothesis of cointegration, a simpler model becomes appropriate,
taking the form of

\[ \Delta x_t = \gamma + \sum_{i=1}^{l} \pi_i \Delta x_{t-i} + \varepsilon_t. \]

(3.8)

We perform the tests of cointegration with a VECM using four lags on the differenced
variables. Table 3.5 presents a rank test for the cointegration of \textit{ccrate}, \textit{lrevdebt}, \textit{lcons} and
\textit{lsp500}, and table 3.6 presents a rank test for the cointegration of \textit{lrevdebt}, \textit{lcons} and \textit{lsp500} only.
The middle column of the table—labeled “Trace*”—represents the small-sample-corrected trace
statistic. The last column of the table—labeled “P-Value*”—represents the marginal
significance of the small-sample-corrected trace statistic. The entry on the top row is a test of the
null hypothesis that there are no cointegrating relationships against the alternative that there is at
least one relationship. The second-row entry is a test of the null hypothesis that there exists no
more than one relationship, against the alternative hypothesis that there are two or more. In table
3.5, the first row’s small-sample-corrected test statistic is 45.8 and its marginal significance level
is 0.225. Each row in table 3.5 does not allow us to reject the null hypothesis of fewer
cointegrating relationships in favor of the alternative of more cointegrating relationships. Hence
we accept the null hypothesis that there are no cointegrating relationships between these four variables. In Table 3.6 the first row’s small-sample-corrected test statistic is 29.7 with a marginal significance level of 0.176. Each row in Table 3.6 shows that we are unable to reject the null hypothesis of fewer cointegrating relationships in favor of more cointegrating relationships. Hence, once again we accept the null hypothesis of no cointegration.

**Table 3.5.** Rank test statistics: credit card rate, revolving credit, S&P 500, and consumption.

<table>
<thead>
<tr>
<th>Rank of $\pi$</th>
<th>Eigenvalue</th>
<th>Trace*</th>
<th>95% critical value</th>
<th>P-Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.208</td>
<td>45.778</td>
<td>53.945</td>
<td>0.225</td>
</tr>
<tr>
<td>1</td>
<td>0.116</td>
<td>22.076</td>
<td>35.070</td>
<td>0.594</td>
</tr>
<tr>
<td>2</td>
<td>0.068</td>
<td>10.673</td>
<td>20.164</td>
<td>0.581</td>
</tr>
<tr>
<td>3</td>
<td>0.051</td>
<td>4.272</td>
<td>9.142</td>
<td>0.385</td>
</tr>
</tbody>
</table>

**Table 3.6.** Rank test statistics: revolving credit, S&P 500, and consumption.

<table>
<thead>
<tr>
<th>Rank of $\pi$</th>
<th>Eigenvalue</th>
<th>Trace*</th>
<th>95% critical value</th>
<th>P-Value*</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.178</td>
<td>29.674</td>
<td>35.070</td>
<td>0.176</td>
</tr>
<tr>
<td>1</td>
<td>0.079</td>
<td>10.014</td>
<td>20.164</td>
<td>0.644</td>
</tr>
<tr>
<td>2</td>
<td>0.025</td>
<td>1.442</td>
<td>9.142</td>
<td>0.872</td>
</tr>
</tbody>
</table>

Therefore we estimate a VAR without any cointegrating relationships. We determine the proper lag length by the SBC. We calculate the SBC as

$$SBC = T ln |\Sigma| + N k ln(T),$$

where $T$ is the number of observations, $\Sigma$ is the variance-covariance matrix of the VAR, $N$ is the number of equations and $k$ is the number of regressors in each equation. We set the lower limit of lags at four in order to eliminate any residual seasonality in the data. We set the upper limit at eight because we have six variables and only 132 quarters of data. The SBC with four lags turns out to be -3712, whereas the SBC with eight lags is -3131. Therefore the optimal number of lags according to the SBC is four. Hence the sample size is necessarily restricted to 1978:II to
2009:IV. Five observations are lost because our model includes four lags on differenced variables.

We next perform residual analysis on our VAR to determine whether the residuals are stationary and the extent to which they are autocorrelated. Figures 3.15-3.20 present the ACFs and PACFs of the VAR residuals with four lags. There is a small amount of residual autocorrelation in the unemployment rate, the credit card rate and the federal funds rate, but these are at fairly long lags with the exception of the fifth autocorrelation function for the federal funds rate.

