## Title
Economic Crises and Production Factors Flows



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**ECONOMIC CRISES AND PRODUCTION FACTORS FLOWS**

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by

**Yanshuo Chen**

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**Abstract**

Economic Crises and Production Factors Flows

by

Yanshuo Chen

This dissertation is a collection of essays that relate, in different forms, economic crises to production factors flows. Production factors include capital and labor.

Essay 1 proposes a novel explanation for the origin of the housing boom in the early 2000s: the household asset allocation channel. It argues that following the dot-com bubble crash in 2000, households shifted their investments away from stocks and toward houses, leading to an increase in housing prices from 2000 to 2006. Through a theoretical model, it is demonstrated that the households' portfolio share in stocks influences housing prices through two mechanisms: the wealth effect and the flow-of-funds effect. Furthermore, the model quantitatively shows that approximately 18 percent of the U.S. real housing price growth during 2000-2006 can be attributed to the households' portfolio shifts.

Essay 2 provides empirical evidence of a causal relationship between households' stock market participation and housing prices in the early 2000s. It observes that the decline in stock market participation during 2001-2003, as a result of the dot-com bubble crash, led to an immediate and medium-term (2001-2006) increase in housing prices. Additionally, this essay investigates the micro-foundations of this phenomenon,

revealing that the residence purchases by young individuals and investors play an important role.

Essay 3 refers the reader to survey articles on the effects of the Global Financial Crisis on international capital flows. International capital flows have challenged economists' models for decades. Over time, global capital flows go through boom and bust cycles, sudden stops, and unprecedented bonanzas. Determinants of capital flows include "pull factors," recipient countries' economic and structural characteristics, and "push factors" or "global factors".

Essay 4 proposes a model-based method to estimate industrial unemployment during recessions. Unlike most surveys that evaluate industrial unemployment based on respondents' last job held, which may not reflect their current job searches, this novel approach provides a more accurate estimation. Using this method, the number of industrial unemployment cases after the Great Recession (2008-2015) was estimated.

To my parents

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*Encyclopedia of Economics and Finance.* The co-author listed in this publication directed and supervised the research which forms the basis for the dissertation.

# Chapter 1

# Stock Market Participation and Housing Price

## 1.1 Introduction

At the beginning of this century, the U.S. experienced the dot-com bubble crash and the housing market boom. It is now well accepted that the housing market was at the heart of the Global Financial Crisis (GFC). Is there a causal link between these two events, the dot-com bubble crash and the housing market boom? If yes, we can endogenously connect the GFC with the dot-com bubble crash and infer that one crisis may bury some seeds for another crisis.

In a popular book, *"Irrational Exuberance"*, Robert Shiller speculates that the the dot.com bubble crash boosted the housing market. For instance, Shiller writes that "the drops in the stock market after 2000 had the perverse effect of further intensifying the demand for housing by transferring investor enthusiasm from the stock market to the housing market."[1] However, Shiller admits that it is challenging to understand the time-varying relationship between the stock market and the housing market. For example, Shiller writes that "This seeming evidence of cross feedback from the stock market to the housing market may seem fragile, since such feedback does not always occur, but one must remember that we are dealing with social science, not theoretical physics. We do not fully understand why feedback between markets has the form it does and why it changes through time, but we have learned something about it. "

This chapter uses a calibrated structural model to analyze the impact of a stock market crash on the housing market. I propose a new view, household asset allocation channel, to explain the origin of the housing bubble in the early 2000s. I argue that after the dot-com bubble crash, households invested less in stocks and invested more in houses and this pushed up the housing prices. The theoretical model shows the mechanism that the stock market affects the housing market. The model answers the question raised by Shiller, which is: why stock market return was negatively correlated with housing prices after the dot-com bubble crash, and why the form of the relationships between stock market return and housing prices changes through time.

I build a theoretical model following Dong, Liu, Wang, and Zha (2022).[2] I depart from the Dong, Liu, Wang, and Zha (2022) version of the model in two important dimensions. First, to study how stock market investment can affect the housing market, I introduce capital market investment into a tractable heterogeneous-agent framework

[1] Shiller(2015) shows some evidence from questionnaire surveys that the drops in the stock market in 2000-2003 made less people believe that stock market was the best investment for them and more people believe that housing was the best investment for them.

