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# Essays in Health Economics

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# ESSAYS IN HEALTH ECONOMICS

by

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Abstract

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Health is defined as an individual's mental or physical condition and being healthy means to be free from illness or injury. Health is relevant to both the supply and demand sides of the national economy. On the demand side, consumers derive satisfaction from being healthy. Consumers purchase goods and services to improve their health but also engage in activities that impair health such as smoking or drinking too much. On the supply side, firms produce health care goods and services to meet the market demand for health care derived from consumers' demand for better health. In addition, health augments labor inputs since the healthier the population, the larger the labor force and the higher the marginal productivity of labor, as in fewer sick days. This dissertation is comprised of three essays related to the effect of social environments and economic incentives on health and health behaviors.

The first essay examines whether whether immigrants converge towards natives' level of smoking prevalence with assimilation. Results show that assimilation is associated with a greater likelihood of being a smoker for immigrants from lower smoking countries relative to the U.S. and a lower likelihood of being smoker for immigrants from higher smoking countries. Differences in responsiveness to taxes or smoke free air laws cannot explain the convergence in smoking rates between immigrants from higher and lower smoking countries.

The second essay examines the effect of mortgage debt on health. Homeownership in the U.S. is promoted through the use of financing. These policies improve the liquidity of the housing market and make homeownership more affordable. But it also encourages greater consumption of mortgage debt. Using mortgage loan to value (LTV) as a proxy for financial stress, I show that homeowners with high LTVs are more likely to be in poor health.

The third essay examines the effect of unemployment duration on health. I hypothesis

that unemployment duration affects health through financial stress. Results show that high mortgage loan to value is not significantly correlated with most measures of poor health but when interacted with high home leverage is positively and significantly correlated with poor health. However, I cannot rule out reverse causality given that those in poor health have a significant likelihood of having high LTV in the next period.

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# 1 Healthy and unhealthy assimilation: Country of origin and smoking behavior among immigrants

*Leigh Ann Leung*

**Abstract**

Smoking rates in the country of origin were used to empirically examine whether immigrants converge towards natives' level of smoking prevalence with assimilation. Results show that assimilation is associated with a greater likelihood of being a smoker for immigrants from lower smoking countries relative to the U.S. and a lower likelihood of being smoker for immigrants from higher smoking countries. Moreover, assimilation is associated with a greater likelihood of ever quitting smoking among immigrants from higher smoking countries and a greater likelihood of ever initiating smoking among immigrants from lower smoking countries. This study then investigates whether differences in responsiveness to taxes or smoke free air laws can explain the convergence in smoking rates between immigrants from higher and lower smoking countries. Results from the hazard of smoking initiation and cessation estimations show that elasticities are not significantly different between immigrants from higher and lower smoking countries. Therefore, tobacco taxes or smoke free air laws cannot explain the opposite assimilation pattern between higher and lower smoking countries.

**Author Keywords:** Determinants of health, Smoking, Assimilation, Tax

**JEL classification codes:** I18

## 1.1 Introduction

The healthy immigrant effect (HIE) refers to two observations – that immigrants have better health relative to native-born residents (natives) upon arrival and that with assimilation, immigrants converge to the health of natives. This effect has been documented in a number of developed countries with large immigrant populations (Kennedy et al., 2006 for Australia and United Kingdom, McDonald and Kennedy, 2005, Deri, 2005 for Canada, Lechner and Mielck, 1998 for Germany, and House et al., 1990, Stephen et al., 1994 for United States) for health outcomes such as obesity, diabetes, cancer, smoking, alcohol dependence, and depression.

Two hypotheses have been proposed to explain the first part of the healthy immigrant effect. One hypothesis suggests that healthier immigrants are self-selected to migrate. According to the self-selection hypothesis, recent immigrants should be healthier than both natives and the population in the country of origin. The other, referred to as the social norms hypothesis, suggests that recent immigrants are healthier than the native population because of habits and behaviors acquired in the country of origin that promote better health. According to the social norms hypothesis, recent immigrants should be healthier than natives but are otherwise similar in health to the population in the country of origin.

Unlike the self-selection hypothesis, the social norms hypothesis also explains the second part of the healthy immigrant effect. With assimilation, immigrants relinquish the healthy habits and behaviors acquired in the country of origin and instead adopt those of natives. As a consequence, immigrants converge to the health of natives, a process known as unhealthy assimilation.

Previous studies have shown that body mass index (BMI) levels for recent immigrants were lower than that of natives but with longer durations in the receiving country, immigrants' BMIs converged to that of natives (McDonald and Kennedy, 2005 in Canada and Antecol and Bedard, 2006, Kaushal, 2009 in the U.S.). The rate of convergence varied depending on country of origin and the level of education at migration. Other studies using likelihood of poor health, activity limitations, and presence of a chronic condition as health measures have shown that recent immigrants arrive healthier but converge to natives' health

levels with assimilation (Deri, 2005 in Canada and Lechner and Mielck, 1998 in Germany). Studies using smoking as a health measure have found that recent immigrants are less likely to smoke compared to natives but the likelihood depends on gender, foreign-born status, and degree of assimilation (Baluja et al., 2003, Acevedo-Garcia et al., 2005, Huang, 2008 in the U.S. and Wilkinson et al., 2005, Angel et al., 2001 for Mexican immigrants in the U.S.). These studies examined the effect of foreign-born status on propensity to smoke but did not model smoking behavior by country of origin.

Existing evidence supporting the social norms explanation argue that immigrants acquired healthy behaviors prior to migration (Antecol and Bedard, 2006, Kaushal, 2009). However, these studies typically estimate the effect of assimilation on health for the "average" immigrant. For example, in the U.S., Mexican-Americans comprise the largest share of immigrants. Therefore, the estimated effect of assimilation on health would be largely driven by the experience of this group. But not all immigrants acquired healthy behaviors in the origin country. If immigrants identify with social norms in the country of origin and smoking is more socially accepted in some countries than others, then some immigrants will be more receptive to smoking than others. In this case, the average effect of assimilation on propensity to smoke may conceal different patterns of assimilation depending on the country of origin.

The goal of this study is to empirically test the social norms hypothesis for immigrants in the U.S. using smoking as a case study health behavior. The hypothesis suggests two testable predictions regarding smoking behavior among immigrants: 1) the higher the smoking prevalence in a sending country, the more likely a recent immigrant from that country will be a smoker and 2) assimilation should increase the propensity to smoke for immigrants from countries where smoking is not the social norm but should decrease the propensity to smoke for immigrants from countries where smoking is the social norm, the latter exemplifying healthy assimilation.

This study contributes to the literature on the healthy immigrant effect with new evidence on the social norms hypothesis. Consistent with the hypothesis, I show that with assimilation, immigrants converge to natives' smoking behaviors. Specifically, assimilation is associated with a greater likelihood of being a smoker for immigrants from lower smoking

countries relative to the U.S. and a lower likelihood of being a smoker for immigrants from higher smoking countries. Moreover, assimilation is associated with a greater likelihood of ever quitting smoking among immigrants from higher smoking countries and a greater likelihood of ever initiating smoking among immigrants from lower smoking countries. After adjusting for socioeconomic factors, smoking prevalence rates among immigrants by country of origin is similar to smoking prevalence rates in the respective country of origin.

This study also investigates whether differences in responsiveness to tobacco tax or smoke free air laws can explain the convergence in smoking rates between immigrants from higher and lower smoking countries. Results for the hazards of smoking initiation and cessation suggest that anti-smoking policies do not have a significant effect on initiation but do affect cessation. Therefore, immigrants from lower smoking countries are likely to start smoking and those from higher smoking countries are likely to quit.

## 1.2 Estimation

### 1.2.1 Data

Individual-level data on immigrants was obtained from the Current Population Survey (CPS) Tobacco Use Supplement (TUS)[1]. Seventeen cross-sections from 1995 to 2007 were pooled. The sample was restricted to foreign-born individuals age 18 to 65 at the time of survey who immigrated to the U.S. after 1949. Observations with missing data for country of origin, years since migration, year of arrival, or socioeconomic factors were excluded. Countries with fewer than 100 observations for each gender were also excluded. The resulting dataset contains 98,842 observations representing 66 countries[2]. Tables 1.1 and 1.2 summarize the individual characteristics by estimation sample, gender, and origin country

[1]The CPS is a nationally representative cross-sectional survey conducted by the Bureau of Labor Statistics (BLS) that contains demographic and tobacco-use data for foreign- and native-born individuals in the U.S. The TUS, funded by the National Cancer Institute (NCI), is a supplemental survey periodically appended to the CPS to capture information on current attitudes towards smoking and on current and retrospective tobacco use

[2]The pooled CPS-TUS dataset of all foreign born individuals age 18 to 65 at the time of survey who immigrated to the U.S. after 1949 has 112,495 observations. Of these, 13,265 were dropped due to missing values in each of the relevant variables yielding 99,230 observations. Of these, 388 observations were dropped due to fewer than 100 observation in the origin country and gender cell yielding 98,842 observations in the working dataset.

smoking prevalence.

An ideal dataset matches immigrants to gender-specific smoking rates for the country of origin in the year of migration. But historical data on smoking prevalence is not available for all origin countries and for all years of migration. This is particularly the case for developing countries which are typically the immigrant-sending countries. As an alternative, gender-specific smoking rates as of 2006 or the nearest previous surveyed year were averaged when possible across two sources – World Health Organization Tobacco-Free Initiative (WHOTFI) and the Worldbank Global Development Indicators (WGDI). Immigrant and origin population smoking rates are summarized in Tables 1.3 and 1.4 for higher and lower smoking prevalence countries relative to the U.S. Most immigrant men are from countries with higher male smoking rates and most immigrant women are from countries with lower female smoking rates.

### 1.2.2 Variable definitions

A valid measure of an immigrant's level of assimilation is the degree to which the immigrant identifies with the social norms in the sending country relative to that in the receiving country. Waters and Jimenez (2005) identified four dimensions of assimilation: socioeconomic status, language, intermarriage, and residential concentration. Intermarriage and lower residential concentration assimilation are typically observed over several generations and hence not less relevant for this study which examines smoking behavior among foreign-born immigrants. Language attainment, or the ability to speak English in this case, would not be a valid measure of assimilation in the context health assimilation for immigrants from English-speaking countries. Assimilation in socioeconomic status, including earnings and educational attainment, is typically measured as a linear process with years since migration (Chiswick, 1978, Borjas, 1985, 1995, Schoeni, 1998, Antecol and Bedard, 2006, Lubotsky, 2007). Years since migration was chosen as the measure of the degree of assimilation in this study. This has the additional advantage of allowing for comparison with previous studies that estimate the effect of assimilation on health using the same measure.

Years since migration was calculated as the difference between the survey year and the immigrant's year of arrival. In the CPS, the year of arrival was surveyed as a categorical

variable indicating a range of two or more years. To construct a continuous variable for years since migration, the year of arrival was recoded with the midpoint value of the range for each category[3]. Similarly, family income, also surveyed as a categorical variable indicating a range of annual dollar amounts, was recoded to midpoint values except for the highest bracket which was recoded to the lower bound.

The CPS-TUS provides a smoking status categorical variable that identifies an individual as either an every day smoker, a some day smoker, a never smoker, or a former smoker. This was used to create an indicator variable for current smoker which is defined as a person who, at the time of interview, reported smoking every day or some days. For self-respondents, the CPS-TUS asked retrospective questions about the age when the individual first smoked regularly and the age when the individual completely stopped smoking. This information was used along with age of migration to determine whether the individual initiated or quit smoking in the country of origin or in the U.S. Figure 1.1 shows the distribution of ages for smoking initiation and Figure 1.2 shows the distribution of ages for smoking cessation. The average age of initiation is 18.5 while the average age of smoking cessation is 33.7 years as shown in Table 1.1.

Assuming that individuals experienced a single transition from non-smoker to smoker for current smokers and from smoker to non-smoker for current former-smokers, censored panel datasets were constructed to estimate the effect of cigarette taxes on smoking initiation and cessation. The hazard to initiation sample consists of individuals who initiated smoking in the U.S. and current never-smokers[4]. The hazard to cessation sample consists of ever-smoker individuals who quit smoking in the U.S. and current smokers[5]. Table 1.1 summarizes the individual characteristics for these two samples.

[3]Year of arrival recoded with the minimum value, instead of the midpoint value, of the year of arrival range did not materially change the results.

[4]Age of smoking initiation was calculated using the responses to the survey question "How old (were/was) (you/name) when (you/he/she) first started smoking cigarettes FAIRLY REGULARLY". A respondent may have smoked his/her first cigarette at an earlier age but only the age when they started smoking fairly regular smoking was used in the starting hazard model.

[5]Age of smoking cessation was calculated using the responses to the survey question "About how long has it been since you COMPLETELY quit smoking cigarettes?". A respondent may have had one or more quit attempts in the past but only the most recent quit attempt was used in for quitting hazard model.

### 1.2.3 Smoking prevalence in the U.S. from 1995 to 2007

Smoking prevalence was calculated as the sample-weighted average of the current smoking indicator variable. Figures 1.3 and 1.4 show the prevalence of smoking in each survey year by high-low country of origin, by long/short duration since migration. Smoking prevalence has declined for all groups in this period. Previous studies have attributed this decline to higher cigarette taxes (Chaloupka and Warner, 2000), higher prevalence of work place smoking bans (Evans et al., 1999), and a gradual shift towards anti-smoking sentiment (DeCicca et al., 2008). Figure 1.5 shows smoking prevalence by high-low country of origin and long/short duration since migration. Smoking prevalence for assimilated immigrants from lower smoking countries are higher than that for short duration immigrants. Smoking prevalence for assimilated immigrants from higher smoking countries are lower than that for short duration immigrants in years 1995/1996 and 2000/2001 but higher in years 2002/2003 and 2006/2007. The variability of smoking prevalence among recent immigrants from higher smoking countries may be due to differences in immigrant cohorts over time.

### 1.2.4 An immigrant's likelihood of being a current smoker

A country has a set of social norms that govern acceptable behavior. Higher smoking prevalence in a country indicates that smoking is more socially acceptable which in turn influences an individual's decision to smoke. These norms influence behavior even after an individual decides to emigrate. Therefore, origin population smoking rates can be used to examine the pattern of smoking among immigrants. If immigrants identify with the social norms in the country of origin, then recent immigrants from high smoking countries are more likely to be smokers while those from low smoking countries are less likely to be smokers. Furthermore, the social norms hypothesis predicts that with assimilation, immigrants converge towards natives' level of smoking prevalence.

Income is an important determinant of an immigrant's likelihood of being a current smoker. Bobak et al. (2000) looked at the relationship between tobacco use and poverty and found that while smoking is more common among poor men than rich men in nearly all countries, the income gradient of smoking is smaller in developed countries. Two other

important factors are years since migration, which captures the degree of assimilation, and year of arrival, which captures potential differences in smoking rates by arrival cohort. Since years since migration and year of survey linearly determine year of arrival given pooled cross-sectional data (Borjas, 1985), survey year was used to control for cohort effects.

The probability of being a current smoker is modeled as a linear function of income, years since migration, year of survey, and demographic controls. Since previous studies found differences in the rate of earnings assimilation and in arrival cohorts by country of origin, the parameters for these three variables were allowed to vary by country of origin. Unobserved, time-invariant country-specific factors were captured with country indicators. Variables for female, age, education, marital status, number of household members, metropolitan residence were assumed to affect an immigrant's likelihood of being a current smoker in the same way regardless of the origin country. Finally, all parameters were allowed to vary by gender.

The linear probability model for an immigrant's likelihood of being a smoker is given by

$$\Pr[S = 1|\mathbf{x}] = \alpha_c + \alpha_c \times (\beta_c Assimilation + \gamma_c Income + \delta_c Year) + X\Theta \qquad (1.1)$$

where $S$ is an indicator for current smoker, $\alpha_c$ is an indicator for country of origin $c$, $\beta_c$ is the country-specific effect of assimilation, $\gamma_c$ is a country-specific effect of the natural log of income, $\delta_c$ is the country-specific effect of a linear time trend, $X_i$ is a vector of individual-specific demographic variables for female, age, education, marital status, number of household members, and metropolitan residence, and $\Theta$ is a vector of the coefficients on $X$.

An alternate specification replaces the country fixed effects in equation 1.1 with a single continuous variable for the smoking rates in the country of origin. This specification allows for estimation of the effect of origin country smoking prevalence as a single coefficient which is interpreted as the correlation coefficient between smoking rates in the origin country populations and smoking rates among immigrants. The linear probability model using

country of origin smoking rates is given by

$$\Pr[S = 1|\mathbf{x}] = \lambda Origin + \alpha_c \times (\beta_c Assimilation + \gamma_c Income + \delta_c Year) + X\Theta \qquad (1.2)$$

where $\lambda$ is the effect of origin country smoking prevalence. The average partial effect of assimilation from equation 1.2 can be expressed as[6]

$$\text{Average Partial Effect of Assimilation} = \frac{1}{N}\sum_{c=1}^{C}\sum_{i=1}^{N}\beta_c\alpha_{ci} \qquad (1.4)$$

where $\beta_c$ is the effect of assimilation for immigrants from country $c$ from equation 1.2, $N$ is the number of observations, $C$ is the number of countries, and $\alpha_{ci}$ equals one if individual $i$ is from country $c$.

Countries of origin were categorized as higher and lower smoking prevalence relative to U.S. smoking prevalence depending on whether the mean smoking rate in the country of origin was greater or less than that in the U.S. for 2006 by gender. The average partial effect of assimilation for immigrants from countries with higher (lower) smoking rates relative to the U.S. was calculated by summing over only the higher (lower) smoking countries.

Since smoking prevalence varies by state in the U.S., an alternate method is to categorize countries of origin as higher and lower relative to smoking prevalence in an immigrant's state of residence[7]. The average partial effect of assimilation was calculated using this method as well.

[6]The average marginal effect of assimilation for a general binary response model is given by

$$\text{Average Partial Effect of Assimilation} = \frac{1}{N}\sum_{c=1}^{C}\sum_{i=1}^{N}\frac{\partial \Pr[S = 1|\mathbf{x}]}{\partial Assimilation}\beta_c \qquad (1.3)$$

where $\Pr[S = 1|\mathbf{x}] = G(Origin + \alpha_c \times (\beta_c Assimilation + \gamma_c Income + \delta_c Year) + X\Theta)$. Note that $G(z) = z$ for the linear probability model, $G(z) = \int_{-\infty}^{z}\phi(\nu)d\nu$ for the probit model, and $G(z) = \frac{exp(z)}{1+exp(z)}$ for the logit model.

[7]This assumes that immigrants remained in the current state of residence since arrival to the U.S. (Kritz and Nogle, 1994, Newbold, 1999, Nogle, 1997, Funkhouser, 2000).

### 1.2.5 Estimation results for an immigrant's likelihood of being a current smoker

Equations 1.1–1.4 were estimated using ordinary least squares[8]. Results for equations 1.1–1.4 are shown in Table 1.5. The effect of assimilation on an immigrant's likelihood of ever initiating and likelihood of ever quitting smoking was estimated using the same specifications as equations 1.1–1.4 with the left-hand side variable replaced an indicator variable for ever initiated smoking and ever quit smoking, respectively. Results of these regressions are shown in Tables 1.6 and 1.7.

For all three outcomes in Tables 1.5–1.7, the first column shows the country fixed effects specification while the last three columns show the continuous variable for origin country smoking prevalence specification. In all three tables, the estimated coefficients on socioeconomic variables in columns (3) and (4) are the same as in column (2) and therefore suppressed for readability. For conciseness, estimated effects are reported as average marginal effects[9]. Errors are clustered in groups of gender by origin country[10].

#### Effect of assimilation on an immigrant's likelihood of being a current smoker

The effect of assimilation is positive but insignificant in columns (1) and (2). When the effect of assimilation is interacted with the indicator variable for origin country smoking prevalence relative to the U.S., the separated effects become significant with opposite signs.

Column (3) shows that immigrants from countries with higher smoking rates relative to the U.S. are 0.0638 percentage points less likely to be smokers while those from countries with lower smoking rates are 0.138 percentage points more likely to be smokers per year in the U.S. Column (4), using state of residence smoking rates, shows immigrants from countries with higher smoking rates are 0.0628 percentage points less likely to be smokers, and immigrants from countries with lower smoking rates are 0.128 percentage points more likely to be smokers per year in the U.S. The assimilation effects separated by higher/lower

[8] Equations 1.1–1.4 were also estimated as logit models using maximum likelihood estimation with similar results.