**Figure 3.15.** ACFs and PACFs for residuals of $\Delta \text{revdebt}$. 

![ACF and PACF plot](image)
Figure 3.16. ACFs and PACFs for residuals of $Δlunemp$.

Figure 3.17. ACFs and PACFs for residuals of $Δlcons$. 

Figure 3.18. ACFs and PACFs for residuals of Δls500.

Figure 3.19. ACFs and PACFs for residuals of Accrate.
Moreover, table 3.7 shows AR(1) results for each residual series and table 3.8 shows the Ljung-Box Q-statistics with 20 lags for each equation. For each of the variables, table 3.7 indicates that we cannot reject the null hypothesis that there is no autocorrelation of the residuals. Additionally, the Ljung-Box Q-statistics in table 3.8 do not allow us to reject the null hypothesis of no autocorrelation with the exception of the unemployment rate and the federal funds rate.

This increases the appropriate confidence level for our model.

**Table 3.7.** AR(1) results for each set of residuals, best VAR model.

<table>
<thead>
<tr>
<th>Equation</th>
<th>AR(1) coefficient</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta i$</td>
<td>-0.019524852</td>
<td>0.82818150</td>
</tr>
<tr>
<td>$\Delta p$</td>
<td>-0.051923806</td>
<td>0.56117523</td>
</tr>
<tr>
<td>$\Delta z$</td>
<td>0.0790276510</td>
<td>0.37137053</td>
</tr>
<tr>
<td>$\Delta c$</td>
<td>-0.030907432</td>
<td>0.72222285</td>
</tr>
<tr>
<td>$\Delta f$</td>
<td>0.0768733151</td>
<td>0.38944606</td>
</tr>
<tr>
<td>$\Delta u$</td>
<td>-0.019581483</td>
<td>0.82472165</td>
</tr>
</tbody>
</table>

**Table 3.8.** Ljung-Box Q-statistics, 20 lags, best VAR model.

<table>
<thead>
<tr>
<th>Equation</th>
<th>Q(20)</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta i$</td>
<td>25.748</td>
<td>0.174303</td>
</tr>
<tr>
<td>$\Delta p$</td>
<td>12.586</td>
<td>0.894432</td>
</tr>
<tr>
<td>$\Delta z$</td>
<td>16.701</td>
<td>0.672286</td>
</tr>
<tr>
<td>$\Delta c$</td>
<td>19.242</td>
<td>0.506124</td>
</tr>
<tr>
<td>$\Delta f$</td>
<td>48.676</td>
<td>0.000342</td>
</tr>
<tr>
<td>$\Delta u$</td>
<td>33.016</td>
<td>0.033606</td>
</tr>
</tbody>
</table>
We present the impulse responses of the system with a 16-quarter horizon, estimated in levels rather than in differences, in figure 3.21. As a robustness check, in figure 3.22 we present the system’s impulse responses using income instead of consumption. As an additional robustness check, we estimate the system’s impulse responses under the assumption that the unemployment rate is I(0), obtaining results not reported here. The results concerning variables’ effects on debt levels are essentially the same in each case. The surrounding bands represent 90-percent confidence intervals derived through Monte Carlo integration with 2500 replications.

Figure 3.21. Impulse responses, best VAR model.
Figure 3.22. Impulse responses of VAR model using income, not consumption.

Figure 3.21 suggests several important observations. First, consider the effects of an unemployment shock. A positive shock to the unemployment rate seems to have a persistent effect on itself, which is consistent with the unemployment rate being I(1) at a quarterly frequency. A shock to unemployment also at first reduces permanent income, represented by consumption, in a statistically significant way, but then turns out to have an ambiguous effect—although probably still negative—after the passage of about four quarters. This unemployment shock also reduces debt holdings, probably due to supply constraints. Further, it has a negative effect on asset prices, as increased unemployment reduces corporate earnings and also makes investors more pessimistic. Interestingly, a shock to unemployment does not seem to affect the credit card rate. However, it does have a statistically significant, and persistent, negative effect on the federal funds rate, probably as the Federal Reserve responds to the worsened economic conditions by lowering the policy rate.

Second, consider the effects of a consumption shock. A positive shock to consumption unsurprisingly reduces the unemployment rate. It also has a long-lasting positive effect on itself,
suggesting that consumption, and by implication permanent income, are very persistent.

Additionally, a shock to permanent income increases debt as households borrow to bring their spending more in line with expected lifetime income. This phenomenon is consistent with the PIH.