[2] This paper provides a micro foundation for the housing demand shocks with a heterogeneous-agent framework. In their model with heterogeneous beliefs, a positive shock to credit supply raises housing demand of optimistic buyers and boosts housing prices.

for housing. I assume the family behaves as a positive feedback trader (i.e., selling after price decreases) in the capital market. Second, I introduce a learning process into the model. Following this setting, households are more optimistic about the future value of housing services during the housing boom.

I found that equilibrium house price satisfies the aggregate Euler equation, and the capital share (i.e., the share of portfolio on capital) drives a wedge in the aggregate housing Euler equation. As I showed analytically, capital market participation can affect housing prices through two channels: the wealth effect and the flow-of-funds effect. The wealth effect means that when the expected capital market return is high, households expect to earn more from the capital market. Then the households forecast the future housing price would rise, because the households would be richer and invest more in the housing market. Thus, the households would like to pay more for the houses today. The flow-of-funds effect means that when households invest more in the capital market, they have less money to buy houses due to the flow-of-funds constraint. The model predicts that housing prices increase as the stocks market participation goes down whenever the flow-of-fund effect dominates. Based on the model, I quantitatively decomposed the U.S. real housing growth during 2000-2006. My model matches the housing price growth during 2000-2006 very well. The households asset allocation channel explains about 18 percent of the U.S. real housing price growth. The learning process is necessary for the model to match the data during 2000-2006. Intuitively, the households asset allocation channel drove the housing prices growth during 2000-2003. The rapid housing prices growth shifted households' belief. The optimistic belief drove the housing prices up during 2003-2006, although the stock market began to rebound after 2003. In other words, housing was an alternative investment vehicle to stocks during 2000-2003. Then it turned to be a speculative asset due to optimistic beliefs during 2003-2006.

## 1.2 Previous Work

This chapter relates to the literature about the substitution between houses and equity. Leombroni et al. (2020) also studied the asset prices from the perspective of household asset position. They showed that the Great Inflation in the 1970s led to a portfolio shift by making housing more attractive than equity, because high expected inflation generates tax effects that favor housing investments (e.g., the returns on housing are essentially untaxed, while mortgage interest rate payments are tax deductible). They are tax-driven portfolio shifts. My methodological approach differs from their paper in two aspects. First, in their model, households solve lifecycle consumption-portfolio choice problems, they decide houses allocation and equity allocation simultaneously. However, in my model, households' equity allocation decision is independent of the housing allocation decision. Instead, the equity decision is determined by accumulated historical equity return. A stock market crash lowers the accumulated historical equity return and led to a portfolio shift from equity to housing. They are event-driven portfolio shifts. Second, the setup of my model makes the model tractable and allow me to get an analytical solution. The analytical solution shows the mechanism of how the equity share affect housing price. In addition, some previous literature studies how the house purchases can affect stocks investment. Yao (2005) finds that compared with house renters, investors owning a house would hold a lower equity proportion in their net worth. Hu (2005) points out that households' risky asset share of liquid wealth will fall after a house purchase because of liquidity concern. This paper studies how the stocks investment can affect house purchases. Lyng et al. (2019) finds that households' equity market participation rate drops during the years of house purchase.

Much of the previous literature studies the housing boom from the perspective of credit supply view, which argues that an increase in credit supply unrelated to fundamental improvements in productivity or income was the shock that initiated the housing boom in the early 2000s.[3] There was an expansion in the supply of mortgage credit for home purchases towards low-income households that had previously been unable to obtain a mortgage (Mian and Sufi, 2016). The household asset allocation channel in this paper complements the credit supply view in explaining the housing booms from two perspectives. First, Severino (2016) argues that mortgage originations increased for borrowers across all income levels. As the main participants of the housing market and equity markets are high-income and middle-income households (Campbell, 2006), the household asset allocation channel explains the rise in mortgage originations for high-income and middle-income households. Second, as I show in the model part, households finance their spending on housing down payment using both internal funds (i.e., their own savings) and external funds (i.e., external debt). The credit supply view focuses on the external funds. The household asset allocation view studies the internal funds- when households invest less in the equity market, they have more funds to buy houses.