[9] Parameters for years since migration, time trend, and log income vary by country and gender while the parameters on socioeconomic variables vary by gender.

[10] Clustering by origin country did not materially change the results.

origin smoking prevalence are significantly different from each other for both columns (3) and (4).

The estimated effect of assimilation does not materially change when the state of residence smoking rates are used as the basis for comparison. Immigrants from higher smoking countries are 0.0628 percentage points less likely to be smokers while those from lower smoking countries are 0.128 percentage points more likely to be smokers per additional year in the U.S. Again, a Wald test confirmed that the two estimates are significantly different[11].

**Effect of origin population smoking prevalence on an immigrant's likelihood of being a current smoker**

Table 1.5 column (2) shows the estimation results for equation 1.2. The estimated effect of origin country smoking prevalence is 0.929. This suggests that a 10 percent increase in the origin country smoking rate is associated with 9 percent increase in the likelihood that a recent immigrant is a current smoker, almost a one-to-one relationship.

**Effect of assimilation on an immigrant's likelihood of ever initiating and ever quitting smoking**

The likelihood of ever initiating smoking and ever quitting smoking can be used as outcome variables to verify whether assimilation is associated with quitting behavior for immigrants from higher smoking countries and initiating behavior for immigrants from lower smoking countries. The models for likelihood of ever initiating and ever quitting smoking is given by

$$\Pr[EverStart = 1|\mathbf{x}] = \lambda Origin + \alpha_c \times (\beta_c Assimilation + \delta_c Year) + female + age \quad (1.5)$$

[11]This pattern for the effect of assimilation holds when the sample is split by year of immigration pre- and post-1985 and when when the sample is limited to a subset of OECD countries (Australia, Canada, France, Germany, Ireland, Italy, Japan, Mexico, South Korea, and United Kingdom) where historical data on smoking prevalence rates from 1960 to 2007 were available. In the case of splitting the sample by year of migration, the estimated effect of assimilation for higher and lower smoking countries are insignificantly different from zero, though they are significantly different from each other at the 10 percent level. In the case of limiting the sample to OECD countries, the estimated effect of assimilation is negative and significant at the 10 percent level for higher smoking countries and insignificant for lower smoking countries, though they are insignificantly different from each other. These results are available from the author upon request.

$$\Pr[EverQuit = 1|\mathbf{x}] = \lambda Origin + \alpha_c \times (\beta_c Assimilation + \delta_c Year) + female + age \quad (1.6)$$

where only time-invariant explanatory variables are used since the full set of socioeconomics variables are not available at the year in which the respondent started or quit smoking. The outcome variable in equation 1.5, $EverStart$, is an indicator variable which is equal to one if the individual ever-smoked and zero otherwise. The outcome variable in equation 1.6, $EverQuit$, is an indicator variable which is equal to one if the individual ever-quit and zero otherwise and the sample was restricted to ever-smokers.

Estimation results for the likelihood of ever-initiating among immigrants are shown in Table 1.6. Assimilation is associated with a higher likelihood of initiation as shown in columns (1) and (2). When the effect is interacted with the indicator for origin country smoking prevalence relative to the U.S., assimilation is larger for immigrants from lower smoking countries as shown in columns (3) and (4). Immigrants from lower smoking countries are more likely to have ever initiated smoking.

Estimation results for the likelihood of ever-quitting among immigrant ever-smokers are shown in Table 1.7. Assimilation is associated with a higher probability of cessation as shown in columns (1) and (2). Columns (3) and (4) show the assimilation effect for higher and lower smoking prevalence in the origin countries relative to the U.S. The estimated effect is positive and only significant for immigrants from higher smoking countries. This suggests that immigrants from higher smoking countries are more likely to have ever quit smoking.

**Relative rates of health assimilation**

The effect of assimilation for smoking prevalence can be compared to that for other health measures. There are two studies that have examined health assimilation in the U.S., both using data from the National Health Interview Survey (NHIS). Kaushal (2009) used obesity prevalence as a health measure and Antecol and Bedard (2006) used obesity prevalence, likelihood of poor health, presence of a chronic condition, and presence of an activity limitation as health measures[12]. The effect of assimilation was estimated using indicator variables for

[12]Obesity is defined as BMI greater than or equal to 30.

ranges of years since migration in increments of 5 years ending with an indicator for 15 or more years. To obtain a per year effect, I divided the estimates by 5 and to obtain a single estimate for assimilation, I averaged the coefficients across the indicator variables for assimilation.

With these adjustments, the assimilation effect for obesity prevalence from Kaushal (2009) is 0.53 percentage points per year and from Antecol and Bedard (2006) is 0.52 percentage points. From Antecol and Bedard (2006), the assimilation effect for the likelihood of poor health is 0.59 percentage points, presence of a chronic condition is 1.05 percentage points, and presence of an activity limitation is 0.82 percentage points. The assimilation effect for smoking prevalence presented in this study is 0.064 percentage points for immigrants from higher smoking countries and 0.138 percentage points for immigrants from lower smoking countries. For the likelihood of ever-quitting and the likelihood of ever-initiating smoking, the assimilation effect is 0.177 and 0.255 percentage points, respectively.

The pace of assimilation for smoking is slower than that for other health measures. But since smoking prevalence among immigrants is relatively low, 13 percent versus 21 percent for natives, assimilation could still have a material impact on the incidence of smoking among immigrants even in the medium term if there is a change in the pattern of migration. For example, if recent immigrants are from lower smoking countries, 10 years of living in the U.S. would add 1.38 percentage points to current smoking prevalence, a 10 percent increase. If recent immigrants are from higher smoking countries, 10 years of living in the U.S. would subtract 0.64 percentage point from current smoking prevalence, a 5 percent decrease.

### 1.2.6 An immigrant's hazard of smoking initiation and cessation

States have instituted cigarette excise taxes as far back as 1940 (Lillard et al., 2011) and smoke free air restrictions began in 1973 with Arizona (Chaloupka and Warner, 2000). Previous studies suggest that both taxes and restrictions have been effective in reducing smoking prevalence (Chaloupka and Warner, 2000). Can differences in responsiveness to taxes or restrictions explain the difference in assimilation between immigrants from countries with higher and lower smoking prevalences relative to the U.S.?

An immigrant's "exposure" to cigarette taxes and restrictions in the state of residence depends on age at migration and years since arrival. Therefore, a discrete time hazard model was chosen to estimate the effect of cigarette taxes and restrictions[13]. The panel dataset of immigrants, constructed using retrospective data, begins in the year of arrival and ends at the year of event (initiation or cessation) or censored at the survey year if the event does not occur[14]. The state tobacco excise tax data is available from 1965 while smoke free air restrictions data is available from 1991. Cigarette taxes were adjusted for inflation using the average annual consumer price index. Smoke free air restrictions is coded as an indicator variable equal to one if there existed any smoke free air restriction in the state for a given year.

The hazard to smoking initiation is modeled as a linear probability given by[15]

$$\begin{aligned}\Pr[Start = 1|\mathbf{x}] = \alpha_H \times (\pi_H Tax_{st} + \eta_H SFA_{st}) + \alpha_L \times (\pi_L Tax_{st} + \eta_L SFA_{st}) \\ +\beta_j + \omega_a + \tau_t + \nu_s + \alpha_H + female\end{aligned} \tag{1.7}$$

Similarly, the hazard to smoking cessation is modeled as a linear probability given by

$$\begin{aligned}\Pr[Quit = 1|\mathbf{x}, EverStart = 1] = \alpha_H \times (\pi_H Tax_{st} + \eta_H SFA_{st}) \\ + \alpha_L \times (\pi_L Tax_{st} + \eta_L SFA_{st}) + \beta_j + \omega_a + \tau_t + \nu_s + \alpha_H + female\end{aligned} \tag{1.8}$$

where $\alpha_H$ ($\alpha_L$) is an indicator for higher (lower) smoking country, $Tax_{st}$ is the natural log of the inflation-adjusted cigarette excise tax in a state and year, $SFA_{st}$ is an indicator

[13] A number of studies have examined smoking behavior using discrete time hazard models including Douglas and Hariharan (1994), Douglas (1998), DeCicca et al. (2002), Nonnemaker and Farrelly (2011), Lillard et al. (2011). The advantage of this approach is that the window between migration and smoking initiation or cessation is much wider than the survey period which allows for more variation in taxes over time and across states. The disadvantage is that immigrants are assumed to have remained in the state of residence since arrival to the U.S. The validity of this assumption has been examined in the literature on inter-state mobility of immigrants. For example, Kritz and Nogle (1994), Newbold (1999), Nogle (1997), Funkhouser (2000) found that while some immigrants move across states, most immigrants remain in the port-of-entry state. Nogle (1997) provides summary statistics for the share of immigrants that moved inter-state in the U.S. between 1985 and 1990. They show that the share who moved inter-state, 7%, is much less than the share that lived abroad or remained in the same state, 18% and 75%, respectively. However, the share of inter-state movers ranges from 3% to 16% depending on the state.

[14] Time to initiation was calculated as the number of years from age at migration to the age that the individual reported regular smoking. Time to cessation was calculated as the number of years from age at migration to the age that the individual reported quitting smoking.

[15] Both hazard to starting and quitting were also estimated as logit models using maximum likelihood estimation. These results, which are available upon request, are not materially different from those using OLS estimation.

variable for presence of a smoke free air law in a state and year, $\beta_j$ is an indicator variable for the duration spell, $\omega_a$ is an indicator variable for age, $\tau_t$ is an indicator for year, $\nu_s$ is an indicator for state, and $female$ is an indicator for female.

For the hazard to initiation estimation, individuals who reported initiating in the origin country were excluded. Likewise, for the hazard to cessation estimation, individuals who reported quitting in the origin country were excluded. Indicators for age, year, and state were used to control for time-invariant differences across states and age or year dependent differences in smoking behavior.

### 1.2.7 Estimation results for hazard of smoking initiation and cessation

The estimation results for the effects of cigarette taxes and smoke free air preemptions on an immigrant's hazard of initiating and quitting smoking are shown in Table 1.8. Columns (1) and (3) show the estimated effects of inflation-adjusted tobacco excise taxes and the presence of any smoke free air preemption for starting and quitting hazards, respectively. Columns (2) and (4) separates the estimated effects by immigrants from higher and lower smoking prevalence relative to the U.S. for starting and quitting hazards, respectively.

Tax elasticities were calculated at the mean values of the outcome variables. Price elasticities were calculated using the estimated tax elasticity and an estimate for the relationship between cigarette price and tax from Sumner, 1981[16].

For the hazard to smoking initiation, the estimated effect of taxes is not significant and not significantly different between immigrants from higher and lower smoking countries. The estimated effect of smoke free air laws is significant at the 10th percentile level for immigrants from higher smoking countries though the effect is not statistically significantly different for immigrants from higher and lower smoking countries.

For hazard to smoking cessation, the estimated effect of taxes is again insignificant and insignificantly different between immigrants from higher and lower smoking countries. However, the effect of smoke free air preemptions is significant at the 99th percentile level.

[16] $\epsilon = \eta \frac{\overline{p}}{\overline{t}} \frac{\partial t}{\partial p}$ where $\overline{p}$ is the mean cigarette price, $\overline{t}$ is the mean cigarette tax, $\epsilon$ is the price elasticity, $\eta$ is the tax elasticity, and $\frac{\partial t}{\partial p}$ is the effect of cigarette tax on price. The price elasticity was calculated using $\frac{\partial t}{\partial p} = 1.069$ from Sumner, 1981.

Still the effect is not statistically significantly different for immigrants from higher and lower smoking countries.

## 1.3 Discussion

This study tests whether immigrant smoking behavior supports the social norms hypothesis. Results show that assimilation affects immigrants differently depending on the country of origin. Immigrants from countries with higher smoking rates than the U.S. are less likely to be smokers with assimilation while those from countries with lower smoking rates are more likely to be smokers with assimilation. Since most immigrant men are from countries with higher male smoking rates and most immigrant women are from countries with lower female smoking rates, immigrant men tend to experience healthy assimilation while immigrant women tend to experience unhealthy assimilation.

More broadly, these findings relate to the role of peer influences on smoking behavior. Previous studies on peer effects have used schools (Gaviria and Raphael, 2001, Powell et al., 2005, Fletcher, 2010), spouses (Cutler and Glaeser, 2010), and neighborhoods (Norton et al., 1998) as social reference groups. Immigration can be viewed as a natural experiment in which individuals move between country-based peer groups and assimilation measures the effect of switching peers groups.

Consider a non-smoker who moves from a low smoking country to a high. The longer the duration of stay in the new country, the more likely a non-smoker will interact with and be influenced by smokers. On the other hand, a smoker who moves from a high smoking country to a low, with longer duration of stay, is more likely to be influenced by anti-smoking policies or non-smokers' anti-smoking sentiment which can affect smoking behavior (DeCicca et al., 2008). Even within a country, there may be variation in smoking rates by region. For example, across states in the U.S., smoking rates range from 9.1 percent in Utah to 26.8 percent in West Virginia. Future research should explore whether a similar pattern exists for individuals who move from a low smoking region to a high and vice versa.

This study also explores whether differences in responsiveness to cigarette taxes or smoke free air laws can explain the observed pattern of assimilation. Taxes do not significantly

affect the starting hazard among immigrants but presence of any smoke free air preemption may have an effect for immigrants from higher smoking countries. As well, taxes do not significantly affect the quitting hazard among immigrants but the presence of any smoke free air preemption appears to significantly increase the quitting hazard similarly for immigrants from higher smoking countries. In summary, differences in response to taxes or presence of any smoke free air preemption cannot explain why, with assimilation, immigrants from lower smoking countries have a higher starting hazard.

Immigrants comprise a fifth or more of the population in states like California, New York, and New Jersey, and Florida. Understanding smoking behavior among immigrants can inform anti-tobacco policy in these areas. For example, citing the high smoking rate among Asian men, the New York City Health Department recently launched a new public education campaign with graphic ads in Chinese offering nicotine patches and gum and a Chinese language option for a hotline to enroll in the program (Nir, 2012), and a similar program targeting the city's Russian community is in the works. Interventions aimed at reducing smoking prevalence among immigrants should not only include programs that encourage immigrants from higher smoking countries to quit, but also ones that discourage immigrants from lower smoking countries from starting.

Table 1.1: Summary of individual characteristics (sample-weighted means)

| | All | Ever-smokers | Starting Hazard 27 and under | Quitting Hazard 27 and over |
|---|---|---|---|---|
| current smoker | 0.13 | 0.54 | 0.03 | 0.82 |
| income | 39,847.35 | 40,958.63 | 36,810.15 | 38,629.63 |
| years since migration | 15.73 | 17.95 | 12.28 | 16.32 |
| age at migration | 22.92 | 23.62 | 15.58 | 26.82 |
| age | 38.63 | 41.55 | 27.85 | 43.14 |
| less than high school | 0.33 | 0.30 | 0.36 | 0.33 |
| high school | 0.23 | 0.25 | 0.24 | 0.25 |
| less than college | 0.17 | 0.19 | 0.20 | 0.17 |
| college | 0.16 | 0.17 | 0.13 | 0.16 |
| more than college | 0.10 | 0.09 | 0.07 | 0.08 |
| female | 0.50 | 0.31 | 0.52 | 0.30 |
| married | 0.67 | 0.68 | 0.53 | 0.71 |
| members in HH | 3.80 | 3.50 | 4.06 | 3.48 |
| resides in MSA | 0.74 | 0.77 | 0.70 | 0.71 |
| share from country where smoking prevalence is: | | | | |
| greater than U.S. | 0.49 | 0.70 | 0.44 | 0.71 |
| less than U.S. | 0.51 | 0.30 | 0.56 | 0.29 |
| greater than state of residence | 0.47 | 0.67 | 0.43 | 0.68 |
| less than state of residence | 0.53 | 0.33 | 0.57 | 0.32 |
| age when first started smoking cigarettes fairly regularly | 18.54 | 18.54 | 19.70 | 18.51 |
| age when completely stopped smoking cigarettes | 33.66 | 33.66 | 24.43 | 40.33 |
| Observations | 98,842 | 24,251 | 35,080 | 8,908 |

Smoking initiation hazard sample excludes immigrants who initiated prior to migration.
Smoking cessation hazard sample excludes immigrants who quit prior to migration and never-smokers.

Table 1.2: Summary of individual characteristics by gender and origin country smoking prevalence (sample-weighted means)

| | Origin country smoking prevalence is: Greater than U.S. | Less than U.S. | Male | Female |
|---|---|---|---|---|
| current smoker | 0.19 | 0.07 | 0.18 | 0.07 |
| income | 40,911.69 | 38,831.42 | 39,981.83 | 39,715.44 |
| years since migration | 16.14 | 15.33 | 15.54 | 15.91 |
| age at migration | 22.81 | 23.02 | 22.54 | 23.29 |
| age | 38.94 | 38.34 | 38.07 | 39.18 |
| less than high school | 0.31 | 0.35 | 0.35 | 0.32 |
| high school | 0.23 | 0.24 | 0.23 | 0.24 |
| less than college | 0.17 | 0.18 | 0.16 | 0.19 |
| college | 0.16 | 0.17 | 0.15 | 0.18 |
| more than college | 0.12 | 0.07 | 0.12 | 0.08 |
| female | 0.16 | 0.83 | 0.00 | 1.00 |
| married | 0.68 | 0.65 | 0.67 | 0.67 |
| members in HH | 3.74 | 3.85 | 3.84 | 3.75 |
| resides in MSA | 0.74 | 0.74 | 0.74 | 0.75 |
| share from country where smoking prevalence greater than U.S. | 1.00 | 0.00 | 0.82 | 0.16 |
| less than U.S. | 0.00 | 1.00 | 0.18 | 0.84 |
| greater than state of residence | 0.93 | 0.03 | 0.83 | 0.12 |
| less than state of residence | 0.07 | 0.97 | 0.17 | 0.88 |
| age when first started smoking fairly regularly | 18.27 | 19.19 | 18.12 | 19.47 |
| age when completely stopped smoking | 33.84 | 33.28 | 33.58 | 33.80 |
| Observations | 47,511 | 51,331 | 47,269 | 51,573 |

Table 1.3: Gender-specific smoking rates in the country of origin and among immigrants for countries where smoking prevalence is greater than the U.S.