Third, consider a debt shock. A shock to debt in this framework appears to be a supply-side shock, as it results in a statistically significant reduction in the federal funds rate. This effect of a debt shock appears to be very persistent in future debt levels.

Fourth, consider a shock to asset prices. A positive shock to the S&P 500 has a negative and significant effect on unemployment, possibly reflecting the improved outlooks of firms that are hiring workers. This shock has a positive and persistent effect on consumption as households perceive that their wealth, and hence their permanent income, have risen. It also has a positive and persistent effect on debt for the same reason.

Fifth, consider a shock to the credit card rate. This seems to be a demand-driven shock, as it results in a positive and statistically significant increase in consumption. It also has a positive and statistically significant effect on asset prices and therefore probably indicates an increased expected return to capital.

Sixth and last, consider a shock to the federal funds rate. This shock has a positive and significant effect on the unemployment rate. This is somewhat consistent with Christiano, Eichenbaum and Evans (1996a), who find that a contractionary monetary policy shock raises the unemployment rate after about a two-quarter lag. This finding also coincides with Christiano, Eichenbaum and Evans (1999), who find an immediate negative and significant decrease in GDP as a result of such a shock. The increase in unemployment probably contributes to such a decrease in GDP. The federal funds shock has a negative effect on consumption and debt as
loanable funds are drawn out of the credit card market and into other instruments. The negative impact on debt is consistent with Bernanke and Blinder (1992), who find a reduction in consumer and real-estate loans after a contractionary monetary policy shock. Finally, this federal funds rate shock also has a delayed but positive effect on the credit card rate as monetary policy gradually finds its way into the consumer credit market.

Lastly, we present error variance decompositions in table 3.9. The table suggests that shocks to debt, unemployment, consumption and the federal funds rate account for most (about 85 percent) of the forecast error variance in debt. Note that the credit card rate is estimated to account for only about 3 percent of the forecast error variance, suggesting that it is not very influential.

### Table 3.9. Error variance decompositions with a 24-quarter horizon, best VAR model.

<table>
<thead>
<tr>
<th>% of variance in debt attributable to shocks in:</th>
<th>% of variance in debt attributable to shocks in:</th>
<th>% of variance in debt attributable to shocks in:</th>
<th>% of variance in debt attributable to shocks in:</th>
</tr>
</thead>
<tbody>
<tr>
<td>unemployment</td>
<td>consumption</td>
<td>S&amp;P 500</td>
<td>credit card rate</td>
</tr>
<tr>
<td>31.223</td>
<td>18.075</td>
<td>20.383</td>
<td>9.466</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.320</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>17.532</td>
</tr>
</tbody>
</table>

### 3.5 Conclusions

The purpose of this chapter is to explore the effects of important macroeconomic shocks on households’ use of revolving credit. Several results stand out. Our findings suggest that in the short term, consumers are not very flexible to credit card interest rates in their use of revolving credit, but that contractionary monetary policy shocks tend to indicate a tighter credit environment and hence restrict the supply of funds in the revolving credit market. In addition, the negative effect on debt levels of positive unemployment shocks is evidence of credit supply
constraints. Moreover, the PIH is corroborated in several areas, among which are the following two. First, a positive shock to permanent income, represented by personal consumption expenditures, seems to be accompanied by an increase in debt levels. Second, an increase in asset prices—which are a component of permanent income—seems to be accompanied by an increase in debt levels as well.

These results carry some important implications. To begin, they corroborate the PIH with a particular set of data. Our results thus suggest that users of revolving consumer credit exercise some degree of foresight in their decisions. While many of the heaviest reliers on revolving credit might be hyperbolic discounters, there is enough planning among the total community of revolving credit users for them to exhibit PIH-consistent behavior in the aggregate. Secondly, our results are evidence of a very low short-term interest rate elasticity of demand for revolving consumer credit. This suggests that consumers have difficulties changing their borrowing habits in the short term. Thirdly, the negative effect of unemployment on borrowing points to the limits of emergency credit for low-income borrowers. While higher-income borrowers are more likely to own homes against which they can borrow in unfortunate circumstances, people without homes tend to have much more limited sources of credit. These detailed findings are benefits of using the methodologies of the VAR toolkit to examine this area of macroeconomics.
REFERENCES


We obtain state non-business Chapter 7 filing rates from the Bankruptcy Data Project at Harvard Law School, which begins at the start of 2006. We divide filing rates by state population, using a simple interpolation method to correct for the fact that state population figures are only published annually by the U.S. Census Bureau. We obtain nominal state homestead exemptions from state legal codes. Some states allow bankrupts to choose between the exemptions offered in their state legal code and those offered by federal bankruptcy law. For states that allow this, when the state exemption level is less generous than the federal level we use the federal level. We obtain unemployment rates from the Bureau of Labor Statistics. Nominal home prices are obtained from Freddie Mac’s Conventional Mortgage Home Price Index. Divorce rates are obtained from the Centers for Disease Control. All nominal variables are deflated by the national consumer price index for all urban consumers for all items. The consumer price index is published by the Bureau of Labor Statistics.