[3]See Adelino et al. (2012), Favilukis et al. (2016); Justiniano et al. (2019); Tim Landvoigt, Minika Piazzesi, and Martin Schneider (2015); among others.

Also, it is useful to contrast these results with two popular viewpoints. The first viewpoint posited that investors should rebalance their portfolio towards a stable risky asset share in response to stock market movements.[4] In other words, the households should buy more stocks after the stock market crash. However, such a conclusion assumes that households do not revise their target shares over time (Guiso et al. 2013). Calvet et al. (2009) find that Swedish investors revised their risky asset target share downwards by about 15 percent during the bear market of 2001 and 2002. The second viewpoint posited that housing markets are illiquid relative to other asset markets (Piazzesi and Schneider, 2016). Thus, it is unlikely that people would sell their stocks and buy houses after the stock market crashes, because of the concern of liquidity. However, households who buy houses as principal dwelling won't be affected by the concern of liquidity. I find that compared with the period 1994-1999, more young households entered the housing market after the Dot-com bubble crash. Also, I find that the stock market crash increases the investor share despite the concern of liquidity. The housing prices are determined by transacted houses. Young investors and speculators can significantly affect the housing prices despite their small size.

## 1.3 Quantitative Model

To rationalize the empirical results of the previous parts, I built a quantitative model following Dong, Liu, Wang, and Zha (2022). I depart from the Dong, Liu, Wang, and Zha (2022) version of the model in two important dimensions. First, to study how

[4] According to the theoretical predictions of the basic partial equilibrium Merton model, a household should choose a risky share equal to a target risky share that depends on its relative risk aversion and its beliefs about the market return and market risk (Guiso and Sodini, 2013).

stock market participation affects the housing market, I introduced a capital market investment into a tractable heterogeneous-agent framework for housing.I assume the family behaves as a positive feedback trader (i.e., selling after price decreases) in the capital market. Second, I introduce a learning process into the model. I assume the households form beliefs over the future value of housing services from the path of realized housing prices growth. Following this setting, households are more optimistic about the future value of housing services during the housing boom.

### 1.3.1 Model Environment

There is a large family with infinite households. The utility function of the family is as follows:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[ \frac{c_t^{1-\gamma}}{1-\gamma} + \widetilde{\varphi}_t \frac{s_{ht}^{1-\theta}}{1-\theta} \right] \tag{1.1}$$

where $c_t$ denotes consumption of goods, $s_{ht}$ denotes the consumption of housing service. $E$ is an expectation operator, and $\beta$ is a subjective discount factor. $\gamma > 0$ and $\theta > 0$ are the parameters that measure the curvature of the utility function with respect to consumption and housing service, respectively. $\widetilde{\varphi}_t$ denotes the utility value of housing service, it is a temporary shock. Suppose $\widetilde{\varphi}_t$ follows a random walk process, and its growth rate $g_{t+1} = \frac{\widetilde{\varphi}_{t+1}}{\widetilde{\varphi}_t}$ is randomly drawn from the i.i.d. distribution $\widetilde{F}$. Each household holds heterogeneous beliefs about the future utility value of housing services. A household j's perceived future utility value of housing services is given by

$\widetilde{\varphi}_{t+1} = \widetilde{\varphi}_t \varepsilon_t^j$, where the belief $\varepsilon_t^j$ is i.i.d. and is drawn from the distribution $F(\bar{\varepsilon}_t, \bar{\varepsilon}_t \sigma_\varepsilon^2)$ . $\bar{\epsilon}_t$ is time-varying, it is determined by the path of observable realized housing prices growth. Note that $\widetilde{F}$ and $F$ need not to be the same.

At the beginning of period t, all the households of the family enjoy the same consumption of goods $c_t$ and of housing service $S_{ht}$.