| | Male | | | Female | | |
|---|---|---|---|---|---|---|
| | Country Smoking rate | Sample Size | Immigrant Smoking rate | Country Smoking rate | Sample Size | Immigrant Smoking rate |
| United States of America | 0.24 | 47269 | 0.18 | 0.18 | 51573 | 0.05 |
| Argentina | 0.30 | 225 | 0.16 | 0.21 | 217 | 0.12 |
| Armenia | 0.58 | 110 | 0.45 | . | . | . |
| Bangladesh | 0.42 | 211 | 0.20 | . | . | . |
| Bolivia | 0.34 | 103 | 0.17 | 0.28 | 102 | 0.04 |
| Bosnia and Herzegovina | 0.48 | 244 | 0.40 | 0.30 | 211 | 0.27 |
| Cambodia | 0.47 | 241 | 0.18 | . | . | . |
| Chile | 0.36 | 135 | 0.18 | 0.29 | 140 | 0.14 |
| China | 0.58 | 2399 | 0.13 | . | . | . |
| Colombia | 0.27 | 811 | 0.14 | . | . | . |
| Costa Rica | 0.25 | 105 | 0.14 | . | . | . |
| Cuba | 0.39 | 1521 | 0.22 | 0.25 | 1503 | 0.11 |
| Czech Republic | . | . | . | 0.23 | 110 | 0.16 |
| Egypt | 0.32 | 243 | 0.23 | . | . | . |
| France | 0.32 | 240 | 0.26 | 0.24 | 233 | 0.18 |
| Germany | 0.32 | 688 | 0.22 | 0.22 | 1310 | 0.24 |
| Greece | 0.57 | 266 | 0.32 | 0.39 | 204 | 0.15 |
| Hungary | 0.42 | 144 | 0.24 | 0.31 | 132 | 0.17 |
| India | 0.43 | 2289 | 0.09 | . | . | . |
| Indonesia | 0.52 | 151 | 0.22 | . | . | . |
| Iraq | 0.28 | 135 | 0.23 | . | . | . |
| Ireland | 0.32 | 273 | 0.19 | 0.28 | 254 | 0.21 |
| Italy | 0.31 | 622 | 0.23 | . | . | . |
| Japan | 0.41 | 498 | 0.25 | . | . | . |
| Jordan | 0.54 | 111 | 0.39 | . | . | . |
| Laos | 0.60 | 339 | 0.21 | . | . | . |
| Lebanon | 0.46 | 230 | 0.23 | 0.32 | 179 | 0.15 |
| Mexico | 0.29 | 16440 | 0.18 | . | . | . |
| Morocco | 0.29 | 105 | 0.21 | . | . | . |
| Netherlands | 0.32 | 153 | 0.18 | 0.26 | 166 | 0.13 |
| Pakistan | 0.29 | 418 | 0.19 | . | . | . |
| Philippines | 0.45 | 2278 | 0.20 | . | . | . |
| Poland | 0.32 | 711 | 0.29 | 0.31 | 857 | 0.16 |
| Portugal | 0.31 | 426 | 0.24 | . | . | . |
| Republic of Korea | 0.53 | 1107 | 0.31 | . | . | . |
| Romania | 0.44 | 186 | 0.20 | 0.23 | 206 | 0.14 |
| Russia | 0.65 | 677 | 0.24 | 0.22 | 868 | 0.11 |
| South Africa | 0.29 | 130 | 0.16 | . | . | . |
| Spain | 0.34 | 132 | 0.19 | 0.25 | 137 | 0.20 |
| Sweden | . | . | . | 0.19 | 103 | 0.14 |
| Syrian Arab Republic | 0.51 | 100 | 0.17 | . | . | . |
| Thailand | 0.38 | 208 | 0.28 | . | . | . |
| Trinidad and Tobago | 0.30 | 272 | 0.15 | . | . | . |
| Turkey | 0.51 | 173 | 0.35 | 0.18 | 123 | 0.18 |
| Ukraine | 0.64 | 239 | 0.20 | 0.20 | 258 | 0.12 |
| United Kingdom | 0.24 | 1103 | 0.20 | 0.22 | 1275 | 0.17 |
| Venezuela | 0.26 | 161 | 0.14 | 0.20 | 219 | 0.14 |
| Viet Nam | 0.38 | 1351 | 0.25 | . | . | . |

Table 1.4: Gender-specific smoking rates in the country of origin and among immigrants for countries where smoking prevalence is less than the U.S.

| | Male | | | Female | | |
|---|---|---|---|---|---|---|
| | Country Smoking rate | Sample Size | Immigrant Smoking rate | Country Smoking rate | Sample Size | Immigrant Smoking rate |
| United States of America | 0.24 | 47269 | 0.18 | 0.18 | 51573 | 0.05 |
| Armenia | . | . | . | 0.03 | 101 | 0.12 |
| Australia | 0.20 | 113 | 0.19 | 0.17 | 104 | 0.10 |
| Bangladesh | . | . | . | 0.01 | 139 | 0.01 |
| Barbados | . | . | . | 0.02 | 103 | 0.01 |
| Brazil | 0.18 | 382 | 0.19 | 0.12 | 465 | 0.13 |
| Cambodia | . | . | . | 0.05 | 287 | 0.02 |
| Canada | 0.19 | 1293 | 0.17 | 0.16 | 1609 | 0.16 |
| China | . | . | . | 0.03 | 2806 | 0.03 |
| Colombia | . | . | . | 0.11 | 1073 | 0.08 |
| Costa Rica | . | . | . | 0.08 | 132 | 0.10 |
| Dominican Republic | 0.15 | 1029 | 0.11 | 0.11 | 1633 | 0.08 |
| Ecuador | 0.15 | 558 | 0.13 | 0.03 | 610 | 0.05 |
| Egypt | . | . | . | 0.01 | 150 | 0.04 |
| El Salvador | 0.22 | 1730 | 0.14 | 0.03 | 1763 | 0.04 |
| Ethiopia | 0.07 | 162 | 0.13 | 0.00 | 147 | 0.03 |
| Ghana | 0.07 | 133 | 0.05 | . | . | . |
| Guatemala | 0.16 | 947 | 0.15 | 0.02 | 793 | 0.03 |
| Haiti | . | . | . | 0.04 | 736 | 0.02 |
| Honduras | . | . | . | 0.02 | 547 | 0.04 |
| India | . | . | . | 0.06 | 1950 | 0.01 |
| Indonesia | . | . | . | 0.04 | 141 | 0.08 |
| Iran | 0.22 | 582 | 0.20 | 0.02 | 458 | 0.12 |
| Iraq | . | . | . | 0.03 | 118 | 0.06 |
| Israel | 0.22 | 185 | 0.20 | 0.14 | 137 | 0.11 |
| Italy | . | . | . | 0.18 | 556 | 0.11 |
| Jamaica | 0.23 | 703 | 0.14 | 0.08 | 988 | 0.05 |
| Japan | . | . | . | 0.12 | 900 | 0.13 |
| Laos | . | . | . | 0.13 | 337 | 0.03 |
| Mexico | . | . | . | 0.09 | 14437 | 0.05 |
| Nicaragua | . | . | . | 0.05 | 433 | 0.07 |
| Nigeria | 0.08 | 265 | 0.10 | 0.00 | 173 | 0.03 |
| Pakistan | . | . | . | 0.04 | 308 | 0.02 |
| Panama | . | . | . | 0.04 | 154 | 0.05 |
| Peru | 0.23 | 483 | 0.16 | 0.07 | 560 | 0.06 |
| Philippines | . | . | . | 0.09 | 3554 | 0.05 |
| Portugal | . | . | . | 0.13 | 431 | 0.08 |
| Republic of Korea | . | . | . | 0.06 | 1592 | 0.09 |
| South Africa | . | . | . | 0.09 | 116 | 0.08 |
| Thailand | . | . | . | 0.02 | 408 | 0.08 |
| Trinidad and Tobago | . | . | . | 0.05 | 390 | 0.05 |
| Viet Nam | . | . | . | 0.02 | 1427 | 0.02 |

Table 1.5: Effect of assimilation on an immigrant's likelihood of current smoking: OLS estimation using a linear probability model.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| country smoking prevalence | | 0.929*** | | |
| | | (0.325) | | |
| years since migration | 0.000358 | 0.000408 | | |
| | (0.000248) | (0.000248) | | |
| years since migration for immigrants whose origin country smoking prevalence is: | | | | |
| greater than U.S. | | | -0.000638*** | |
| | | | (0.000235) | |
| less than U.S. | | | 0.00138*** | |
| | | | (0.000245) | |
| greater than state of residence | | | | -0.000628*** |
| | | | | (0.000242) |
| less than state of residence | | | | 0.00128*** |
| | | | | (0.000205) |
| log income | -0.0104*** | -0.00912*** | | |
| | (0.00250) | (0.00229) | | |
| year | -0.0119*** | -0.0121*** | | |
| | (0.00220) | (0.00219) | | |
| high school | -0.0100 | -0.00974 | | |
| | (0.00633) | (0.00651) | | |
| less than college | -0.0258*** | -0.0260*** | | |
| | (0.00801) | (0.00805) | | |
| college | -0.0638*** | -0.0638*** | | |
| | (0.0107) | (0.0105) | | |
| more than college | -0.0968*** | -0.0960*** | | |
| | (0.0161) | (0.0157) | | |
| age | 0.000377 | 0.000359 | | |
| | (0.000294) | (0.000294) | | |
| married | -0.0230*** | -0.0237*** | | |
| | (0.00340) | (0.00357) | | |
| number of HH members | -0.00704*** | -0.00712*** | | |
| | (0.00114) | (0.00115) | | |
| lives in MSA | -0.00269 | -0.00373 | | |
| | (0.00351) | (0.00359) | | |
| Observations | 98842 | 98842 | 98842 | 98842 |
| $R^2$ | 0.0740 | 0.0724 | 0.0724 | 0.0724 |
| Origin country FE | ✓ | | | |

Robust errors in parentheses are clustered in groups of gender by origin country

Estimates of years since migration, log income, and year of survey are average marginal effects

$H_0$: Marginal effects for years since migration are equal

$^{*}$ $p < 0.10$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Table 1.6: Effect of assimilation on an immigrant's likelihood of ever initiating smoking: OLS estimation using a linear probability model.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| country smoking prevalence | | 0.487** | | |
| | | (0.196) | | |
| years since migration | 0.00133*** | 0.00124*** | | |
| | (0.000286) | (0.000286) | | |
| years since migration for immigrants whose origin country smoking prevalence is: | | | | |
| greater than U.S. | | | 0.000668** | |
| | | | (0.000326) | |
| less than U.S. | | | 0.00177*** | |
| | | | (0.000323) | |
| greater than state of residence | | | | 0.000440 |
| | | | | (0.000315) |
| less than state of residence | | | | 0.00192*** |
| | | | | (0.000299) |
| year | -0.0199*** | -0.0197*** | | |
| | (0.00293) | (0.00290) | | |
| age | 0.00349*** | 0.00348*** | | |
| | (0.000573) | (0.000558) | | |
| female | -0.196*** | -0.0845** | | |
| | (0.00971) | (0.0429) | | |
| Observations | 98842 | 98842 | 98842 | 98842 |
| $R^2$ | 0.132 | 0.127 | 0.127 | 0.127 |
| $\chi^2$ | | | 6.275 | 14.497 |
| p-value | | | 0.0122 | 0.0001 |
| Origin country FE | ✓ | | | |

Robust errors in parentheses are clustered in groups of gender by origin country

Estimates of years since migration, log income, and year of survey are average marginal effects

$H_0$: Marginal effects for years since migration are equal

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.7: Effect of assimilation on an immigrant's likelihood of ever quitting smoking: OLS estimation using a linear probability model.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| country smoking prevalence | | -0.203 | | |
| | | (0.143) | | |
| years since migration | 0.00177*** | 0.00173*** | | |
| | (0.000560) | (0.000563) | | |
| years since migration for immigrants whose origin country smoking prevalence is: | | | | |
| greater than U.S. | | | 0.00255*** | |
| | | | (0.000508) | |
| less than U.S. | | | -0.0000847 | |
| | | | (0.000742) | |
| greater than state of residence | | | | 0.00266*** |
| | | | | (0.000506) |
| less than state of residence | | | | 0.0000233 |
| | | | | (0.000679) |
| year | 0.00610** | 0.00573** | | |
| | (0.00242) | (0.00236) | | |
| age | 0.00779*** | 0.00779*** | | |
| | (0.000490) | (0.000490) | | |
| female | 0.0202** | -0.0154 | | |
| | (0.00854) | (0.0309) | | |
| Observations | 24251 | 24251 | 24251 | 24251 |
| $R^2$ | 0.0805 | 0.0773 | 0.0773 | 0.0773 |
| $\chi^2$ | | | 12.043 | 13.016 |
| p-value | | | 0.0005 | 0.0003 |
| Origin country FE | ✓ | | | |

Robust errors in parentheses are clustered in groups of gender by origin country

Estimates of years since migration, log income, and year of survey are average marginal effects

$H_0$: Marginal effects for years since migration are equal

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table 1.8: Effect of cigarette tax and smoke free air preemption on an immigrant's starting and quitting hazards: OLS estimation using a discrete time hazard model.

| | Starting Hazard | | Quitting Hazard | |
|---|---|---|---|---|
| | 27 and under | 27 and under | 27 and over | 27 and over |
| | (1) | (2) | (3) | (4) |
| ln(real tax) | 0.0000363 | | -0.00293 | |
| | (0.000596) | | (0.00207) | |
| greater than U.S. | | 0.000136 | | -0.00288 |
| | | (0.000749) | | (0.00209) |
| less than U.S. | | -0.0000379 | | -0.00307 |
| | | (0.000643) | | (0.00274) |
| Any smoke-free air preemption | -0.000595 | | 0.00666*** | |
| | (0.000473) | | (0.00179) | |
| greater than U.S. | | -0.00125 | | 0.00591*** |
| | | (0.000863) | | (0.00167) |
| less than U.S. | | -0.000130 | | 0.00845** |
| | | (0.000679) | | (0.00338) |
| Observations | 202743 | 202743 | 63437 | 63437 |
| Sample | 35080 | 35080 | 8908 | 8908 |
| $R^2$ | 0.00865 | 0.00866 | 0.00657 | 0.00658 |
| p-value (ln(real tax)) | | 0.806 | | 0.933 |
| p-value (any SFA laws) | | 0.356 | | 0.426 |
| tax elasticity | 0.00494 | | -0.118 | |
| tax elasticity (> U.S.) | | 0.0113 | | -0.121 |
| tax elasticity (< U.S.) | | -0.00963 | | -0.115 |
| price elasticity | 0.0250 | | -0.593 | |
| price elasticity (> U.S.) | | 0.0582 | | -0.613 |
| price elasticity (< U.S.) | | -0.0482 | | -0.562 |

Robust errors in parentheses clustered by state

Models include indicators for female, higher smoking country, age, duration spell, state, and year

Tax elasticity evaluated at the mean initiation and cessation rate

$H_0$: Marginal effects for are equal for higher and lower smoking countries

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

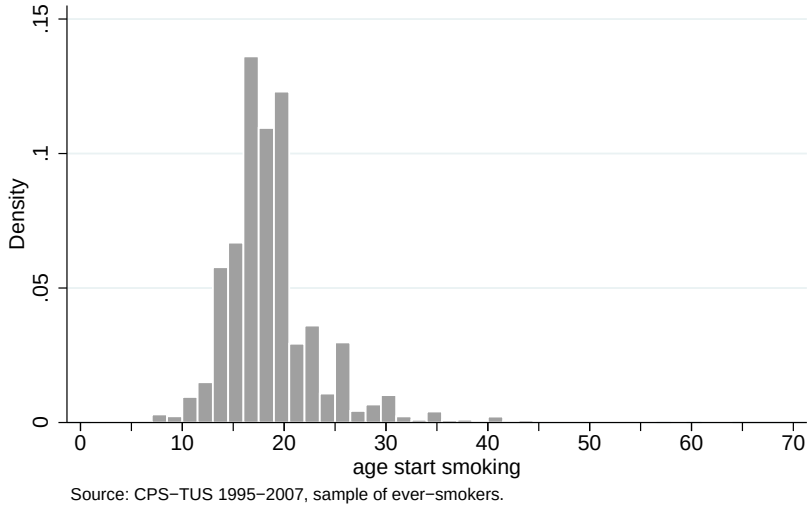


Figure 1.1: Distribution of age at initiation for immigrant ever-smokers.

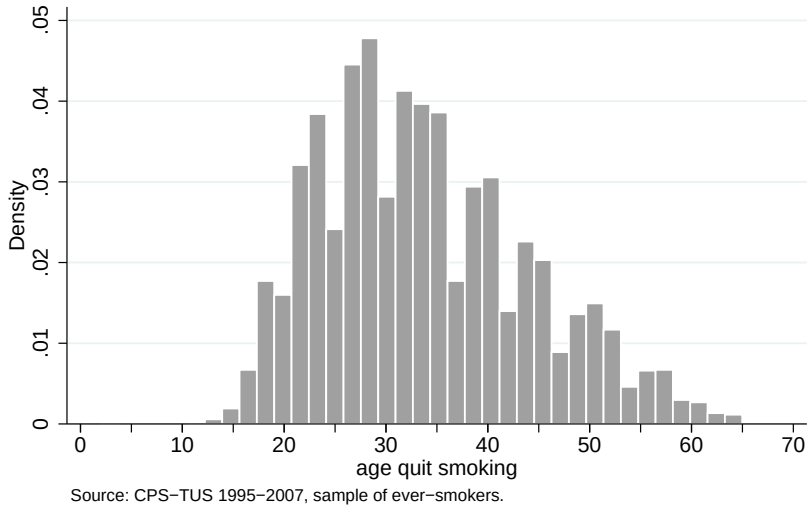


Figure 1.2: Distribution of age at cessation for immigrant ever-quitters.

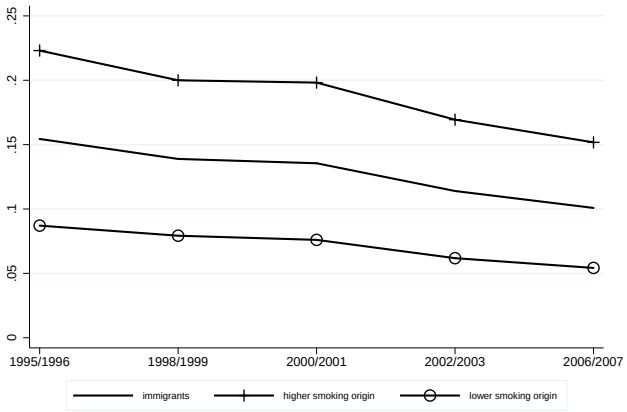


Figure 1.3: Smoking prevalence by origin country smoking prevalence relative to the U.S., 1995–2007.

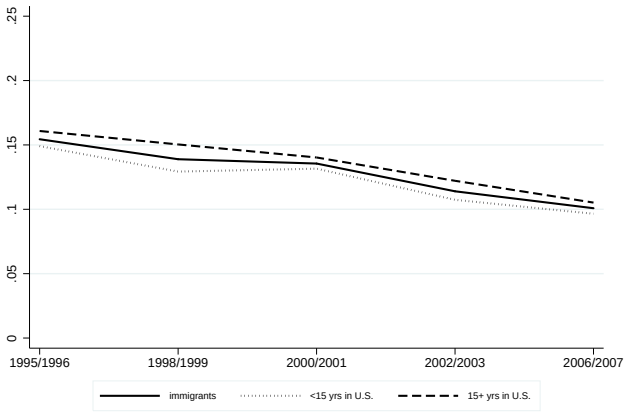


Figure 1.4: Smoking prevalence by years since migration, 1995–2007.

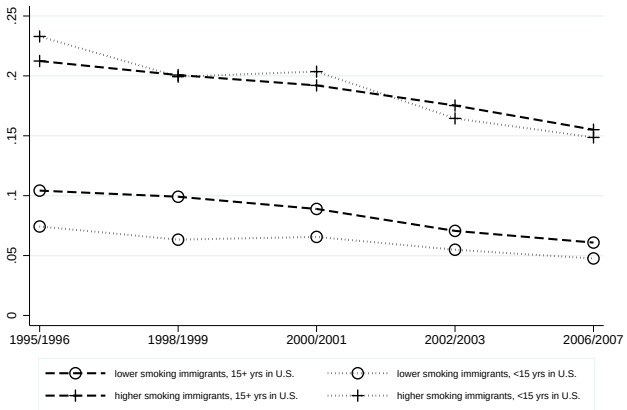


Figure 1.5: Smoking prevalence by origin country smoking prevalence relative to the U.S. and years since migration, 1995–2007.

# 2 Effect of mortgage debt on health

*Catherine Lau and Leigh Ann Leung*

**Abstract**

This study examines the effect of mortgage debt on health among homeowners using six waves of the Health and Retirement Survey (HRS) from 1998 to 2008. Health status is measured by overall well being, incidence of high blood pressure, obesity, and depressive symptoms. Using home prices as an instrument to identify the causal effect in an IV framework, we found that a high mortgage loan to home value leads to a greater likelihood of a decline in overall well being and the presence of a depressive symptom. Since homeownership in the U.S. is promoted through subsidized home financing, our findings have important policy implications and also highlight the need to improve financial literacy.

**Author Keywords:** Homeownership, mortgage debt, health, instrumental variables

**JEL classification codes:** I18

## 2.1 Introduction

Owner-occupied housing is a major asset on U.S. households' balance sheet, accounting for over a third of total assets (Poterba and Samwick (2001)). A number of social benefits are associated with homeownership. Homeownership lengthens housing tenure by increasing the cost of relocating and reducing household mobility. Longer housing tenure promotes family stability and better child outcomes. Longer housing tenure is also associated with better self-reported health (Dietz and Haurin (2003), Pollack et al. (2004)). Homeowners have an incentive to improve housing structures and participate in political and social activities. Though homeowners bear the cost of capital reinvestments and community engagement, neighboring homeowners benefit as well through higher home valuations[1] (Dietz and Haurin (2003), Glaeser and Shapiro (2003)).