The following variables do not come from their sources in seasonally adjusted form: exemption levels, home prices, filing rates and divorce rates. It would be inappropriate in any setting to attempt to seasonally adjust exemption levels. For the other variables we decide against using a simple seasonal adjustment method, whereby each variable is multiplied by a seasonal index, because we have only twelve time series observations for each state with which to estimate seasonal indexes. This paucity of observations poses severe limitations for any
attempt at seasonal adjustment. The results we obtain after using seasonal adjustment tend to be significantly more ambiguous than those we obtain without using seasonal adjustment.
APPENDIX B

DATA SOURCES FOR CHAPTER 2

Interest rates, disposable income, personal consumption expenditures and household debt are taken from the Federal Reserve Economic Database (FRED) of the Federal Reserve Bank of St. Louis. We divide these latter three by the population, also obtained from FRED, to obtain per-capita figures. The Case-Shiller home price index is taken from data published by Karl Case and Robert Shiller. We obtain the S&P 500 index from Yahoo! Finance. Household credit, the Case-Shiller index and the S&P 500 index are all deflated by the consumer price index since we originally obtain them in nominal form. All other variables are already in constant dollars in FRED. For each series, if the lowest frequency available is monthly, the third month of each quarter is used to represent that quarter. All data are already seasonally adjusted except the Case-Shiller index, which we adjust for seasonality ourselves. Appendix C discusses our method of seasonal adjustment.
APPENDIX C

COMMENTS ON SEASONAL ADJUSTMENT OF THE CASE-SHILLER HOME PRICE INDEX

Noting that each quarter should have a seasonal effect, we regress the Case-Shiller index on a constant as well as second-, third- and fourth-quarter dummy variables \( d_2, d_3 \) and \( d_4 \) as follows:

\[
ct = \text{constant} + \beta_2 d_{2t} + \beta_3 d_{3t} + \beta_4 d_{4t} + \epsilon_t,
\]

where \( ct \) is the log of the real Case-Shiller index for quarter \( t \). We then take the residuals, the \( \epsilon_t \) series, and use them to fill the series \( lcsresids \). The series appears to retain its non-stationarity.

An alternative seasonal adjustment method for the Case-Shiller index is to run the regression

\[
ct = \text{constant} + \beta cs_{t-4} + \epsilon_t
\]

and to record the \( \epsilon_t \) series as \( lcsresids \). However, as table C.1 shows, it is less certain that the error term retains its I(1) properties with equation (C.2). Additionally, table C.1 shows that equation (C.1) appears to eliminate the seasonality more effectively. Although the impulse response results are not altered beyond recognition with equation (C.2), we use equation (C.1) for these reasons.
Using equation (C.1), a Dickey-Fuller test of the residual series yields a t-statistic of -1.43, very far from the five-percent critical value of -2.89 necessary to reject the null hypothesis of non-stationarity. A KPSS test rejects the null hypothesis of stationarity at the one-percent level, yielding a test statistic of 1.18 while the one-percent critical value is 0.74.

Using equation (C.2) and taking the residual, a Dickey-Fuller test fails to reject the null hypothesis of non-stationarity. However, using this method, a KPSS test fails to reject the null hypothesis of stationarity at the ten-percent confidence level or better, yielding a test statistic of 0.23 while the ten-percent critical value is 0.35. Other results are not significantly altered by the use of this method.

Figures C.1-C.6 show the ACFs and PACFs of the series as adjusted according to equations (C.1) and (C.2), respectively. Figure C.3 shows the ACFs and PACFs of the differenced Case-Shiller index with no seasonal adjustment. Figures C.4-C.6 show the ACFs and PACFs of the differences of the original series and the series adjusted according to equations (A.1) and (A.2), respectively. In each case the ACFs and PACFs show little evidence of seasonality. However, table C.1 shows the results of AR(4) regressions of the differences of the unadjusted series and of the series adjusted by the two seasonal adjustment methods, with p-
values are in parentheses. Equation (C.1) seems to best eliminate the seasonality, as (C.2) fails to take the statistical significance out of the fourth lag. For these reasons, we use (C.1) as our seasonal adjustment method for the Case-Shiller home price index.