Then, the family's cash on hands is denoted as $a_t$. The cash $a_t$ can be invested in two ways. First, the family can invest part of its cash on hands in capital (think about fruit trees). The capital will be completely depreciated in period t. Following the spirit of Cutler, Poterba, and Summers (1990) (also see Shleifer (2000), and Gabaix and Koijen (2021)), I assume the family behaves as a positive feedback trader in the capital market, whose portfolio share on capital $e_t$ is based on the history of past returns $\widetilde{R}_i, i = 1, ..., t-1$ (think about the fruit grown on the fruit trees) rather than the expectation of future fundamentals.[5] Assume portfolio share on capital $e_t$ and log accumulated historical return $ln(StockIndex)_t$ are cointegrated. $\Delta e_t$ is determined based on the Error Correction Model

$$A(L)\Delta e_t = \omega + B(L)\widetilde{R}_t + \tau(e_{t-1} - \theta_0 - \theta_1 ln(StockIndex)_{t-1}) + \nu_t \tag{1.2}$$

where $StockIndex$ denotes the stock market index, $ln(StockIndex)_t$ denotes the log accumulated historical capital return, $\widetilde{R}_t = ln(StockIndex)_t - ln(StockIndex)_{t-1}$ denotes

[5] Cutler, Poterba, and Summers (1990) and Shleifer (2000) point out that positive feedback trading, selling after price decreases, could result from the use of stop loss orders, from portfolio insurance, from a positive wealth elasticity of demand for risky assets, or from margin call-induced selling after periods of low returns. Gabaix and Koijen (2021) empirically shows that stock market flows is strongly correlated with returns.

capital return.

After the family invests $e_t a_t$ into the capital market. They can invest the rest $(1 - e_t)a_t$ in the housing market. The housing investment decision is made by small households, rather than the large family. The households are dispersed to decentralized housing markets with the same amount of internal funds $(1-e_t)a_t$ from the family. The households' beliefs about the future marginal utility value of housing services $\varepsilon_t$ are heterogeneous. The heterogeneous beliefs $\varepsilon_t$ is the only source of heterogeneity among households. Then, based on the heterogeneous beliefs $\varepsilon_t$, each household determines if he buy a house or not. A house buyer with the belief $\varepsilon_t$ has two sources to finance her spending on houses $Q_t h_{t+1}(\varepsilon_t)$: internal funds $(1 - e_t)a_t$ that is received from the family, and external debt $b_{t+1}(\varepsilon_t)$ that he can borrow from the inter households credit market at the interest rate $R_t$. At the end of period t, the households return to the family and pool their funds and houses.

When the family and the households make their decisions, they face some constraints. The family faces a budget constraint:

$$\begin{aligned} &c_t + r_{ht}s_{ht} + e_t a_t + (1 - e_t)a_t \\ &= \widetilde{R}_{t-1}e_{t-1}a_{t-1} + (Q_t + r_{ht})\int h_t(\varepsilon_{t-1})dF(\varepsilon_{t-1}) - \int b_t(\varepsilon_{t-1})dF(\varepsilon_{t-1}) \end{aligned} \tag{1.3}$$

where $Q_t$ denotes the housing price, and $r_{ht}$ denotes the rental rate of housing.

The house buyer households face three constraints: the flow-of-funds constraint, the collateral constraint, and the short-selling constraint. The flow-of-funds constraint is as follows:

$$Q_t h_{t+1}(\varepsilon_t) \leq (1-e_t)a_t + \frac{b_{t+1}(\varepsilon_t)}{R_t} \tag{1.4}$$

It implies that, to buy a house, the sum of the house buyer household's internal funds $(1-e_t)a_t$ and external debt $b_{t+1}(\varepsilon_t)$ should equal with the housing price. For the non-house-buyer household, this condition is not binding.

The collateral constraint is as follows:

$$\frac{b_{t+1}(\varepsilon_t)}{R_t} \leq \kappa_t Q_t h_{t+1}(\varepsilon_t) \tag{1.5}$$

where $\kappa_t$ is the exogeneous loan-to-value ratio shock. $\kappa_t$ is i.i.d. and is drawn from the distribution $K(\bar{\kappa}, \sigma_\kappa^2)$. This condition implies that the external debt cannot exceed a fraction of the housing value.

The short-selling constraint implies that the households cannot short sell the houses:

$$h_{t+1}(\varepsilon_t) \geq 0 \tag{1.6}$$

Denote the Lagrangian multipliers associated with the constraints (1.3), (1.4), (1.5) and (1.6) by $\lambda_t$,$\eta_t$,$\pi_t$ and $\mu_t$, respectively.