Since home purchases require a great deal more capital than households typically have on hand, most home sales are financed. While homes constitute a large share of household assets, home mortgages constitute a large share of household liabilities. U.S. policy encourages homeownership but little is understood about the ramifications of the concomitant debt. In fact, the government's subsidy of mortgage financing[2] encourages leverage over equity in home purchases and greater consumption of housing than households would have chosen if these subsidies did not exist (Glaeser and Shapiro (2003)). In 2008, 93 percent of homes purchased involved financing, though in 2010, this declined to 91 percent (Hale (2009, 2010)). The prevalence of house financing is also affected by the interaction between policy and economic conditions. During periods of mortgage credit expansion, riskier homebuyers can also qualify for mortgages, thereby increasing the prevalence of mortgage finance in home sales (Mian and Sufi (2009), Keys et al. (2010)).

While homeownership leads to positive social outcomes, mortgage indebtedness potentially leads to negative health outcomes. We use Grossman's (1972) model of health as a stock variable, which depreciates over time but can be augmented by combining time,

[1] The externality works in the opposite direction since a foreclosure lowers neighboring home values.

[2] The cost of borrowing is subsidized by allowing interest paid on mortgages to be deducted from income (Rosen (1985)) and through government guarantees which reduce the credit risk of mortgage loans, essentially lowering the interest rate.

income, and medical care, to illustrate the potential negative impact of mortgage indebtedness on health. We hypothesize a direct and an indirect path through which mortgage indebtedness leads to poor health. First, higher mortgage indebtedness increases financial stress. Epidemiological studies have found that stress plays a role in cardiovascular disease (Dorian and Taylor (1984)). Previous studies have also found that stress affects both the contraction of and progression of certain diseases (Calcagni and Elenkov (2006), Contrada and Baum (2009)), and in particular stress can increase the probability of catching a cold (Takkouche et al. (2001)). Financial stress can also lead to unhealthy behaviors such as drinking, smoking, or substance abuse, or may cause sleep problems and eating disorders (Neil Schneiderman (2008)). Second, since higher mortgage indebtedness corresponds to a negative wealth effect, it can lead to fewer health investments, particularly preventative care.

Mortgage indebtedness can be measured as the ratio of mortgage loan to home value (LTV). A high LTV means that homeowners have little or no equity in the home value. In the model, a decline in home prices affects homeowners differently depending on their level of home equity[3]. Among homeowners with little or no equity, a decline in home prices increases LTV, and leads to financial stress and fewer health investments[4]. Among homeowners with sizable equity cushions, a decline in home prices increases LTV, but may not necessarily lead to financial stress or changes in health investments.

Given the potential negative relationship between debt and health, policies that promote homeownership through financing may have unintended health consequences, especially when home prices decline sharply. Prior studies on debt and health consider individuals near or at foreclosure. However, the share of homeowners that default is small compared to the share of homeowners with mortgage debt outstanding and the negative impact of debt on health may affect homeowners not in foreclosure. Furthermore, most existing studies use data that are limited to a specific state or set of states in the U.S. To our knowledge, this is

[3]The level of home equity is related to housing tenure. New homeowners are more likely to have less equity compared to seasoned homeowners given the amortizing structure of mortgage loans.

[4]Empirical evidence for the indirect effect is mixed. Keese and Schmitz (2010) using longitudinal data for Germany found that individuals with debt are more likely to visit a doctor. Since Germany has universal health care, the indirect effect of debt on health is likely smaller. Currie and Tekin (2011) using foreclosure data for four states in the U.S. found that a higher number of foreclosures is associated with more hospital visits and fewer preventive medical visits.

the only study to use household mortgage loan to home value to estimate the effect of the mortgage indebtedness on mental and physical health among a nationally representative sample of adults over the age of 50 in the U.S.

We show that high mortgage indebtedness is associated with a greater likelihood of poor health, a decline in well-being, obesity, high blood pressure, and presence of a depressive symptom. However, if mortgage indebtedness and health are endogenous, then OLS estimates are biased. The endogeneity may be due to reverse causality or that debt and health are simultaneous determined by a unobserved omitted variable, e.g. ability, health or wealth endowments, risk tolerance, or time preference. We argue that the recent housing decline serves as a natural experiment by shifting the level of mortgage indebtedness across metropolitan statistical areas (MSA) over time. We use home prices as an instrument for the mortgage loan to home value (LTV) ratio in an Instrumental Variable (IV) framework to identify the causal effect of mortgage debt on health. Among mortgagors, we found that a 10 percent increase in the probability of high LTV increases the likelihood of a decline in well-being by 4 percent and the likelihood of a depressive symptom by 3 percent. We examined whether the results are robust to changes in the estimation sample, redefinition of the variable of interest (LTV), and the estimation model. Following Currie and Tekin (2011), we also used the incidence of cancer as a falsification test.

## 2.2 Literature Review

Defaulting on mortgage debt is a disruptive life event that may negatively affect health. In the U.S., the rise in foreclosures since 2008 has prompted research on the impact of foreclosures on health. Pollack and Lynch (2009) compared the health of individuals, recruited through a mortgage counseling agency, undergoing foreclosure with that of a community sample from the 2008 Southeastern Pennsylvania Household Health Survey. They found that the foreclosed sample were significantly more likely to have hypertension, heart disease, and a clinically diagnosed psychiatric condition than the control group. The foreclosed also reported greater consumption of smoking and drinking in the past month. In a broader study covering four states – Arizona, California, Florida, and New Jersey – Currie and Tekin

(2011) found that zip codes with a greater number of foreclosures also experienced a greater rise in Emergency Room visits and hospitalizations for stress related conditions, controlling for county-specific, time-varying factors such as labor market conditions. Furthermore, the effect was greater among younger individuals and for conditions that are typically avoidable with preventative care.

Prior to default, borrowers who have missed two or more consecutive payments on the mortgage loan are considered delinquent. Previous studies have examined the effect of mortgage debt delinquency on health. For the U.S., Alley et al. (2011), using the 2006 and 2008 waves of the Health and Retirement Survey (HRS), compared the health outcomes of mortgagors who had been more than two months delinquent on their mortgage payments in the past two years to those who are current on their mortgage payments. They found that delinquent respondents were significantly more likely to have depressive symptoms and to have less access to health relevant resources. These results are qualitatively consistent with similar studies in the U.K. Taylor et al. (2006), using the British Household Panel Survey (BHPS) from 1991 to 2003, a period that covers the recession in the early nineties, found that being past due on mortgage debt is associated with a negative psychological effect among men, controlling for financial conditions and other personal traits. Nettleton and Burrows (1998), using the Survey of English Housing[5] from 1991-1992 and 1994-1995, found that difficulty meeting mortgage payments is associated with a decline in mental well-being.

Previous studies have also examined the effect of unsecured debt on health. Drentea and Lavrakas (2000), using a sample of adults in Ohio, found that greater credit card debt-to-income is associated with a greater likelihood of physical health impairment. In a follow up study, Drentea (2000) found that greater credit card debt-to-income is associated with a greater likelihood of having mental anxiety. Similarly, Brown et al. (2005), using the 1995 and 2000 waves of the British Household Panel Survey (BHPS), found that greater unsecured household debt is associated with the likelihood of having poor mental health. Keese and Schmitz (2010), using the German Socioeconomic Panel (GSOEP) from 1999-2009, found that greater debt is associated with worse mental health and a higher incidence

[5]The Survey of English Housing is a supplemental survey to the British Household Panel Survey (BHPS) consisting of households headed by younger individuals, single parents, single male parents, divorced and separated, divorced and inactive.

of obesity. They also estimated a fixed effects model to control for individual-specific, time-invariant factors that may be endogenous to health and debt. Fixed effects estimates show that greater indebtedness leads to poor mental health and lower health satisfaction with mortgage debt having a large effect on mental health. Though, loan amounts of unsecured debt are typically less than that of mortgage, these findings suggest that even unsecured debt has a negative effect on health.

Finally, a number of studies have examined the effect of self-reported financial stress on health. Bridges and Disney (2010) and Skapinakis et al. (2006) found that individuals experiencing financial difficulties were more likely to exhibit depression. O'Neill et al. (2005) and Lyons and Yilmazer (2005) found a positive correlation between self-reported financial stress and poor self-reported health. While these studies show a negative relationship between financial stress and health, the particular type of debt leading to financial stress was not identified.

The literature on the health effects of debt has primarily focused the household's ability to make debt repayments, that is whether the household is liquidity constrained. Another measure of a household's financial condition is the debt to asset ratio, an indicator of balance sheet leverage. In contrast to prior studies, this study focuses on households with high mortgage debt to assets but not necessarily delinquent or in default. We argue that households with a high mortgage loan to home value (LTV) also experience financial stress given that debt secured by the primary residence comprise the largest share of household balance sheets. Since the number of homeowners that have experienced a decline in home equity is larger than the number in delinquency or foreclosure, we argue that the potential effect of having high LTV on health is relevant to a broader segment of the population[6].

## 2.3 Data

Individual level data on health, housing, financial situation, and other socioeconomic factors were obtained from the University of Michigan Health and Retirement Survey (HRS). The

[6]For example, Alley et al. (2011), using only the HRS 2008 participants eligible to be asked mortgage-delinquency questions, reported a mortgage delinquency rate of 3 percent whereas, using complete HRS 2008 wave, 13 percent of mortgagors have high LTV.

HRS is a nationally representative survey of adults over the age of 50 conducted every two years. Since young adults are more likely to borrow to finance a home purchase, excluding these individuals is a limitation of the data. On the other hand, older adults are more likely to be homeowners and less likely to transition in or out of homeownership[7].

Six waves of the HRS from 1998 to 2008 were chosen to overlap with the housing boom and bust cycle and allow for panel estimation. Individuals living in a multifamily home, nursing home, farm, or ranch were excluded. For the OLS and IV estimations, each wave was treated as a cross-section to create a pooled dataset with slightly over 80,000 observations. For the fixed effects estimation, the same dataset, excluding individuals who died between 1998 and 2008, was treated as an unbalanced panel with a little over 19,000 observations.

The HRS housing module contains extensive information on housing-related items such as homeownership, housing structure, home purchase price, current house price, and housing debt outstanding. The HRS dataset was merged to an index of house prices by metropolitan statistical area (MSA). Home price index data was obtained from Freddie Mac[8] which publishes the Freddie Mac House Price Index (FMHPI). The FMHPI is constructed using repeat transactions on single-family detached or townhome properties which serve as collateral for mortgage loans purchased by either Freddie Mac or Fannie Mae. The FMHPI closely tracks other constant-quality home prices indices such as Standard and Poor's Case-Shiller and Federal Housing Finance Agency.

### 2.3.1 Variable definitions

Health conditions related to financial stress include self-reported overall well-being, negative change in overall well-being, obesity, high blood pressure, and presence of a depressive symptom. HRS measures overall well-being as a categorical variable where 1 indicates excellent health, 2 indicates very good health, 3 indicates good health, 4 indicates fair health, and 5 indicates poor health. Poor overall health was constructed as a dichotomous variable where 1 indicates fair or poor overall health. Decline in health was constructed as

[7]The participation rate of homeownership stabilizes at around 70 percent after age 45 (Poterba and Samwick (2001)).

[8]Freddie Mac is a former government sponsored entity now under a conservatorship directed by the Federal Housing Finance Agency (FHFA).

a dichotomous variable where 1 indicates an increase in the self-reported overall well-being categorical variable. Obesity was constructed as a dichotomous variable where 1 indicates a body-mass index of 30 or greater. High blood pressure is a self-reported dichotomous variable where 1 indicates presence of high blood pressure. The HRS measures mental health with a modified version of the Center for Epidemiologic Studies Depression (CESD) scale. The CESD score is the sum of six indicators for the presence of depressive symptoms (depression, everything is an effort, sleep is restless, felt alone, felt sad, and could not get going) minus the sum of two indicators for the presence of non-depressive symptoms (felt happy and enjoyed life). CESD scores range from 1 to 8, with 8 representing those exhibiting the most depressive symptoms. We converted this measure of depression into a dichotomous variable with 1 indicating the presence of any depressive symptom. Cancer is a self-reported dichotomous variable where 1 indicates presence of cancer.

Households experience financial stress when the burden of mortgage indebtedness becomes excessive. To measure excessive mortgage indebtedness, we use the loan to value (LTV) ratio defined as the amount of mortgage loan outstanding divided by the self-reported home value[9]. LTV measures the degree of leverage used to finance the primary residence, which, all else equal, declines over time given the amortizing nature of mortgage loans. If housing values decline, then home equity is reduced and may even be negative. As well, homeowners with a high LTV cannot reduce housing consumption accordingly and even if they manage to sell the home, they are more likely to incur a financial loss due to lower equity and transaction fees. Therefore, we hypothesize that high LTV, through financial stress, leads to a greater likelihood of a negative health outcome.

[9]The Rand version of HRS home value and mortgage debt variables were used instead of the raw HRS variable since it had fewer missing values. All housing variables refer to the respondent's primary residence. A small number of respondents had a LTV that far exceeded average values. LTV was top-coded at their respective 99 percentile values. An indicator variable was included to adjust for LTV top-coding.

## 2.4 Estimation Model

The reduced form model for health as a function of mortgage indebtedness and socioeconomic factors is given by

$$H_{it} = \alpha + \lambda_{LTV} + \tau_t + \delta_{msa} + \gamma_{msa} \times t + X_{it}\Theta + \epsilon_{it} \tag{2.1}$$

where $H_{it}$ is a dichotomous indicator for presence of each health condition, $\lambda_{LTV}$ is a dichotomous indicator for LTV greater than 0.8, $\tau_t$ is an indicator for each wave, $\delta_{msa}$ is an indicator for each MSA, $\gamma_{msa} \times t$ is a MSA-specific linear time trend, $X_{it}$ is a vector of socioeconomic variables which includes total non-housing assets, household income, gender, age, education, race/ethnicity, marital status, labor force status, employment status, blue-collar worker, and health insurance status for individual $i$ in wave $t$, and $\Theta$ is a vector of parameters.

The cutoff of 0.8 for high LTV was chosen based on the loan requirement at purchase for a conventional mortgage. Though loan requirements vary with macroeconomic conditions, typically mortgage lenders require homebuyers to pay at least 20 percent of the appraised home value at closing. Therefore, if LTV rises above 80 percent, then the mortgagor experiences a decline in equity, which we hypothesize is a source of financial stress.

Since LTV relates to the value of the primary residence, it is likely correlated with the individual's non-housing assets (Flavin and Yamashita (2002)). Total non-housing assets and household income control for differences due to household portfolio choice[10]. In addition, MSA and year fixed effects control for time-invariant differences across MSAs and year-specific differences in health conditions, respectively. Finally, to ensure that our instrument more likely reflects exogenous deviations from long-run trends in home prices by MSA, we also include MSA-specific linear time trends.

Equation 2.1 was estimated in an IV framework to identify the causal effect of LTV on health using the Freddie Mac House Price Index (FMHPI) as the instrument. The FMHPI is a valid instrument because home prices are strongly correlated with LTV, given

[10]Income and non-housing assets are in units of dollars per thousand.

that self-reported home value is the denominator of the LTV ratio, but should not directly affect health except through LTV, which proxies the individual's level of financial stress[11]. Equation 1.1 was estimated in an exactly identified model with the first stage given by:

$$\lambda_{LTV} = \beta + \kappa \text{FMHPI}_{msa,t}^{-1} + \tau_t + \delta_{msa} + \gamma_{msa} \times t + X_{it}\Theta + \eta_{it} \tag{2.2}$$

where $\text{FMHPI}_{msa,t}^{-1}$ is the inverse of the FMHPI normalized to 1 in year 2000.

The effect of high LTV on health was estimated for the sample population, homeowners, and mortgagors. Since the sample population contains both renters and homeowners, an indicator variable for homeowners was included when estimating equations 2.1 and 2.2 using the sample population. Including an indicator variable for homeowners adjusts for selection between homeowners and renters and ensures that the parameter on high LTV is only identified using homeowners' LTV.

### 2.4.1 Summary statistics

Table 2.1 shows the sample-weighted means for the socioeconomic, health, and housing finance variables for the sample population, homeowners, and mortgagors. Since the HRS represents an older sample of the U.S. population, the share of homeowners is larger than that for overall U.S. population, 78 percent compared to 67.5 percent as of 2008 (*Current Population Survey/Housing Vacancy Survey* (2011)). On average, mortgagors tend to be healthier than the sample population with lower prevalence of depressive symptoms, high blood pressure, and cancer. This could be because mortgagors also tend to be younger, 61 versus 65 years. In contrast, the prevalence of obesity is higher among mortgagors. Table 2.2 shows the housing finance variables for the sample population, homeowners, and mortgagors for each wave from 1998 to 2008. Table 2.3 shows health conditions for the sample population, homeowners, and mortgagors for each wave from 1998 to 2008. Among mortgagors, the prevalence of obesity and high blood pressure has increased over this period while the prevalence of poor health, negative changes in health and cancer remained relatively stable. Depressive symptoms declined slightly.

[11] Engelhardt (2003) used home price indices to correct for measurement error in self-reported home values. They found that self-reported home values are generally overestimated in the range of 10%.

## 2.5 Results

### 2.5.1 Effect of high LTV on health among mortgagors

Table 2.4 shows the estimation results among mortgagors using OLS for each of the five health conditions. Errors were adjusted for heteroskedasticity and clustered by MSA. Estimates show that a high LTV is significantly correlated with a greater likelihood of fair/poor well-being, negative change in well-being, obesity, presence high blood pressure, and presence of a depressive symptom. The significance and sign of estimates for the remaining socioeconomic factors vary depending on the health condition. For all five conditions, more years of schooling, being in the labor force, and greater non-housing assets are associated with a lower likelihood of poor health conditions.

Table 2.5 shows the estimation results among mortgagors using IV for each of the five health conditions. The IV estimates are positive but magnitudes are roughly larger by a factor of 10. Only the estimate on likelihood of a negative change in well-being remains statistically significant at the 95 percent level. IV and OLS estimates for a negative change in well-being are 0.402 and 0.0282, respectively. This implies that OLS estimates are biased towards zero.

We consider several potential omitted variables. Individuals who are less patient, more risk loving, or have a low health endowment are more likely to have a high LTV. However, these individuals are also more likely to be in poor health suggesting that OLS estimates will be biased away from zero. The only way for OLS estimates to be biased towards zero is if the omitted variable is positively correlated with high LTV and negatively correlated with poor health or vice versa. We hypothesize that the omitted variable could be ability or wealth endowment. Individuals who have a high ability or a high wealth endowment are less likely to be credit constrained, more likely to qualify for a high LTV, and less likely to be in poor health. This could explain why OLS estimates are biased towards zero.

### 2.5.2 Robustness Checks

We examine whether the results are robust to changes in the estimation sample, redefinition of the variable of interest (LTV), and the estimation model. The estimation sample was increased to include homeowners with no mortgages and renters, both groups with LTV equal to zero. As well, the sample was reduced to exclude individuals age 65 and above to ensure that the results are not driven by this age group. We also estimated the effect of low LTV on the same health conditions expecting that the estimated effect would be either insignificant or negative. Following Currie and Tekin (2011), we used the incidence of cancer as a falsification test. Finally, we considered an alternative estimation model with an unobserved, individual specific, time-invariant omitted variable.

#### Effect of high LTV on health by homeownership-status

Although the main finding relates to mortgagors, it is also of interest to examine the effect among the sample population and homeowners. And since previous studies have found that debt affects mental health in particular, the eight symptoms that comprise the CESD measure were separately examined as outcome variables. Table 2.6 shows the effect of high LTV on the five health conditions and eight depressive symptoms among the sample population, homeowners, and mortgagors.

Among mortgagors, the OLS and IV estimates are positive for each of the depressive symptoms and significant at the 95 percent level for restless sleep, did not enjoy life, and hard to get going. In the sample of homeowners, homeowners with no mortgages are added to the sample of mortgagors. This more than doubles the sample size and should increase the power of the t-test. However, the adjusted errors among homeowners are roughly the same as that for mortgagors. This suggests that the heterogeneity of renters and homeowners with no mortgages contribute to the error term and does not improve the power. In the sample population, renters are added to the sample of homeowners increasing the sample by over 20,000 observations. The IV estimates for presence of depressive symptom and felt alone are significant at the 95 percent level.