**Figure C.1.** ACFs and PACFs of the log of the real Case-Shiller index.

![Figure C.1](image1)

**Figure C.2.** ACFs and PACFs of the log of the Case-Shiller index adjusted according to equation (C.1).

![Figure C.2](image2)
Figure C.3. ACFs and PACFs of the log of the Case-Shiller index adjusted according to equation (C.2).

Figure C.4. ACFs and PACFs of the log difference of the Case-Shiller index.
Figure C.5. ACFs and PACFs of the log difference of the Case-Shiller index adjusted according to equation (C.1).

Figure C.6. ACFs and PACFs of the log difference of the Case-Shiller index adjusted according to equation (C.2).
Table D.1 shows rank test statistics for the system using only three lags and using the full available time window. Table D.2 shows the resulting cointegrating space. Tables D.3 and D.4 show the same information using five lags. Although table D.3 indicates that there are not enough degrees of freedom to perform the Bartlett small-sample correction with five lags, both three lags and five lags result in cointegrating relationships that are essentially the same as those obtained with four lags. In both cases, the test suggests a long-term relationship in which debt levels are positively related both to consumption and to home prices. Thus if a cointegrating relationship exists, we have more confidence in its nature.

Table D.1. Rank test for cointegration of \( lcsresids, ldpc \) and \( lcons \), three lags.

<table>
<thead>
<tr>
<th>Rank of ( \pi )</th>
<th>Eigenvalue</th>
<th>Trace*</th>
<th>95% critical value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.317</td>
<td>41.500</td>
<td>35.070</td>
<td>0.008</td>
</tr>
<tr>
<td>1</td>
<td>0.161</td>
<td>12.225</td>
<td>20.164</td>
<td>0.437</td>
</tr>
<tr>
<td>2</td>
<td>0.092</td>
<td>0.082</td>
<td>9.142</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Table D.2. Cointegrating relation with three lags (t-statistics in parentheses).

<table>
<thead>
<tr>
<th>( lcsresids )</th>
<th>( lcons )</th>
<th>( ldpc )</th>
<th>constant</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.444 (-5.835)</td>
<td>-1.430 (-14.999)</td>
<td>1.000 (N/A)</td>
<td>4.156 (4.308)</td>
</tr>
</tbody>
</table>
### Table D.3. Rank test for cointegration of `lcsresids`, `ldpc` and `lcons`, five lags.

<table>
<thead>
<tr>
<th>Rank of $\pi$</th>
<th>Eigenvalue</th>
<th>Trace</th>
<th>95% critical value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.346</td>
<td>56.961</td>
<td>35.070</td>
<td>0.000</td>
</tr>
<tr>
<td>1</td>
<td>0.150</td>
<td>20.082</td>
<td>20.164</td>
<td>0.051</td>
</tr>
<tr>
<td>2</td>
<td>0.066</td>
<td>5.975</td>
<td>9.142</td>
<td>0.199</td>
</tr>
</tbody>
</table>

*Note:* The Bartlett Small Sample Correction cannot be computed due to the number of lags in use. Uncorrected values are used instead.

### Table D.4. Cointegrating relation with five lags (t-statistics in parentheses).

<table>
<thead>
<tr>
<th><code>lcsresids</code></th>
<th><code>lcons</code></th>
<th><code>ldpc</code></th>
<th><code>constant</code></th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.714 (-10.302)</td>
<td>-1.114 (-13.530)</td>
<td>1.000 (N/A)</td>
<td>1.113 (1.346)</td>
</tr>
</tbody>
</table>
APPENDIX E
DATA SOURCES FOR CHAPTER 3

We take disposable income, personal consumption expenditures, household credit, the unemployment rate and the federal funds rate from FRED of the Federal Reserve Bank of St. Louis. We take the credit card interest rate from the Federal Reserve Board of Governors. We take the S&P 500 from Yahoo! Finance. We deflate household credit and the S&P 500 by the consumer price index since we originally obtain them in nominal form. For each series, if the lowest frequency available is monthly, the third month of each quarter is used to represent that quarter. We divide disposable income, personal consumption expenditures and household credit by the population, also obtained from FRED, to obtain per-capita figures.