The first order conditions with respect to $c_t$ and $s_{ht}$ are given by

$$\lambda_t = \frac{1}{c_t} \tag{1.7}$$

$$\lambda_t r_{ht} = \widetilde{\varphi}_t s_{ht}^{-\theta} \tag{1.8}$$

The first order condition with respect to $a_t$ implies that

$$\lambda_t = (1 - e_t) \int \eta_t(\varepsilon_t) dF(\varepsilon_t) + E_t(\beta \lambda_{t+1} \tilde{R}_t) e_t \tag{1.9}$$

A marginal unit of goods transferred from consumption to investment in capital and housing reduces family consumption by one unit and hence the utility cost is $\lambda_t$. The utility gain from this transfer includes two parts: the shadow value of housing (i.e., $\eta_t(\varepsilon_t)$) averaged across all households, and the expected capital return (i.e., $\widetilde{R}_t$).

The first order condition with respect to $h_t(\varepsilon_t)$ implies that

$$\eta_t(\varepsilon_t) Q_t = \beta E_t[\lambda_{t+1}(Q_{t+1} + r_{h,t+1}) | \widetilde{\varphi}_{t+1} = \widetilde{\varphi}_t \varepsilon_t] + \kappa_t Q_t \pi_t(\varepsilon_t) + \mu_t(\varepsilon_t) \tag{1.10}$$

$\eta_t(\varepsilon_t) Q_t$ is the utility cost of purchasing an additional unit of housing. The additional unit of housing yields resale value and rental value in the next year $Q_{t+1} + r_{h,t+1}$. Also, the additional unit of housing provides shadow utility benefit $\kappa_t Q_t \pi_t(\varepsilon_t) + \mu_t(\varepsilon_t)$ by relaxing the collateral constraint and the short-selling constraint.

The first order condition with respect to $b_{t+1}(\varepsilon_t)$ implies that

$$\beta R_t E_t[\lambda_{t+1}|\widetilde{\varphi}_{t+1} = \widetilde{\varphi}_t \varepsilon_t] + \pi_t(\varepsilon_t) = \eta_t(\varepsilon_t) \tag{1.11}$$

$\eta_t(\varepsilon_t)$ is the utility benefit of borrowing an extra unit of goods for the member with belief shock $\varepsilon_t$. The marginal costs include two parts: the debt needs to be repaid next period at the interest rate $R_t$, the utility cost of tightening the collateral constraint $\pi_t(\varepsilon_t)$.

A competitive equilibrium is a collection of allocations $c_t, s_{ht}, a_t, h_{t+1}(\varepsilon_t), b_{t+1}(\varepsilon_t)$ and prices $Q_t, R_t, r_{ht}$ such that

(1) Taking the prices as given, the allocations solve the family and household's utility maximizing problem.

(2) Markets for goods, housing, and credit all clear, such that

$$c_t = \widetilde{R}_{t-1} e_{t-1} a_{t-1} \tag{1.12}$$

$$s_{ht} = 1 \tag{1.13}$$

$$\int h_t(\varepsilon_{t-1}) dF(\varepsilon_{t-1}) = 1 \tag{1.14}$$

$$\int b_{t+1}(\varepsilon_t) dF(\varepsilon_t) = 0 \tag{1.15}$$

where I assume the aggregate housing supply is constant and equals to 1, and the aggregate net debt supply is 0.

### 1.3.2 Equilibrium characterization

To characterize the equilibrium, I need to do a thought experiment. The housing purchases are partly financed by external debt, house-buyers borrow from the inter households credit market. A household with a higher belief of future housing service value $\varepsilon_t$ would like to buy more housing, and they face binding borrowing constraints. A household with a lower belief of future housing service $\varepsilon_t$ would not buy houses, but they will lend money to the home buyers. Thus, there exists a cutoff level belief $\varepsilon_t^*$, such that a household with $\varepsilon_t \geq \varepsilon_t^*$ is a house-buyer, and a household with $\varepsilon_t \leq \varepsilon_t^*$ is a non-house-buyer. Thus, identifying the marginal household $\varepsilon_t^*$ is the key step to define an equilibrium.