**Effect of low LTV on health**

We estimated the effect of low LTV, defined as an LTV of 40 percent or less, on the likelihood of each health condition. Mortgagors with low LTV should not experience financial stress as these homeowners have sizable home equity. Table 2.7 shows that the estimated effect of low LTV is negative and significant for outcomes using OLS. Among mortgagors, the estimated effect of low LTV is negative and significant for a decline in well-being, not enjoying life, and difficulty getting going.

**Fixed Effects**

We consider an estimation model with an unobserved, individual specific, time-invariant omitted variable. The fixed effects model is given by

$$H_{it} = \alpha + \lambda_{LTV} + \omega_i + \tau_t + X_{it}\Theta + \epsilon_{it} \tag{2.3}$$

where $\omega_i$ is a dichotomous indicator for each individual, $X_{it}$ is a vector of time-varying socioeconomic variables which includes total non-housing assets, household income, age, marital status, labor force status, employment status, blue-collar worker, and health insurance status for individual $i$ in wave $t$, and $\Theta$ is a vector of parameters.

Tables 2.8 shows the effect of high LTV on the likelihood of each condition using fixed effects estimation. A 10 percent increase in the likelihood of having high LTV increases the likelihood of being in fair/poor health and having a negative change in health by 15 and 19 percent among the sample population and homeowners, respectively. Among mortgagors, the estimate is not significant but since the adjusted error is roughly the same as for the other two groups, this lack of significance is likely due to lack of power. Interestingly, while the IV estimates suggest that high LTV affects health through mental stress, fixed effects estimates do not show a significant effect on incidence of depressive symptoms.

**Cancer as a control outcome**

Following Currie and Tekin (2011), we used cancer as a "control" outcome. Assuming that financial stress does not cause cancer, then high LTV should have no effect on presence of cancer. Table 2.9 shows that high LTV does not have a significant effect on the likelihood of cancer neither among mortgagors, homeowners, nor the sample population.

**Sub-sample by age**

Finally, the effect of high LTV was estimated on a restricted sample of individuals less than 65 years old to ensure that our results are not driven by individuals age 65 and over. The sample of mortgagors is reduced to 17,131 from 18,222 observations. The sample population is reduced to 27,705 from 61,607 and the sample of homeowners is reduced to 34,560 from 80,036. The results for the sample restricted by age are qualitatively consistent with the unrestricted sample.

## 2.6 Discussion

High LTV is significantly correlated with poor self-reported well-being, a decline in well-being, obesity, high blood pressure, and presence of a depressive symptom. High LTV is not significantly correlated with cancer suggesting that these findings are not an artifact of the data. Though the estimates of IV are larger in magnitude relative to OLS, the adjusted errors are also larger, such that only decline in well-being and presence of a depressive symptoms such as restless sleep, did not enjoy life, and hard to get going remain statistically significant.

We compared the effect of high LTV with that of mortgage delinquencies from Alley et al. (2011) and foreclosures from Currie and Tekin (2011) on health in the U.S. Although, Alley et al. (2011) used the same dataset, they used a subsample of homeowners who responded to an internet-based questionnaire which specifically asked mortgage delinquency status.Alley et al. (2011) estimated the log odds of a major decline in self-reported health to be 1.17 and of a depressive symptom to be 7.86. Converting from odds ratios and assuming a

probability of delinquency of 3 percent[12], the predicted probabilities for a decline in health and depressive symptom is 1.67 and 2.73 percent, respectively.

Currie and Tekin (2011) estimated the effect of foreclosure on the number of hospitalization and ER visits related to hypertension and anxiety to be 0.0055 and 0.025, respectively, among those age 50-64. The average number of foreclosures per zip code between 2005 and 2009 was 84. This corresponds to a 7.39 percent increase in the number of hospitalization and ER visits related to hypertension and a 15.85 percent increase in visits related to anxiety.

According to Table 2.2, between 2006-2008, the prevalence of high LTV increased by 30 percent. This corresponds to an estimated increase of 6.33 percent in the likelihood of high blood pressure and 9.6 percent in the likelihood of a depressive symptom among mortgagors.

Estimates for all three studies are summarized in Table 2.11. The predicted change in outcome using high LTV is comparable with that using number of foreclosures. However, the predicted change using mortgage delinquency is lower than expected. This could be due to our incorrectly calculating the change in delinquency prevalence rate or to the difference in the estimation sample.

A limitation of this study is that HRS data only surveys people over 50 years of age. Since Currie and Tekin (2011) found the most pronounced effects on those between 20 and 49 years of age, the effect of high LTV could be larger for a younger cohort. On the other hand, since younger homeowners have more time to recoup losses in home equity, the effect on health may be smaller. An area for further research would be to use a dataset with younger homeowners.

From a policy perspective, our results highlight the unintended health consequences of promoting financing for home purchases, especially when home prices are subject to volatility. Innovations in the mortgage loan market have allowed high leverage and frequent refinancing. At the same time labor markets are characterized by less stability, with shorter tenures at the same firm and more frequent unemployment spells. Policymakers should

[12] Alley et al. (2011) did not report the weighted-mean prevalence of mortgage delinquency in the sample, only the number of observations. We calculated the delinquency rate based on the reported number of observations.

consider whether the benefits of homeownership outweigh the negative health effects of high mortgage indebtedness.

Table 2.1: Summary statistics (HRS 1998-2008 pooled)

| | All | Homeowners | Mortgagors |
|---|---|---|---|
| homeowner | 0.78 | 1.00 | 1.00 |
| mortgagor | 0.36 | 0.46 | 1.00 |
| female | 0.55 | 0.53 | 0.50 |
| age | 65.89 | 65.26 | 60.89 |
| years of schooling | 12.79 | 13.15 | 13.67 |
| black | 0.10 | 0.08 | 0.09 |
| hispanic | 0.07 | 0.06 | 0.06 |
| other | 0.04 | 0.04 | 0.05 |
| married | 0.64 | 0.73 | 0.78 |
| in labor force | 0.44 | 0.48 | 0.66 |
| unemployed | 0.01 | 0.01 | 0.01 |
| has health insurance | 0.84 | 0.84 | 0.79 |
| blue-collar | 0.50 | 0.45 | 0.38 |
| household income | 70,757.51 | 79,868.59 | 95,344.69 |
| non-housing assets | 325,975.64 | 393,406.98 | 316,221.91 |
| mortgage loan | 35,975.02 | 46,153.61 | 100,458.58 |
| house value | 188,206.94 | 239,472.00 | 274,344.97 |
| LTV | 0.16 | 0.21 | 0.45 |
| high LTV | 0.04 | 0.05 | 0.11 |
| low LTV | 0.81 | 0.76 | 0.47 |
| poor health | 0.26 | 0.22 | 0.19 |
| negative change in health | 0.25 | 0.23 | 0.21 |
| obesity | 0.26 | 0.25 | 0.29 |
| high blood pressure | 0.50 | 0.48 | 0.45 |
| depressive symptoms | 0.55 | 0.51 | 0.49 |
| cancer | 0.13 | 0.13 | 0.10 |
| observations | 80,088 | 61,638 | 26,233 |

Sample-weighted means.

Mortgage loans on primary residence.

High LTV defined as LTV > 0.80. Low LTV defined as LTV <= 0.40.

Obesity defined as BMI>30. Depressive symptoms defined as CESD>0.

Table 2.2: Homeownership and mortgage indebtedness time trends, 1998-2008.

| | 1998 | 2000 | 2002 | 2004 | 2006 | 2008 |
|---|---|---|---|---|---|---|
| | All | | | | | |
| LTV | 0.16 | 0.15 | 0.14 | 0.17 | 0.17 | 0.17 |
| high LTV | 0.04 | 0.04 | 0.03 | 0.04 | 0.04 | 0.05 |
| low LTV | 0.81 | 0.82 | 0.83 | 0.79 | 0.81 | 0.81 |
| Freddie Mac Home Price Index | 87.75 | 100.00 | 116.57 | 143.01 | 160.93 | 133.44 |
| homeowners | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 | 0.78 |
| mortgagors | 0.34 | 0.35 | 0.32 | 0.38 | 0.38 | 0.36 |
| | Homeowners | | | | | |
| LTV | 0.20 | 0.20 | 0.18 | 0.22 | 0.21 | 0.21 |
| high LTV | 0.05 | 0.04 | 0.04 | 0.05 | 0.05 | 0.06 |
| low LTV | 0.76 | 0.76 | 0.78 | 0.73 | 0.76 | 0.76 |
| Freddie Mac Home Price Index | 87.88 | 100.00 | 116.25 | 142.08 | 159.49 | 132.41 |
| | Mortgagors | | | | | |
| LTV | 0.46 | 0.45 | 0.45 | 0.46 | 0.44 | 0.46 |
| high LTV | 0.11 | 0.10 | 0.10 | 0.10 | 0.10 | 0.13 |
| low LTV | 0.46 | 0.47 | 0.46 | 0.46 | 0.50 | 0.48 |
| Freddie Mac Home Price Index | 87.23 | 100.00 | 117.44 | 145.06 | 163.79 | 132.70 |
| observations | 14,764 | 13,668 | 12,698 | 14,264 | 12,684 | 12,010 |

Sample-weighted shares except for LTV and Freddie Mac Home Price Index
which are sample-weighted means.

Table 2.3: Health conditions time trends, 1998-2008.

| | 1998 | 2000 | 2002 | 2004 | 2006 | 2008 |
|---|---|---|---|---|---|---|
| | All | | | | | |
| poor health | 0.27 | 0.24 | 0.25 | 0.26 | 0.26 | 0.27 |
| negative change in health | 0.26 | 0.24 | 0.26 | 0.27 | 0.25 | 0.26 |
| obesity | 0.22 | 0.23 | 0.24 | 0.26 | 0.29 | 0.30 |
| high blood pressure | 0.44 | 0.47 | 0.51 | 0.49 | 0.53 | 0.57 |
| depressive symptoms | 0.59 | 0.58 | 0.54 | 0.53 | 0.54 | 0.52 |
| cancer | 0.11 | 0.12 | 0.14 | 0.12 | 0.14 | 0.15 |
| | Homeowners | | | | | |
| poor health | 0.23 | 0.20 | 0.21 | 0.21 | 0.21 | 0.22 |
| negative change in health | 0.24 | 0.21 | 0.24 | 0.24 | 0.23 | 0.23 |
| obesity | 0.22 | 0.23 | 0.24 | 0.25 | 0.28 | 0.29 |
| high blood pressure | 0.42 | 0.45 | 0.50 | 0.47 | 0.51 | 0.55 |
| depressive symptoms | 0.56 | 0.55 | 0.51 | 0.49 | 0.51 | 0.48 |
| cancer | 0.11 | 0.12 | 0.14 | 0.12 | 0.13 | 0.15 |
| | Mortgagors | | | | | |
| poor health | 0.20 | 0.17 | 0.19 | 0.18 | 0.18 | 0.20 |
| negative change in health | 0.21 | 0.18 | 0.22 | 0.23 | 0.20 | 0.21 |
| obesity | 0.25 | 0.26 | 0.29 | 0.28 | 0.32 | 0.34 |
| high blood pressure | 0.38 | 0.42 | 0.47 | 0.43 | 0.47 | 0.52 |
| depressive symptoms | 0.53 | 0.52 | 0.48 | 0.48 | 0.49 | 0.46 |
| cancer | 0.09 | 0.10 | 0.12 | 0.09 | 0.10 | 0.12 |
| observations | 14,764 | 13,668 | 12,698 | 14,264 | 12,684 | 12,010 |

Sample-weighted means.

Obesity defined as BMI>30. Depressive symptoms defined as CESD>0.

Table 2.4: OLS: Effect of high LTV on the likelihood of each condition among mortgagors.

| | Mortgagors | | | | |
|---|---|---|---|---|---|
| | poor health | neg chg in health | obesity | high blood pressure | depressive symptoms |
| high LTV | 0.0514*** | 0.0282*** | 0.0524*** | 0.0263** | 0.0653*** |
| | (0.00894) | (0.0100) | (0.0129) | (0.0111) | (0.0125) |
| female | -0.0266*** | -0.00100 | -0.0277*** | -0.0315*** | 0.0365*** |
| | (0.00808) | (0.00692) | (0.00874) | (0.0109) | (0.00788) |
| age | -0.00292 | -0.0132*** | 0.00963** | 0.0371*** | -0.00988* |
| | (0.00398) | (0.00397) | (0.00450) | (0.00470) | (0.00555) |
| age squared/100 | 0.00266 | 0.0121*** | -0.0120*** | -0.0220*** | 0.00637 |
| | (0.00333) | (0.00326) | (0.00339) | (0.00358) | (0.00442) |
| years of schooling | -0.0206*** | -0.00523*** | -0.00898*** | -0.00504*** | -0.0164*** |
| | (0.00149) | (0.00143) | (0.00175) | (0.00191) | (0.00207) |
| black | 0.0495*** | -0.0344*** | 0.105*** | 0.161*** | 0.0452*** |
| | (0.0112) | (0.00926) | (0.0148) | (0.0163) | (0.0128) |
| hispanic | 0.0524*** | -0.00842 | 0.0137 | -0.0225 | 0.00425 |
| | (0.0139) | (0.0179) | (0.0190) | (0.0164) | (0.0258) |
| other | 0.0329* | -0.00237 | -0.0409 | 0.0284 | 0.0537** |
| | (0.0179) | (0.0175) | (0.0271) | (0.0183) | (0.0216) |
| married | -0.0249** | 0.000529 | -0.0224* | 0.000299 | -0.0914*** |
| | (0.0102) | (0.00755) | (0.0133) | (0.0130) | (0.0107) |
| labor | -0.177*** | -0.114*** | -0.0290*** | -0.0614*** | -0.114*** |
| | (0.00946) | (0.00846) | (0.0104) | (0.00902) | (0.00940) |
| unemployed | 0.0738*** | 0.0585 | 0.0308 | 0.0701** | 0.168*** |
| | (0.0219) | (0.0355) | (0.0315) | (0.0289) | (0.0329) |
| insured | 0.0210*** | 0.0167** | 0.0119 | 0.0278** | 0.00959 |
| | (0.00739) | (0.00651) | (0.0101) | (0.0114) | (0.00966) |
| blue collar | 0.0322*** | 0.00510 | -0.00565 | -0.00768 | 0.0537*** |
| | (0.00839) | (0.00832) | (0.0109) | (0.0124) | (0.0109) |
| income/1000 | -0.0000513 | 0.00000812 | -0.0000518 | -0.0000584** | -0.0000677* |
| | (0.0000347) | (0.0000266) | (0.0000457) | (0.0000292) | (0.0000352) |
| non-housing assets/1000 | -0.00000941*** | -0.00000606* | -0.0000118*** | -0.0000150*** | -0.0000127*** |
| | (0.00000290) | (0.00000351) | (0.00000325) | (0.00000421) | (0.00000350) |
| Observations | 26222 | 23105 | 25857 | 26218 | 24487 |
| $R^2$ | 0.149 | 0.059 | 0.069 | 0.115 | 0.091 |

All specifications include year indicators, MSA indicators, and MSA-specific linear trends.

Robust errors clustered by MSA in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01

High LTV defined as LTV > 0.80.

Table 2.5: IV: Effect of high LTV on the likelihood of each condition among mortgagors.

| | Mortgagors | | | | |
|---|---|---|---|---|---|
| | poor health | neg chg in health | obesity | high blood pressure | depressive symptoms |
| high LTV | 0.306 | 0.402* | 0.131 | 0.211 | 0.320 |
| | (0.207) | (0.231) | (0.239) | (0.215) | (0.244) |
| female | -0.0256*** | 0.000650 | -0.0273*** | -0.0309*** | 0.0373*** |
| | (0.00805) | (0.00685) | (0.00880) | (0.0106) | (0.00786) |
| age | -0.000316 | -0.00890** | 0.0105** | 0.0390*** | -0.00708 |
| | (0.00430) | (0.00420) | (0.00527) | (0.00500) | (0.00621) |
| age squared/100 | 0.00106 | 0.00936*** | -0.0125*** | -0.0232*** | 0.00459 |
| | (0.00338) | (0.00318) | (0.00376) | (0.00371) | (0.00476) |
| years of schooling | -0.0194*** | -0.00330* | -0.00861*** | -0.00416** | -0.0150*** |
| | (0.00180) | (0.00180) | (0.00218) | (0.00201) | (0.00236) |
| black | 0.0309 | -0.0612*** | 0.0994*** | 0.148*** | 0.0266 |
| | (0.0188) | (0.0187) | (0.0228) | (0.0207) | (0.0208) |
| hispanic | 0.0477*** | -0.0147 | 0.0120 | -0.0259* | -0.000761 |
| | (0.0150) | (0.0196) | (0.0192) | (0.0156) | (0.0261) |
| other | 0.0262 | -0.0121 | -0.0429 | 0.0235 | 0.0472** |
| | (0.0196) | (0.0194) | (0.0292) | (0.0188) | (0.0216) |
| married | -0.0192 | 0.00920 | -0.0206 | 0.00430 | -0.0854*** |
| | (0.0119) | (0.00899) | (0.0140) | (0.0122) | (0.0118) |
| labor | -0.179*** | -0.118*** | -0.0296*** | -0.0629*** | -0.117*** |
| | (0.0101) | (0.00867) | (0.0106) | (0.00862) | (0.00930) |
| unemployed | 0.0688*** | 0.0559 | 0.0289 | 0.0665** | 0.163*** |
| | (0.0228) | (0.0368) | (0.0316) | (0.0296) | (0.0350) |
| insured | 0.0223*** | 0.0188*** | 0.0123 | 0.0287*** | 0.0105 |
| | (0.00729) | (0.00697) | (0.0105) | (0.0110) | (0.00970) |
| blue collar | 0.0275*** | -0.00181 | -0.00716 | -0.0111 | 0.0486*** |
| | (0.00857) | (0.0104) | (0.0111) | (0.0130) | (0.0116) |
| income/1000 | -0.0000451 | 0.0000175 | -0.0000499 | -0.0000540* | -0.0000630** |
| | (0.0000305) | (0.0000214) | (0.0000450) | (0.0000280) | (0.0000317) |
| non-housing assets/1000 | -0.00000698** | -0.00000278 | -0.0000111*** | -0.0000133*** | -0.0000102*** |
| | (0.00000342) | (0.00000397) | (0.00000359) | (0.00000445) | (0.00000388) |
| Observations | 26222 | 23105 | 25857 | 26218 | 24487 |
| $R^2$ | 0.114 | . | 0.067 | 0.103 | 0.067 |
| First-stage F-stat | 22.42 | 14.78 | 21.35 | 22.30 | 21.03 |

All specifications include year indicators, MSA indicators, and MSA-specific linear trends.

Robust errors clustered by MSA in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01

High LTV defined as LTV > 0.80.

Table 2.6: Effect of high LTV on the likelihood of each condition.

| | All | | Homeowners | | Mortgagors | |
|---|---|---|---|---|---|---|
| | OLS | IV | OLS | IV | OLS | IV |
| poor health | 0.0559*** | 0.1319 | 0.0594*** | 0.0428 | 0.0514*** | 0.3056 |
| | (0.00837) | (0.25173) | (0.00839) | (0.25975) | (0.00894) | (0.20684) |
| neg chg in health | 0.0345*** | 0.2327 | 0.0361*** | 0.1425 | 0.0282** | 0.4021* |
| | (0.00968) | (0.38378) | (0.00998) | (0.32797) | (0.01002) | (0.23114) |
| obesity | 0.0710*** | -0.0395 | 0.0696*** | -0.1594 | 0.0524*** | 0.1310 |
| | (0.01308) | (0.25744) | (0.01348) | (0.24223) | (0.01289) | (0.23924) |
| high blood pressure | 0.0396*** | 0.4738 | 0.0400*** | 0.3367 | 0.0263** | 0.2106 |
| | (0.01094) | (0.32306) | (0.01131) | (0.26898) | (0.01113) | (0.21470) |
| depressive symptoms | 0.0677*** | 0.8575* | 0.0726*** | 0.1402 | 0.0653*** | 0.3202 |
| | (0.01229) | (0.49481) | (0.01199) | (0.35587) | (0.01247) | (0.24377) |
| depressed | 0.0368*** | 0.2341 | 0.0404*** | 0.0671 | 0.0315*** | 0.1298 |
| | (0.00963) | (0.28668) | (0.00975) | (0.23741) | (0.00972) | (0.18049) |
| everything is an effort | 0.0527*** | 0.1257 | 0.0590*** | -0.0155 | 0.0568*** | 0.1818 |
| | (0.01233) | (0.36052) | (0.01217) | (0.32565) | (0.01215) | (0.27875) |
| restless sleep | 0.0449*** | 0.3164 | 0.0479*** | 0.0278 | 0.0442*** | 0.3942* |
| | (0.01122) | (0.38154) | (0.01140) | (0.31236) | (0.01142) | (0.23016) |
| felt unhappy | 0.0264*** | 0.1726 | 0.0296*** | -0.0532 | 0.0241*** | 0.2409 |
| | (0.00741) | (0.26904) | (0.00740) | (0.22441) | (0.00684) | (0.18100) |
| felt alone | 0.0138* | 0.4970* | 0.0177** | 0.2041 | 0.0139* | 0.0490 |
| | (0.00688) | (0.28114) | (0.00684) | (0.21564) | (0.00705) | (0.15131) |
| did not enjoy life | 0.0172*** | 0.3251 | 0.0185*** | 0.1709 | 0.0190*** | 0.2747** |
| | (0.00589) | (0.22751) | (0.00583) | (0.18921) | (0.00565) | (0.13161) |
| felt sad | 0.0385*** | 0.2726 | 0.0413*** | -0.1262 | 0.0347*** | -0.0898 |
| | (0.00907) | (0.36387) | (0.00924) | (0.28771) | (0.00993) | (0.24880) |
| hard to get going | 0.0316*** | 0.0549 | 0.0347*** | -0.2261 | 0.0267*** | 0.5676** |
| | (0.00867) | (0.40722) | (0.00847) | (0.29487) | (0.00867) | (0.23710) |

All specifications include controls for gender, age, age-squared/100, education, race/ethnicity, marital status, labor force status, income/1000, non-housing assets/1000, and health insurance status.
All specifications include year indicators, MSA indicators, and MSA-specific linear trends.
Robust errors clustered by MSA in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
High LTV defined as LTV $> 0.80$.

Table 2.7: Effect of low LTV on the likelihood of each condition.

| | All | | Homeowners | | Mortgagors | |
|---|---|---|---|---|---|---|
| | OLS | IV | OLS | IV | OLS | IV |
| poor health | -0.0290*** | -0.0926 | -0.0331*** | -0.0294 | -0.0235*** | -0.2013 |
| | (0.00532) | (0.17046) | (0.00525) | (0.17667) | (0.00681) | (0.12563) |
| neg chg in health | -0.0267*** | -0.1511 | -0.0286*** | -0.0898 | -0.0224*** | -0.2328* |
| | (0.00490) | (0.24639) | (0.00502) | (0.21021) | (0.00669) | (0.14100) |
| obesity | -0.0528*** | 0.0274 | -0.0542*** | 0.1095 | -0.0421*** | -0.0836 |
| | (0.00850) | (0.17959) | (0.00882) | (0.17498) | (0.00940) | (0.14506) |
| high blood pressure | -0.0409*** | -0.3313* | -0.0439*** | -0.2305 | -0.0376*** | -0.1378 |
| | (0.00764) | (0.20099) | (0.00813) | (0.17080) | (0.00849) | (0.13177) |
| depressive symptoms | -0.0257*** | -0.5936* | -0.0320*** | -0.0950 | -0.0254*** | -0.2046 |
| | (0.00701) | (0.32360) | (0.00657) | (0.23617) | (0.00858) | (0.15990) |
| depressed | -0.0239*** | -0.1592 | -0.0270*** | -0.0449 | -0.0197*** | -0.0827 |
| | (0.00439) | (0.18732) | (0.00472) | (0.15780) | (0.00562) | (0.11531) |
| everything is an effort | -0.0192*** | -0.0861 | -0.0248*** | 0.0104 | -0.0213*** | -0.1165 |
| | (0.00588) | (0.24267) | (0.00594) | (0.21981) | (0.00619) | (0.17253) |
| restless sleep | -0.0231*** | -0.2148 | -0.0274*** | -0.0186 | -0.0260*** | -0.2510 |
| | (0.00510) | (0.24378) | (0.00502) | (0.20748) | (0.00615) | (0.15594) |
| felt unhappy | -0.0199*** | -0.1179 | -0.0238*** | 0.0358 | -0.0216*** | -0.1538 |
| | (0.00419) | (0.18208) | (0.00444) | (0.15137) | (0.00508) | (0.10689) |
| felt alone | -0.0131*** | -0.3385 | -0.0161*** | -0.1370 | -0.0117** | -0.0313 |
| | (0.00416) | (0.20700) | (0.00381) | (0.15650) | (0.00429) | (0.09873) |
| did not enjoy life | -0.0079** | -0.2225 | -0.0097*** | -0.1147 | -0.0100*** | -0.1753* |
| | (0.00315) | (0.16977) | (0.00300) | (0.12917) | (0.00308) | (0.10316) |
| felt sad | -0.0259*** | -0.1855 | -0.0299*** | 0.0844 | -0.0270*** | 0.0570 |
| | (0.00418) | (0.24372) | (0.00461) | (0.19298) | (0.00594) | (0.15986) |
| hard to get going | -0.0202*** | -0.0373 | -0.0242*** | 0.1508 | -0.0155** | -0.3601* |
| | (0.00466) | (0.27497) | (0.00448) | (0.20525) | (0.00594) | (0.18877) |

All specifications include controls for gender, age, age-squared/100, education, race/ethnicity, marital status, labor force status, income/1000, non-housing assets/1000, and health insurance status.
All specifications include year indicators, MSA indicators, and MSA-specific linear trends.
Robust errors clustered by MSA in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
Low LTV defined as LTV <= 0.4.

Table 2.8: Fixed Effects: Effect of high LTV on the likelihood of each condition.

| | All | Homeowners | Mortgagors |
|---|---|---|---|
| poor health | 0.0151* | 0.0188** | 0.0127 |
| | (0.00803) | (0.00834) | (0.00885) |
| neg chg in health | 0.0086 | 0.0099 | 0.0070 |
| | (0.01068) | (0.01127) | (0.01212) |
| obesity | -0.0032 | -0.0048 | -0.0049 |
| | (0.00670) | (0.00712) | (0.00752) |
| high blood pressure | -0.0070 | -0.0066 | -0.0057 |
| | (0.00686) | (0.00724) | (0.00756) |
| depressive symptoms | 0.0129 | 0.0077 | -0.0016 |
| | (0.01041) | (0.01102) | (0.01167) |
| depressed | -0.0023 | -0.0018 | -0.0050 |
| | (0.00819) | (0.00862) | (0.00911) |
| everything is an effort | 0.0156 | 0.0133 | 0.0122 |
| | (0.00898) | (0.00945) | (0.00990) |
| restless sleep | 0.0129 | 0.0175 | 0.0120 |
| | (0.01006) | (0.01062) | (0.01120) |
| felt unhappy | -0.0064 | -0.0021 | -0.0052 |
| | (0.00792) | (0.00815) | (0.00862) |
| felt alone | -0.0058 | -0.0087 | -0.0105 |
| | (0.00782) | (0.00818) | (0.00882) |
| did not enjoy life | -0.0022 | 0.0015 | -0.0017 |
| | (0.00625) | (0.00656) | (0.00702) |
| felt sad | -0.0097 | -0.0086 | -0.0087 |
| | (0.00891) | (0.00946) | (0.01014) |
| hard to get going | -0.0163* | -0.0221** | -0.0271** |
| | (0.00904) | (0.00943) | (0.00984) |

All specifications include controls for age, marital status, labor force status, income/1000, non-housing assets/1000, and health insurance status.
All specifications include year indicators.
Robust errors in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$
High LTV defined as LTV $> 0.80$.

Table 2.9: Effect of high LTV on the likelihood of cancer.

| | All | | Homeowners | | Mortgagors | |
|---|---|---|---|---|---|---|
| | OLS | IV | OLS | IV | OLS | IV |
| high LTV | -0.00978 | 0.239 | -0.00609 | 0.149 | -0.00658 | 0.0817 |
| | (0.00731) | (0.196) | (0.00708) | (0.151) | (0.00682) | (0.115) |
| homeowner | 0.00223 | -0.0107 | | | | |
| | (0.00582) | (0.0110) | | | | |
| female | -0.00989* | -0.00921* | -0.0104* | -0.00952 | 0.00718 | 0.00753 |
| | (0.00535) | (0.00520) | (0.00607) | (0.00586) | (0.00622) | (0.00613) |
| age | 0.00750*** | 0.00937*** | 0.00883*** | 0.0102*** | 0.00403 | 0.00493 |
| | (0.00176) | (0.00214) | (0.00224) | (0.00266) | (0.00334) | (0.00331) |
| age squared/100 | -0.00283** | -0.00392*** | -0.00342** | -0.00419** | 0.000180 | -0.000381 |
| | (0.00132) | (0.00148) | (0.00169) | (0.00187) | (0.00275) | (0.00272) |
| years of schooling | 0.00234** | 0.00257** | 0.00170 | 0.00191 | 0.000673 | 0.00110 |
| | (0.00107) | (0.00110) | (0.00125) | (0.00129) | (0.00179) | (0.00174) |
| black | -0.0285*** | -0.0358*** | -0.0321*** | -0.0390*** | -0.0369*** | -0.0434*** |
| | (0.00586) | (0.00816) | (0.00721) | (0.00922) | (0.00913) | (0.0119) |
| hispanic | -0.0378*** | -0.0401*** | -0.0369*** | -0.0389*** | -0.0349** | -0.0365** |
| | (0.00778) | (0.00890) | (0.0101) | (0.0109) | (0.0143) | (0.0153) |
| other | -0.0116 | -0.0147* | -0.0143 | -0.0169 | -0.00711 | -0.00943 |
| | (0.00837) | (0.00833) | (0.0111) | (0.0115) | (0.0138) | (0.0139) |
| married | -0.00192 | -0.000593 | -0.000632 | 0.000563 | -0.00268 | -0.000725 |
| | (0.00538) | (0.00525) | (0.00627) | (0.00619) | (0.00930) | (0.00971) |
| labor | -0.0371*** | -0.0406*** | -0.0344*** | -0.0367*** | -0.0389*** | -0.0395*** |
| | (0.00439) | (0.00572) | (0.00513) | (0.00591) | (0.00673) | (0.00690) |
| unemployed | 0.0127 | 0.0127 | 0.0151 | 0.0130 | 0.0123 | 0.0106 |
| | (0.0105) | (0.0104) | (0.0140) | (0.0135) | (0.0178) | (0.0173) |
| insured | 0.00538 | 0.00555 | 0.00190 | 0.00213 | 0.00931 | 0.00979 |
| | (0.00521) | (0.00526) | (0.00568) | (0.00567) | (0.00655) | (0.00666) |
| blue collar | -0.00961* | -0.0110* | -0.0152** | -0.0164*** | -0.00799 | -0.00965 |
| | (0.00578) | (0.00569) | (0.00605) | (0.00596) | (0.00752) | (0.00781) |
| income/1000 | -0.00000347 | -0.00000350 | -0.00000559 | -0.00000493 | -0.00000389 | -0.00000175 |
| | (0.00000224) | (0.00000256) | (0.00000561) | (0.00000625) | (0.00000850) | (0.00000834) |
| non-housing assets/1000 | 0.00000220** | 0.00000296*** | 0.00000218** | 0.00000260** | -0.000000306 | 0.000000537 |
| | (0.00000106) | (0.00000111) | (0.00000102) | (0.00000103) | (0.00000254) | (0.00000266) |
| Observations | 80051 | 80051 | 61610 | 61610 | 26227 | 26227 |
| $R^2$ | 0.045 | 0.027 | 0.049 | 0.040 | 0.065 | 0.058 |
| First-stage F-stat | | 27.44 | | 24.32 | | 22.51 |

All specifications include year indicators, MSA indicators, and MSA-specific linear trends.

Robust errors clustered by MSA in parentheses. * p < 0.1, ** p < 0.05, *** p < 0.01

High LTV defined as LTV > 0.80.

Table 2.10: Effect of high LTV on the likelihood of each condition among individuals less than 65 years old.

| | All | | Homeowners | | Mortgagors | |
|---|---|---|---|---|---|---|
| | OLS | IV | OLS | IV | OLS | IV |
| poor health | 0.0556*** | 0.0469 | 0.0549*** | -0.1496 | 0.0496*** | 0.0972 |
| | (0.00977) | (0.27352) | (0.00990) | (0.26300) | (0.01089) | (0.22943) |
| neg chg in health | 0.0395*** | 0.2261 | 0.0390*** | 0.0353 | 0.0361** | 0.3383 |
| | (0.01324) | (0.34926) | (0.01324) | (0.31675) | (0.01409) | (0.21206) |
| obesity | 0.0808*** | 0.1364 | 0.0781*** | 0.2038 | 0.0654*** | 0.1459 |
| | (0.01522) | (0.24515) | (0.01530) | (0.22509) | (0.01552) | (0.26114) |
| high blood pressure | 0.0507*** | 0.2566 | 0.0484*** | 0.0422 | 0.0410** | 0.0285 |
| | (0.01582) | (0.32845) | (0.01602) | (0.27576) | (0.01529) | (0.24329) |
| depressive symptoms | 0.0659*** | 0.4691 | 0.0673*** | -0.0287 | 0.0651*** | 0.4106 |
| | (0.01481) | (0.37198) | (0.01485) | (0.29952) | (0.01456) | (0.27315) |
| depressed | 0.0295** | 0.2082 | 0.0297** | 0.1298 | 0.0268** | 0.2456 |
| | (0.01129) | (0.25056) | (0.01136) | (0.19139) | (0.01156) | (0.20168) |
| everything is an effort | 0.0476*** | 0.6391* | 0.0497*** | 0.2885 | 0.0549*** | 0.3477 |
| | (0.01303) | (0.35051) | (0.01292) | (0.29413) | (0.01262) | (0.28883) |
| restless sleep | 0.0481*** | 0.0102 | 0.0482*** | -0.0793 | 0.0428*** | 0.3284 |
| | (0.01335) | (0.31820) | (0.01351) | (0.28177) | (0.01305) | (0.26531) |
| felt unhappy | 0.0332*** | 0.1121 | 0.0335*** | -0.0185 | 0.0296*** | 0.2551 |
| | (0.00957) | (0.25009) | (0.00962) | (0.20634) | (0.00916) | (0.19306) |
| felt alone | 0.0182** | 0.3645 | 0.0191** | 0.1971 | 0.0155* | 0.1933 |
| | (0.00841) | (0.30866) | (0.00850) | (0.22752) | (0.00859) | (0.18694) |
| did not enjoy life | 0.0176** | 0.3695* | 0.0161* | 0.3317* | 0.0168** | 0.3558* |
| | (0.00778) | (0.20148) | (0.00769) | (0.18352) | (0.00751) | (0.19104) |
| felt sad | 0.0467*** | -0.0843 | 0.0464*** | -0.1307 | 0.0430*** | -0.0990 |
| | (0.01133) | (0.33987) | (0.01146) | (0.30199) | (0.01241) | (0.26768) |
| hard to get going | 0.0309*** | 0.2253 | 0.0303*** | 0.1149 | 0.0272** | 0.5121** |
| | (0.00928) | (0.26897) | (0.00933) | (0.21609) | (0.00977) | (0.22528) |

All specifications include controls for gender, age, age-squared/100, education, race/ethnicity, marital status, labor force status, income/1000, non-housing assets/1000, and health insurance status.
All specifications include year indicators, MSA indicators, and MSA-specific linear trends.
Robust errors clustered by MSA in parentheses. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 2.11: Cross-study comparison of the effect of high LTV, mortgage delinquency, and foreclosure on health.

| study | dataset | period of analysis | obs | outcome | estimated effect | change in effect (%) | reported estimate | predicted change in outcome (%) |
|---|---|---|---|---|---|---|---|---|
| Alley et al. (2011) | HRS | 2006-2008 | 2239 | decline in health | delinquency | 0.03‡ | 1.17† | 1.66 |
| Alley et al. (2011) | HRS | 2006-2008 | 2239 | depressive symptom | delinquency | 0.03‡ | 7.86*† | 2.73 |
| Currie and Tekin (2011) | Realtytrac, HCUP | 2005-2009 | 66937 | hypertension (age50-64) | foreclosures | 84 | 0.00549*** | 7.39 |
| Currie and Tekin (2011) | Realtytrac, HCUP | 2005-2009 | 66975 | hypertension (age20-49) | foreclosures | 84 | 0.00497*** | 6.07 |
| Currie and Tekin (2011) | Realtytrac, HCUP | 2005-2009 | 66937 | anxiety (age50-64) | foreclosures | 84 | 0.025*** | 15.85 |
| Currie and Tekin (2011) | Realtytrac, HCUP | 2005-2009 | 66975 | anxiety (age20-49) | foreclosures | 84 | 0.056*** | 10.06 |
| | HRS | 2006-2008 | 23105 | neg chg in health | high LTV | 0.3 | 0.402* | 12.06 |
| | HRS | 2006-2008 | 26218 | high blood pressure | high LTV | 0.3 | 0.211 | 6.33 |
| | HRS | 2006-2008 | 24487 | depressive symptom | high LTV | 0.3 | 0.32 | 9.60 |

Health care Cost and Utilization Project (HCUP)

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

† Estimate reported as odds ratio.

‡ Mortgage delinquency rate calculated from the reported number of delinquent observations.

# 3 Mortgage debt, unemployment and health

*Catherine Lau and Leigh Ann Leung*

**Abstract**

We looked at the effect of high mortgage debt interacted with unemployment on health using the NLSY79, a nationally representative sample of 12,686 young men and women who were 14-22 years old when they were first surveyed in 1979. This study expands on our previous work (Lau and Leung (2012)) in which we explored the effect of mortgage debt on health using the Health and Retirement Survey (HRS). Results show that high mortgage loan to value is not significantly correlated with most measures of poor health but when interacted with unemployment is positively and significantly correlated with poor health. The interaction increases the probability that a respondent will report being in poor health by close to 1%. We employ temporal ordering estimation to test whether past periods of unemployment and high LTV are also significantly correlated with current poor health. The OLS results might be a result of reverse causality, with poor health leading to higher debt. We cannot rule out reverse causality given that those in poor health in one survey have a significant likelihood of having high LTV in the next survey (two years later).

**Author Keywords:** Homeownership, mortgage debt, unemployment, health, temporal ordering

**JEL classification codes:** I18

## 3.1 Introduction

Previous studies have found that unemployment leads to poor health and higher mortality. Different hypotheses have been proposed to explain this relationship. One hypothesis is that unemployment leads to a decline in social status which negatively affects health. Another hypothesis suggests that unemployment affects health directly through increase stress. An indirect path in attributes the decline in health to lower lifetime income by reducing investment in medical care. This study examines the effect through financial stress. We hypothesize that if unemployment affects health through stress, the effect will be particularly acute for homeowners with mortgages. To our knowledge, this is the first study to examine the effect the health consequences of the interaction of unemployment and mortgage indebtedness.

We focus on mortgage debt for two main reasons. Firstly, home mortgages constitute a large share of household liabilities, since home purchases require a great deal more capital than households typically have on hand, necessitating financing of the majority of home sales. Secondly, U.S. policy encourages homeownership but little is understood about the ramifications of the concomitant debt. In fact, the government's subsidy of mortgage financing[1] encourages leverage over equity in home purchases and greater consumption of housing than households would have chosen if these subsidies did not exist (Glaeser and Shapiro (2003)). In 2008, 93 percent of homes purchased involved financing, though in 2010, this declined to 91 percent (Hale (2009, 2010)). The degree of house financing is also affected by the interaction between policy and economic conditions. During periods of mortgage credit expansion, riskier homebuyers can also qualify for mortgages, thereby increasing the prevalence of mortgage finance in home sales (Mian and Sufi (2009), Keys et al. (2010)). Since capital gains on homes are not subject to taxes if invested in a more expensive home, sellers in rising price markets are encouraged to invest all their profit back into real estate, distorting demand for expensive homes.

While homeownership in general leads to positive social outcomes, mortgage indebted-

[1]The cost of borrowing is subsidized by allowing interest paid on mortgages to be deducted from income (Rosen (1985)) and through government guarantees which reduce the credit risk of mortgage loans, essentially lowering the interest rate.

ness potentially leads to negative health outcomes. We use Grossman's (1972) model of health as a stock variable, which depreciates over time but can be augmented by combining time, income, and medical care, to illustrate the potential negative impact of mortgage indebtedness on health. We hypothesize a direct and an indirect path through which mortgage indebtedness leads to poor health. First, higher mortgage indebtedness increases financial stress. Epidemiological studies have found that stress plays a role in cardiovascular disease (Dorian and Taylor (1984)). Previous studies have also found that stress affects both the contraction of and progression of certain diseases (Calcagni and Elenkov (2006), Contrada and Baum (2009)), and in particular stress can increase the probability of catching a cold (Takkouche et al. (2001)). Financial stress can also lead to unhealthy behaviors such as drinking, smoking, or substance abuse, or may cause sleep problems and eating disorders (Neil Schneiderman (2008)). Second, since higher mortgage indebtedness corresponds to a negative wealth effect, it can lead to fewer health investments, particularly preventative care investments.

Mortgage indebtedness can be measured as the ratio of mortgage loan to home value (LTV). A high LTV means that homeowners have little to no equity in their home[2]. High LTV may lead to financial stress and fewer health investments[3]. Among homeowners with sizable equity cushions, a decline in home prices increases LTV, but may not necessarily lead to financial stress or changes in health investments.

Given the potential negative relationship between debt and health, policies that promote homeownership through financing may have unintended health consequences, especially in times of readily available credit, when little to no equity may be required. Prior studies on debt and health consider individuals near or at foreclosure. However, the share of homeowners that default is small compared to the share of homeowners with mortgage debt outstanding and the negative impact of debt on health may affect homeowners not in foreclosure. Furthermore, most existing studies use data that are limited to a specific

[2]The level of home equity is related to housing tenure. New homeowners are more likely to have less equity compared to seasoned homeowners given the amortizing structure of mortgage loans.

[3]Empirical evidence for the indirect effect is mixed. Keese and Schmitz (2010) using longitudinal data for Germany found that individuals with debt are more likely to visit a doctor. Since Germany has universal health care, the indirect effect of debt on health is likely smaller. Currie and Tekin (2011) using foreclosure data for four states in the U.S. found that a higher number of foreclosures is associated with more hospital visits and fewer preventive medical visits.

state or set of states in the U.S. To our knowledge, this is the only study to use household mortgage loan to home value to estimate the effect of the mortgage indebtedness on mental and physical health among a nationally representative sample of adults.

The form of housing debt most prevalent in the United States is the 30-year fixed rate mortgage, which was designed in a period when average job tenure was longer. Average job tenure for men in the 45 to 54 age group, which corresponds to the age group of this study, declined from 10.1% to 8.1% in the decade from 1996 to 2006 (Baluja et al. (2003)). We feel that periods of unemployment combined with high mortgage debt can be stressful and negatively affect health.

The contribution of this paper compared to our study using HRS is that we can estimate the effect of mortgage debt on a cohort that is more likely to rely on wage income, less likely to rely on retirement income, and also have lower net worth. A younger cohort will also allow us to examine whether having stable income can mitigate the financial stress associated with mortgage indebtedness. We are testing dual hypotheses: 1) that those with more stable income should experience less stress; and 2) that those with high mortgage debt who are involuntarily unemployed experience even greater stress. Previous studies have shown that unemployment increases mortality. We will review and summarize the literature on this topic and examine the effect of the interaction between unemployment and mortgage debt on health outcomes. We expect that unemployment also compounds the negative health effect of mortgage debt. to our knowledge, this paper is the first to recognize that neither unemployment nor debt alone may have a significant adverse impact on health, but rather the presence of the two variables simultaneously leads to stress and worse health outcomes.

## 3.2 Literature Review

Defaulting on mortgage debt is a disruptive life event that may negatively affect health. In the U.S., the rise in foreclosures since 2008 has prompted research on the impact of foreclosures on health. Pollack and Lynch (2009) compared the health of individuals, recruited through a mortgage counseling agency, undergoing foreclosure with that of a community sample from the 2008 Southeastern Pennsylvania Household Health Survey. They found

that the foreclosed sample were significantly more likely to have hypertension, heart disease, and a clinically diagnosed psychiatric condition than the control group. The foreclosed also reported greater consumption of smoking and drinking in the past month. In a broader study covering four states – Arizona, California, Florida, and New Jersey – Currie and Tekin (2011) found that zip codes with a greater number of foreclosures also experienced a greater rise in Emergency Room visits and hospitalizations for stress related conditions, controlling for county-specific, time-varying factors such as labor market conditions. Furthermore, the effect was greater among younger individuals and for conditions that are typically avoidable with preventative care.

Prior to default, borrowers who have missed two or more consecutive payments on a mortgage loan are considered delinquent. Previous studies have examined the effect of mortgage debt delinquency on health. For the U.S., Alley et al. (2011), using the 2006 and 2008 waves of the Health and Retirement Survey (HRS), compared the health outcomes of mortgagors who had been more than two months delinquent on their mortgage payments in the past two years to those who are current on their mortgage payments. They found that delinquent respondents were significantly more likely to have depressive symptoms and to have less access to health relevant resources. These results are qualitatively consistent with similar studies in the U.K. Taylor et al. (2006), using the British Household Panel Survey (BHPS) from 1991 to 2003, a period that covers the recession in the early nineties, found that being past due on mortgage debt is associated with a negative psychological effect among men, controlling for financial conditions and other personal traits. Nettleton and Burrows (1998), using the Survey of English Housing[4] from 1991-1992 and 1994-1995, found that difficulty meeting mortgage payments is associated with a decline in mental well-being.

Previous studies have also examined the effect of unsecured debt on health. Drentea and Lavrakas (2000), using a sample of adults in Ohio, found that greater credit card debt-to-income is associated with a greater likelihood of physical health impairment. In a follow up study, Drentea (2000) found that greater credit card debt-to-income is associated with a greater likelihood of having mental anxiety. Similarly, Brown et al. (2005), using the

[4]The Survey of English Housing is a supplemental survey to the British Household Panel Survey (BHPS) consisting of households headed by younger individuals, single parents, single male parents, divorced and separated, divorced and inactive.

1995 and 2000 waves of the British Household Panel Survey (BHPS), found that greater unsecured household debt is associated with the likelihood of having poor mental health. Keese and Schmitz (2010), using the German Socioeconomic Panel (GSOEP) from 1999-2009, found that greater debt is associated with worse mental health and a higher incidence of obesity. They also estimated a fixed effects model to control for individual-specific, time-invariant factors that may be endogenous to health and debt. Fixed effects estimates show that greater indebtedness leads to poor mental health and lower health satisfaction with mortgage debt having a large effect on mental health. Though, loan amounts of unsecured debt are typically less than that of mortgage, these findings suggest that even unsecured debt has a negative effect on health.

Finally, a number of studies have examined the effect of self-reported financial stress on health. Bridges and Disney (2010) and Skapinakis et al. (2006) found that individuals experiencing financial difficulties were more likely to exhibit depression. O'Neill et al. (2005) and Lyons and Yilmazer (2005) found a positive correlation between self-reported financial stress and poor self-reported health. While these studies show a negative relationship between financial stress and health, the particular type of debt leading to financial stress was not identified.

The literature on the health effects of debt has primarily focused the household's ability to make debt repayments, that is, whether the household is liquidity constrained. Another measure of a household's financial condition is the debt to asset ratio, an indicator of balance sheet leverage. In contrast to prior studies, this study focuses on households with high mortgage debt to assets but not necessarily delinquent or in default. We argue that households with a high mortgage loan to home value (LTV) also experience financial stress given that debt secured by the primary residence comprise the largest share of household balance sheets. Since the number of homeowners with high leverage is larger than the number in delinquency or foreclosure, we argue that the potential effect of having high LTV on health is relevant to a broader segment of the population[5].

In this paper we examine the effect of housing leverage in conjunction with unemploy-

[5]For example, Alley et al. (2011), using only the HRS 2008 participants eligible to be asked mortgage-delinquency questions, reported a mortgage delinquency rate of 3 percent whereas, using the complete NLSY 2008 wave, 13 percent of mortgagors have high LTV.

ment. Previous studies have found unemployment is associated with an increase in mortality. Sullivan and von Wachter (2009) found that, on average, unemployment increases mortality hazard by 10 – 15%, implying a decrease in life expectancy of 1 – 1. 5 years for workers displaced in middle age. The effect is strongest immediately after a layoff but persists twenty years after displacement and is largest for those less than 45 years of age. S. A. Burgand and House (2007) used two large population-based longitudinal samples to examine the effect of layoffs on self-reported health. They found a negative correlation between unemployment and health even after carefully controlling for selection bias.

## 3.3 Data

Individual level data on health, housing, financial situation, and other socioeconomic factors were obtained from the National Longitudinal Survey of Youth 1979 (NLSY79), part of the National Longitudinal Surveys (NLS) program. These respondents were between 45 and 53 years of age at their 2008 interview. The NLSY79 is composed of three independent subsamples. The first consists of a cross-sectional sample (6,111) of people living in the United States in 1979 and born between January 1, 1957, and December 31, 1964 (inclusive); the second (5,295), over samples Hispanic, Latino, black, and economically disadvantaged persons, also living in the United States and born in the same period as the cross sectional sample, while the third (1,280) is limited to persons born between January 1, 1957, through December 31, 1961 (inclusive), serving in the military as of September 30, 1978. Since our interest in this paper is to extend our results as broadly as possible, we eliminate the military segment.

### 3.3.1 Variable definitions

The NLSY administers an extended health module once a respondent turns forty years of age. The SF-12, which stands for short-form 12-question, is a brief inventory of self-reported mental and physical health. This scale was administered to respondents who had turned 40 since their last interview as part of the age 40+ health module, included in the 1998, 2000, 2002, 2004, and 2006 surveys.

As part of this module, respondents are asked to self-rate their health, on a scale of 1 to 5. We convert this to a dichotomous variable, with one representing those with poor to fair overall health. This is our main dependent variable of interest. Additionally, we look at the effect on other health measures, including obesity, hypertension, frequency of colds, symptoms of depression, and trouble sleeping.

Households experience financial stress when the burden of mortgage indebtedness becomes excessive. To measure excessive mortgage indebtedness, we use the loan to value (LTV) ratio defined as the amount of mortgage loan outstanding plus any other amount owed on home divided by the self-reported home value. LTV measures the degree of leverage used to finance the primary residence, which, all else equal, declines over time given the amortizing nature of mortgage loans. However, if homeowners take out equity and/or housing values decline, then home equity is reduced and may even become negative. As well, homeowners with a high LTV cannot reduce housing consumption accordingly and even if they manage to sell the home, they are more likely to incur a financial loss due to lower equity and transaction fees. Therefore, we hypothesize that high LTV, through financial stress, leads to a greater likelihood of a negative health outcome.

We control for age, education, race, employment, marital status and gender at the time the 40+ health module was administered. We follow (Thompson (2011)), and use both the mean of each respondent's annual household income and the standard deviation of income as independent variables. Income data was inflated to 2006 dollars using the CPI-U-RS. This is done in recognition of health being a stock variable (Grossman (1972) and thus affected by past investments, which are related to income. We include the standard deviation of earnings to control for volatility; fluctuations in income as well as low income may have effects on health. Since our primary research interest concerns the effect of hosing leverage, we match income data to years of homeownership. Since health also has genetic characteristics we control for early mortality of respondents' parents by creating an indicator variable which is zero if the parent died at age 60 or older, and one if the parent died before 60 years of age. We also interact unemployment with LTV, hypothesizing that the effect of the two on health may not be purely additive.

## 3.4 Estimation Model

Our main estimation of the effect of LTV on health is as follows:

$$H_{i40} = \beta_0 + \beta_1 D_i + \beta_2 WksUnemp_i + X_i\Theta + \epsilon_i$$

where $H_{i40}$ is a health condition measured at the time of the 40+ health module, $D_i$ is an indicator variable for high mortgage loan to self-reported home value (measured as greater than 0.8), $WksUnemp_i$ is the number of weeks the respondent has been unemployed in the past year, and $X_i$ is a vector of variables for respondent's socioeconomic characteristics including highest grade completed, wage (dollars/1000), gender, number of weeks the respondent has been out of labor force in the past year, race/ethnicity, marital status, whether the respondent has health insurance, lives in an MSA, and the respondent's parents' characteristics such as mother's highest grade completed, father's highest grade completed, whether mother's age at death is less than 60, and whether father's age at death is less than 60.

**Interaction of Unemployment and High Loan-to-Value: Effect on Health**

The following equation highlights our specification which interacts involuntary unemployment and high loan-to-value:

$$H_{i40} = \beta_0 + \beta_1 D_i + \beta_2 WksUnemp_i + \beta_3 D_i \times WksUnemp_i + X_i\Theta + \epsilon_i$$

**Effect of LTV on investment in health care**

We test our sub-hypothesis that the effect of housing leverage on health may be indirect; as leverage increases, respondents may be less likely or less able to invest in health care. Our estimation model for the effect of high loan to value on use of health care pools the data from the 2002 survey through the 2008 survey. We measure the effect of high LTV on the likelihood of failing to have an annual physical as follows:

$$LastPhysical > 1Yr_{it} = \beta_0 + \beta_1 D_{it} + \beta_2 WksUnemp_{it} + X_{it}\Theta + \epsilon_i$$

This first specification regresses mortgage, home value, unemployment and a host of socioeconomic variables on not having had a physical in the last year. Then we run high LTV and the socioeconomic variables on the same independent variable, and perform a third specification where we interact unemployment and high LTV, in keeping with our main model. The interaction equation is provided below.

$$LastPhysical > 1Yr_{it} = \beta_0 + \beta_1 D_{it} + \beta_2 WksUnemp_{it} + \beta_3 D_{it} \times WksUnemp_{it} + X_i\Theta + \epsilon_i$$

**Temporal Ordering**

Since the 40+ health module is administered to NLSY79 respondents only once, generally in the interview immediately following their turning 40 years of age, fixed effects estimation can not be done with this data. Additionally, our examination of the trends in health outcomes both in this data set and the HRS shows very little movement of these dichotomous variables over time, indicating that they do not lend themselves to fixed effects estimation, which relies on variation around the mean for identification of the effect being studied. We therefore decided to follow other researchers who used the NLSY79, primarily Thompson (2011), and employ temporal ordering, whereby independent variables are measured over prior time periods (t-1), and the dependent variable measured at time t. The temporal ordering model for health as a function of mortgage indebtedness and socioeconomic factors is given by

$$\begin{aligned} H_{i40} = {} & \beta_0 + \beta_1 D_{it} + \beta_2 WksUnemp_{it} + \beta_2 D_{it} \times WksUnemp_{it} \\ & + \beta_4 D_{it-1} + \beta_5 WksUnemp_{it-1} + \beta_6 D_{it-1} + \times WksUnemp_{it-1} + X_i\Theta + \epsilon_i \end{aligned}$$

where $H_{i40}$ is overall health as self-reported at the time of the 40+ health module, $D_{it}$ is an indicator for high LTV, $WksUnemp_{it}$ is the number of weeks unemployed in the last year, $D_{it} \times WksUnemp_{it}$ is the interaction of weeks unemployment and high LTV, $X_i$ is

a vector of socioeconomic variables which includes gender, age, education, race/ethnicity, and marital status for individual $i$ at the time they answered the 40+ health module, and $\Theta$ is a vector of parameters.

### 3.4.1 Summary statistics

Table 3.1 shows the sample-weighted means for the socioeconomic, health, and housing finance variables for mortgagors in the NLSY79 who responded to the 40 and older health module. The average mortgage value is just over $108,000, while home values average $215,000. Fifteen percent of the sample fall into the high loan-to-value category, i.e., loan-to-value is greater than 80%. (We chose 80% as a threshold since 20% equity has traditionally been required by mortgage providers and for Fannie/Freddie eligibility. Our results are robust to alterations to this threshold, however). The mean leverage is just under sixty percent. Both the absolute leverage and amount of the sample falling into the high LTV category are higher than the same measures for the HRS sample, which were 45% and 11%, respectively. This is as expected, since equity generally builds with housing tenure, which is positively correlated with age. Only 7% of the mortgagors in the NLSY79 self-report fair to poor health, but over 50% are obese, 23% suffer from hypertension, 25% from depressive symptoms.

## 3.5 Results

OLS cross sectional results are reported in Table 3.2. Evaluated independently, larger mortgages, more expensive homes are negatively correlated with poor health outcomes, though only home value's effect on obesity and hypertension are statistically significant (the former at the 10% level, the latter at the 5% level). The lack of significance for most of the outcomes is most likely due to multicollinearity: we are regressing home value, mortgage value, wages, on our health outcomes, all of which we expect to be correlated. The signs on the other socioeconomic variables are as expected, with education strongly correlated with better health, married respondents, respondents in the labor force and females healthier than their counterparts.

Table 3.3 show the effect of high mortgage loan to home value on the likelihood or each of the health outcomes. The likelihood of being obese is 5.24% greater for mortgagors with loan-to-values greater than eighty percent; this result is significant at the 10% level. Both weeks unemployed and weeks out of the labor force are significantly correlated with reporting worse overall health, being depressed, and having trouble sleeping. Since health has a genetic component, we control for the age of death of parents, and we account for early childhood factors by controlling for parents' education.

As expected, when we interact high loan-to-value with weeks of involuntary unemployment, Table 3.4, our results increase in significance: the likelihood of being in poor health or having frequent colds is significant at the 5% level; the effect on hypertension is significant at the 10% level.

Since higher mortgage indebtedness corresponds to a negative wealth effect, it can lead to fewer health investments, particularly preventative care. We therefore perform a third estimation where we look at whether high LTV has a negative effect on respondents' propensity to have an annual physical exam. The results in Table 3.5 suggest that any effect high LTV has on getting a routine physical is insignificant, but that involuntary unemployment can lead respondents' to skip physicals. That this is most likely tied to a lack of insurance for the unemployed is supported by the highly (1% level), significant impact the presence of health insurance has on the likelihood of getting an annual physical, in all three specifications. Insured respondents were 20% less likely to go more than a year without a physical than the overall sample of mortgagors. Interestingly, when we interact weeks of unemployment with high LTV, the sign on the coefficient switches: respondents with high mortgage loans to house values and more weeks of involuntary unemployment are more likely to get an annual physical than respondents with similar weeks of unemployment but less highly leveraged. This may support our argument that high LTV harms health and therefore makes the respondent feel more in need of a physical exam, but this is only conjecture. There may be other factors at play.

Table 3.6 gives strong support to our hypothesis that for this sample, health will be negatively affected by involuntary unemployment contemporaneous with high LTV. We see that past high LTV interacted with past weeks of unemployment have the greatest effect

on poor health, so long as we look back only one period (the time between surveys), with significance at the 1% level. The effect loses significance if further in the past, possibly pointing to the resiliency of the population. Unemployment in a prior period has a significant effect on poor health in all specifications, whereas the effect of high LTV is only significant if current high LTV and unemployment are omitted form the regression. (Results of averaging LTV and income over the tenure of homeownership, then regressing these averages and the standard deviation of income against health outcomes were insignificant, and are therefore not reported here. We expected the standard deviation of income to have an effect, since income volatility is generally viewed negatively, but since this is a relatively young sample in a mostly robust economy, we feel that there were probably few negative shocks, and it is negative shocks which are likely to have adverse health effects.)

## 3.6 Discussion

As in our previous research, we find that when viewed separately, neither having a large mortgage nor an expensive home has a significant effect on overall health or the prevalence of depressive symptoms. However, for mortgagors in the NLSY79, high LTV has a significant effect on the likelihood of being obese only, amongst the five health outcomes we measure. For the HRS sample, results of the effect of high LTV are highly significant on all health outcomes. When high LTV is interacted with weeks of unemployment, the probability of reporting fair to poor health increases by almost 1 percentage point, which is significant at the 5% level. Additionally, the interaction of these two variables causes significant increases in hypertension and frequency of colds for mortgagors. These results support both our hypothesis that high LTV is less stressful for younger people who are more likely to have earned income which can be used to reduce leverage, and time to build equity before retirement, and our second hypothesis that unemployment coupled with high LTV will have a negative impact on health.

We do not find that those with high loan-to-value neglect basic preventative care, which we measure as whether or not respondents had an annual physical exam, but the number of weeks of unemployment is positively correlated with not having an annual physical.

We employ temporal ordering to support causality running from debt and unemployment to worse health. The OLS results might be a result of reverse causality, with poor health leading to higher debt. We cannot rule out reverse causality given that poor health has a significant and larger effect on the likelihood of high LTV in two years in Table 3.7 .

From a policy perspective, our results highlight the unintended health consequences of promoting financing for home purchases when labor markets are characterized by less stability, with shorter tenures at the same firm and more frequent unemployment spells. Policymakers should consider whether the benefits of homeownership outweigh the negative health effects of high mortgage indebtedness for persons who will experience spells of unemployment. Additionally, improvements in financial literacy should increase homeowners' awareness of the pitfalls of high leverage. This is of high importance in areas of the country where decent rental housing is in scant supply, and some leverage likely required to have a desirable home.

Table 3.1: Summary statistics (NLSY79 40 and older health module)

| | Mortgagors |
|---|---|
| mortgage loan (dollars/1000) | 108.17 |
| home value (dollars/1000) | 214.90 |
| mortgage loan-to-home value | 0.59 |
| high LTV | 0.15 |
| weeks unemployed (past year) | 0.87 |
| weeks out of labor force (past year) | 4.01 |
| wage (dollars/1000) | 47.00 |
| total family income (dollars/1000) | 85.24 |
| female | 0.49 |
| hispanic | 0.05 |
| black | 0.06 |
| married | 0.80 |
| age | 40.25 |
| insured | 0.93 |
| lives in MSA | 0.16 |
| highest grade completed | 14.11 |
| mother's highest grade completed | 12.02 |
| father's highest grade completed | 12.26 |
| mother's age at death $< 60$ | 0.07 |
| father's age at death $< 60$ | 0.12 |
| poor health | 0.07 |
| physical health z-score | 53.47 |
| mental health z-score | 53.65 |
| obesity | 0.23 |
| hypertension | 0.14 |
| frequent colds | 0.25 |
| trouble sleeping | 0.13 |
| cancer | 0.02 |
| observations | 3,197 |

Sample-weighted means
High LTV defined as LTV>0.80

Table 3.2: OLS: Effect of mortgage loan and home value on the likelihood of each health condition.

| | poor health | obesity | hypertension | freq colds | cesd>5 | trouble sleeping |
|---|---|---|---|---|---|---|
| mortgage loan (dollars/1000) | -0.0000261 | -0.000118 | -0.0000901 | -0.000108 | -0.0000521 | 0.0000281 |
| | (0.0000576) | (0.000118) | (0.0000768) | (0.000136) | (0.000133) | (0.0000853) |
| home value (dollars/1000) | -0.0000460 | -0.000104* | -0.0000729** | -0.0000474 | -0.0000314 | -0.0000567 |
| | (0.0000294) | (0.0000552) | (0.0000305) | (0.0000569) | (0.0000534) | (0.0000416) |
| weeks unemployed (past year) | 0.00279** | -0.00213 | 0.000172 | 0.0000644 | 0.00266* | 0.00396** |
| | (0.00135) | (0.00148) | (0.00118) | (0.00146) | (0.00151) | (0.00155) |
| weeks out of labor force (past year) | 0.00141*** | -0.000950 | 0.000561 | 0.000682 | 0.00196*** | 0.00274*** |
| | (0.000499) | (0.000719) | (0.000558) | (0.000677) | (0.000662) | (0.000638) |
| wage (dollars/1000) | -0.000113 | -0.000196 | -0.0000299 | -0.000147 | -0.000145 | -0.000245 |
| | (0.000101) | (0.000243) | (0.000176) | (0.000229) | (0.000155) | (0.000157) |
| female | -0.00632 | -0.0406** | -0.0439*** | 0.0759*** | 0.0607*** | 0.0238* |
| | (0.0100) | (0.0189) | (0.0139) | (0.0166) | (0.0138) | (0.0125) |
| hispanic | -0.0125 | 0.0514* | -0.0371** | -0.0432* | 0.0105 | -0.0306* |
| | (0.0147) | (0.0280) | (0.0177) | (0.0238) | (0.0202) | (0.0182) |
| black | 0.00189 | 0.126*** | 0.0740*** | -0.0615*** | 0.0117 | -0.0270 |
| | (0.0139) | (0.0271) | (0.0209) | (0.0214) | (0.0193) | (0.0171) |
| married | -0.0239* | 0.0351* | 0.00652 | -0.0282 | -0.0547*** | -0.0507*** |
| | (0.0125) | (0.0208) | (0.0160) | (0.0190) | (0.0170) | (0.0158) |
| insured | -0.0453** | -0.0365 | -0.0449* | -0.0117 | -0.0447 | -0.0326 |
| | (0.0227) | (0.0354) | (0.0259) | (0.0289) | (0.0277) | (0.0257) |
| lives in MSA | 0.0112 | 0.0171 | 0.0200 | 0.0434** | 0.00921 | 0.0219 |
| | (0.0118) | (0.0226) | (0.0165) | (0.0198) | (0.0163) | (0.0153) |
| highest grade completed | -0.00834*** | -0.0157*** | -0.00231 | 0.0114*** | -0.00970*** | -0.00305 |
| | (0.00210) | (0.00387) | (0.00280) | (0.00354) | (0.00291) | (0.00265) |
| mother's highest grade completed | -0.00299 | -0.00115 | 0.00515* | -0.00209 | 0.000839 | -0.00105 |
| | (0.00203) | (0.00405) | (0.00279) | (0.00354) | (0.00290) | (0.00254) |
| father's highest grade completed | 0.000304 | -0.000283 | -0.00286 | 0.00324 | 0.00277 | 0.00114 |
| | (0.00166) | (0.00312) | (0.00217) | (0.00277) | (0.00228) | (0.00195) |
| mother's age at death < 60 | 0.0168 | 0.0294 | 0.0137 | -0.0144 | 0.0184 | 0.00180 |
| | (0.0186) | (0.0333) | (0.0245) | (0.0273) | (0.0245) | (0.0221) |
| father's age at death < 60 | 0.0130 | -0.0255 | 0.0426** | 0.00854 | -0.0214 | -0.0290* |
| | (0.0146) | (0.0255) | (0.0204) | (0.0227) | (0.0183) | (0.0161) |
| Observations | 3194 | 2535 | 3195 | 3195 | 3179 | 3195 |
| $R^2$ | 0.038 | 0.050 | 0.033 | 0.025 | 0.035 | 0.038 |

Robust errors in parentheses

All specifications include age and year indicator variables

Table 3.3: OLS: Effect of mortgage loan-to-home value on the likelihood of each health condition.

| | poor health | obesity | hypertension | freq colds | cesd>5 | trouble sleeping |
|---|---|---|---|---|---|---|
| high LTV | 0.0185 | 0.0524** | -0.00400 | -0.00393 | 0.0000196 | 0.00943 |
| | (0.0138) | (0.0251) | (0.0174) | (0.0204) | (0.0176) | (0.0163) |
| weeks unemployed (past year) | 0.00272** | -0.00232 | 0.00000589 | -0.0000708 | 0.00257* | 0.00390** |
| | (0.00136) | (0.00146) | (0.00118) | (0.00148) | (0.00153) | (0.00156) |
| weeks out of labor force (past year) | 0.00128*** | -0.00131* | 0.000301 | 0.000469 | 0.00185*** | 0.00262*** |
| | (0.000489) | (0.000710) | (0.000552) | (0.000669) | (0.000652) | (0.000632) |
| wage (dollars/1000) | -0.000211** | -0.000463** | -0.000242 | -0.000325 | -0.000239* | -0.000328** |
| | (0.0000919) | (0.000231) | (0.000167) | (0.000203) | (0.000143) | (0.000138) |
| female | -0.00760 | -0.0435** | -0.0464*** | 0.0740*** | 0.0594*** | 0.0225* |
| | (0.00999) | (0.0188) | (0.0139) | (0.0165) | (0.0137) | (0.0124) |
| hispanic | -0.0152 | 0.0426 | -0.0413** | -0.0472** | 0.00871 | -0.0319* |
| | (0.0146) | (0.0279) | (0.0177) | (0.0236) | (0.0200) | (0.0181) |
| black | 0.00245 | 0.129*** | 0.0795*** | -0.0568*** | 0.0126 | -0.0253 |
| | (0.0140) | (0.0272) | (0.0209) | (0.0215) | (0.0194) | (0.0173) |
| married | -0.0245* | 0.0345* | 0.00396 | -0.0302 | -0.0562*** | -0.0514*** |
| | (0.0126) | (0.0209) | (0.0160) | (0.0189) | (0.0170) | (0.0158) |
| insured | -0.0478** | -0.0459 | -0.0503* | -0.0167 | -0.0452 | -0.0350 |
| | (0.0226) | (0.0352) | (0.0259) | (0.0289) | (0.0277) | (0.0257) |
| lives in MSA | 0.0117 | 0.0194 | 0.0220 | 0.0454** | 0.00895 | 0.0224 |
| | (0.0118) | (0.0225) | (0.0165) | (0.0198) | (0.0163) | (0.0152) |
| highest grade completed | -0.00895*** | -0.0176*** | -0.00358 | 0.0103*** | -0.0104*** | -0.00346 |
| | (0.00207) | (0.00384) | (0.00278) | (0.00352) | (0.00286) | (0.00264) |
| mother's highest grade completed | -0.00320 | -0.00174 | 0.00470* | -0.00251 | 0.000732 | -0.00121 |
| | (0.00203) | (0.00403) | (0.00280) | (0.00355) | (0.00290) | (0.00254) |
| father's highest grade completed | 0.000224 | -0.000537 | -0.00315 | 0.00299 | 0.00265 | 0.00105 |
| | (0.00166) | (0.00312) | (0.00217) | (0.00276) | (0.00228) | (0.00196) |
| mother's age at death < 60 | 0.0156 | 0.0240 | 0.0123 | -0.0154 | 0.0178 | 0.000692 |
| | (0.0186) | (0.0333) | (0.0246) | (0.0273) | (0.0246) | (0.0221) |
| father's age at death < 60 | 0.0120 | -0.0302 | 0.0418** | 0.00759 | -0.0207 | -0.0297* |
| | (0.0146) | (0.0256) | (0.0205) | (0.0227) | (0.0183) | (0.0161) |
| Observations | 3194 | 2535 | 3195 | 3195 | 3179 | 3195 |
| $R^2$ | 0.037 | 0.047 | 0.030 | 0.024 | 0.035 | 0.038 |

Robust errors in parentheses

All specifications include age and year indicator variables

Table 3.4: OLS: Effect of mortgage loan-to-home value interacted with unemployment on the likelihood of each health condition.

| | poor health | obesity | hypertension | freq colds | cesd>5 | trouble sleeping |
|---|---|---|---|---|---|---|
| high LTV | 0.0111 | 0.0560** | -0.0111 | -0.0124 | -0.00347 | 0.00769 |
| | (0.0135) | (0.0255) | (0.0174) | (0.0206) | (0.0177) | (0.0164) |
| weeks unemployed (past year) | 0.00154 | -0.00178 | -0.00113 | -0.00142 | 0.00201 | 0.00362** |
| | (0.00131) | (0.00160) | (0.00116) | (0.00145) | (0.00157) | (0.00167) |
| high LTV × weeks unemployed | 0.00949** | -0.00428 | 0.00911* | 0.0109** | 0.00444 | 0.00223 |
| | (0.00475) | (0.00339) | (0.00486) | (0.00456) | (0.00483) | (0.00462) |
| weeks out of labor force (past year) | 0.00127*** | -0.00130* | 0.000293 | 0.000460 | 0.00185*** | 0.00262*** |
| | (0.000489) | (0.000710) | (0.000552) | (0.000669) | (0.000652) | (0.000632) |
| wage (dollars/1000) | -0.000219** | -0.000459** | -0.000250 | -0.000335* | -0.000243* | -0.000330** |
| | (0.0000915) | (0.000231) | (0.000167) | (0.000203) | (0.000143) | (0.000138) |
| female | -0.00803 | -0.0432** | -0.0468*** | 0.0735*** | 0.0592*** | 0.0224* |
| | (0.00995) | (0.0188) | (0.0139) | (0.0165) | (0.0137) | (0.0124) |
| hispanic | -0.0166 | 0.0436 | -0.0427** | -0.0489** | 0.00801 | -0.0322* |
| | (0.0146) | (0.0279) | (0.0177) | (0.0236) | (0.0200) | (0.0181) |
| black | 0.00285 | 0.129*** | 0.0799*** | -0.0563*** | 0.0128 | -0.0252 |
| | (0.0140) | (0.0272) | (0.0209) | (0.0215) | (0.0194) | (0.0173) |
| married | -0.0240* | 0.0344* | 0.00441 | -0.0296 | -0.0560*** | -0.0513*** |
| | (0.0126) | (0.0208) | (0.0160) | (0.0189) | (0.0170) | (0.0158) |
| insured | -0.0466** | -0.0467 | -0.0492* | -0.0153 | -0.0446 | -0.0347 |
| | (0.0225) | (0.0352) | (0.0257) | (0.0287) | (0.0277) | (0.0258) |
| lives in MSA | 0.0115 | 0.0197 | 0.0217 | 0.0451** | 0.00882 | 0.0224 |
| | (0.0118) | (0.0225) | (0.0165) | (0.0198) | (0.0163) | (0.0152) |
| highest grade completed | -0.00899*** | -0.0176*** | -0.00361 | 0.0102*** | -0.0104*** | -0.00347 |
| | (0.00207) | (0.00384) | (0.00278) | (0.00352) | (0.00286) | (0.00264) |
| mother's highest grade completed | -0.00307 | -0.00180 | 0.00482* | -0.00236 | 0.000793 | -0.00118 |
| | (0.00203) | (0.00403) | (0.00280) | (0.00354) | (0.00290) | (0.00255) |
| father's highest grade completed | 0.000187 | -0.000516 | -0.00318 | 0.00295 | 0.00263 | 0.00104 |
| | (0.00164) | (0.00312) | (0.00218) | (0.00276) | (0.00227) | (0.00196) |
| mother's age at death < 60 | 0.0144 | 0.0244 | 0.0111 | -0.0168 | 0.0172 | 0.000406 |
| | (0.0188) | (0.0333) | (0.0244) | (0.0273) | (0.0246) | (0.0221) |
| father's age at death < 60 | 0.0133 | -0.0309 | 0.0431** | 0.00908 | -0.0201 | -0.0294* |
| | (0.0146) | (0.0256) | (0.0204) | (0.0227) | (0.0183) | (0.0161) |
| Observations | 3194 | 2535 | 3195 | 3195 | 3179 | 3195 |
| $R^2$ | 0.041 | 0.048 | 0.031 | 0.026 | 0.036 | 0.038 |

Robust errors in parentheses

All specifications include age and year indicator variables

Table 3.5: OLS: Effect of housing leverage on the whether it has been more than a year since last physical exam (NLSY79 Pooled 2002-2008).

| | >1 year since last physical | >1 year since last physical | >1 year since last physical |
|---|---|---|---|
| mortgage loan (dollars/1000) | 0.0000412 | | |
| | (0.0000486) | | |
| home value (dollars/1000) | 0.00000481 | | |
| | (0.0000222) | | |
| high LTV | | -0.00470 | -0.000800 |
| | | (0.0125) | (0.0127) |
| weeks unemployed (past year) | 0.00188** | 0.00192** | 0.00258*** |
| | (0.000860) | (0.000859) | (0.000950) |
| high LTV × weeks unemployed | | | -0.00381* |
| | | | (0.00203) |
| weeks out of labor force (past year) | -0.000343 | -0.000291 | -0.000291 |
| | (0.000328) | (0.000326) | (0.000326) |
| wage (dollars/1000) | -0.000110 | -0.0000675 | -0.0000668 |
| | (0.000117) | (0.000113) | (0.000113) |
| female | -0.152*** | -0.152*** | -0.152*** |
| | (0.0108) | (0.0108) | (0.0108) |
| hispanic | -0.0263 | -0.0244 | -0.0242 |
| | (0.0164) | (0.0164) | (0.0163) |
| black | -0.164*** | -0.165*** | -0.165*** |
| | (0.0131) | (0.0131) | (0.0131) |
| married | -0.0314*** | -0.0308*** | -0.0306*** |
| | (0.0116) | (0.0115) | (0.0115) |
| insured | -0.203*** | -0.202*** | -0.203*** |
| | (0.0182) | (0.0182) | (0.0182) |
| lives in MSA | -0.00970 | -0.00990 | -0.00970 |
| | (0.0116) | (0.0116) | (0.0116) |
| highest grade completed | -0.000445 | -0.0000838 | -0.0000286 |
| | (0.00234) | (0.00232) | (0.00232) |
| mother's highest grade completed | 0.00240 | 0.00252 | 0.00248 |
| | (0.00234) | (0.00234) | (0.00234) |
| father's highest grade completed | -0.000117 | -0.0000209 | -0.00000124 |
| | (0.00184) | (0.00184) | (0.00184) |
| mother's age at death < 60 | -0.00211 | -0.00211 | -0.00213 |
| | (0.0185) | (0.0185) | (0.0184) |
| father's age at death < 60 | -0.0229 | -0.0223 | -0.0226 |
| | (0.0148) | (0.0148) | (0.0148) |
| Observations | 13049 | 13049 | 13049 |
| $R^2$ | 0.069 | 0.069 | 0.069 |

Robust errors clustered on individuals in parentheses

All specifications include age and year indicator variables

Table 3.6: OLS: Effect of current and lagged mortgage loan-to-home value interacted with current and lagged unemployment on the likelihood of poor health.

| | poor health | poor health | poor health | poor health |
|---|---|---|---|---|
| high LTV | 0.0115 | 0.00860 | 0.00989 | |
| | (0.0133) | (0.0176) | (0.0210) | |
| weeks unemployed | 0.00154 | 0.000890 | 0.000767 | |
| | (0.00131) | (0.00124) | (0.00126) | |
| high LTV × weeks unemployed | 0.00950** | 0.0123** | 0.0104* | |
| | (0.00473) | (0.00488) | (0.00568) | |
| 1-lag high LTV | | 0.00342 | 0.0213 | 0.0311* |
| | | (0.0152) | (0.0203) | (0.0174) |
| 1-lags weeks unemployed | | 0.00361* | 0.00405** | 0.00416** |
| | | (0.00198) | (0.00198) | (0.00204) |
| 1-lag high LTV × weeks unemployed | | 0.00965** | 0.0127*** | 0.0121** |
| | | (0.00492) | (0.00469) | (0.00473) |
| 2-lags high LTV | | | 0.00151 | 0.0000780 |
| | | | (0.0136) | (0.0138) |
| 2-lags weeks unemployed | | | 0.00111 | 0.00109 |
| | | | (0.00209) | (0.00208) |
| 2-lags high LTV × weeks unemployed | | | -0.00365 | -0.00369 |
| | | | (0.00256) | (0.00255) |
| Observations | 3194 | 2625 | 2238 | 2238 |
| $R^2$ | 0.041 | 0.048 | 0.051 | 0.045 |

Robust errors in parentheses

All specifications include full set of control variables

Table 3.7: OLS: Effect of poor health on the likelihood of high LTV in 2 years.

| | high LTV in 2 years |
|---|---|
| poor health | 0.0538** |
| | (0.0236) |
| high LTV | 0.527*** |
| | (0.0228) |
| weeks unemployed (past year) | 0.000627 |
| | (0.000886) |
| high LTV × weeks unemployed | 0.00474 |
| | (0.00441) |
| weeks out of labor force (past year) | 0.000554 |
| | (0.000449) |
| wage (dollars/1000) | 0.00000443 |
| | (0.000109) |
| female | 0.000684 |
| | (0.0115) |
| hispanic | 0.000330 |
| | (0.0174) |
| black | 0.0191 |
| | (0.0179) |
| married | -0.0279** |
| | (0.0141) |
| insured | -0.0607*** |
| | (0.0226) |
| lives in MSA | -0.000896 |
| | (0.0137) |
| highest grade completed | 0.000807 |
| | (0.00256) |
| mother's highest grade completed | 0.00273 |
| | (0.00262) |
| father's highest grade completed | -0.00122 |
| | (0.00195) |
| mother's age at death < 60 | 0.0101 |
| | (0.0204) |
| father's age at death < 60 | 0.0117 |
| | (0.0168) |
| Observations | 2856 |
| $R^2$ | 0.362 |

Robust errors in parentheses

All specifications include age and year indicator variables

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