### 1.3.3 Analytical Results

#### 1.3.3.1 Lemma 1

Dong, Liu, Wang, and Zha (2022) shows that there exists a unique cutoff point $\varepsilon_t^*$ in the support of the distribution $F(\varepsilon)$ and it is given by

$$F(\varepsilon_t^*) = \kappa_t \tag{1.16}$$

$$\frac{\partial F(\varepsilon_t^*)}{\partial \kappa_t} > 0 \tag{1.17}$$

Lemma 1 indicates that the marginal household with belief $\varepsilon_t^*$ is determined by $\kappa_t$. It implies that $\varepsilon_t^*$ increases with $\kappa_t$. In other words, a looser credit supply increases the marginal household's belief of future housing service value $\varepsilon_t^*$.

#### 1.3.3.2 Proposition 2

The equilibrium house price satisfies the aggregate Euler equation

$$\lambda_t Q_t = \delta_t(e_t)[\beta E_t \lambda_{t+1} Q_{t+1} + \xi(\kappa_t)] \tag{1.18}$$

where

$$\xi(\kappa_t) \equiv \frac{\beta \widetilde{\varphi}_t}{1 - F(\varepsilon^*)} \int_{\varepsilon^*} \varepsilon dF(\varepsilon) \tag{1.19}$$

which is a function of $\kappa_t$ since $\varepsilon_t^*$ is related to $\kappa_t$ through $F(\varepsilon_t^*) = \kappa_t$, and

$$\delta_t(e_t) = \frac{1 - e_t}{1 - E_t(\frac{\lambda_{t+1}}{\lambda_t} \widetilde{R}_t) e_t} \tag{1.20}$$

which is a function of $e_t$.

$\xi(\kappa_t)$ is a housing demand shock, $\delta_t(e_t)$ is a housing demand wedge. The numerator of the housing demand wedge $\delta_t(e_t)$ indicates that if the family invest more in the capital market (i.e., $e_t$ increases), the households would have less money to buy houses due to the flow-of-funds constraint, so the housing price will decline. I call it the flow-of-funds effect. The denominator of the housing demand wedge $\delta_t(e_t)$ indicates that if the family invest more in the capital market (i.e., $e_t$ increases), it expects to get more return from the capital market in the future (i.e., $E_t(\frac{\lambda_{t+1}}{\lambda_t}\widetilde{R}_t)e_t$ increases). Then the households forecast the future housing price would rise, because the households would be richer and invest more in the housing market. Thus, the households would like to pay more for the houses today. I call it the wealth effect. The direction of the flow-of-funds effect and the wealth effect are opposite. The effect of $e_t$ on housing price depends on the relative strength of the two effects. It will be shown in Proposition 3.

#### 1.3.3.3 Proposition 3

An increase in portfolio share on capital $e_t$ depresses the house price $Q_t$ when the capital expected return $E_t(\widetilde{R}_t)$ is low, but an increase in $e_t$ raises the house price $Q_t$ when the capital expected return $E_t(\widetilde{R}_t)$ is high. That is

$$\frac{\partial Q_t}{\partial e_t} < 0, E_t(\frac{c_{t+1}}{c_t})^\gamma > E_t(\widetilde{R}_t) \tag{1.21}$$

$$\frac{\partial Q_t}{\partial e_t} > 0, E_t(\frac{c_{t+1}}{c_t})^\gamma < E_t(\widetilde{R}_t) \tag{1.22}$$

Intuitively, Proposition 3 shows that when the portfolio share on capital $e_t$ increases, the growth of housing prices depends on the expected capital return. When the expected capital return is high, the housing price will increase (as shown in expression 1.22). When the expected capital return is low, the housing price will decrease (as shown in expression 1.21). My interpretation of the results is as follows: as I discuss in Section 1.3.3.2, portfolio share on capital can affect housing prices through two channels: wealth effect and flow-of-funds effect. The model predicts that housing prices increase as the portfolio share on capital goes down whenever the flow-of-fund effect dominates the wealth effect.

#### 1.3.3.4 Proposition 4

$$If \quad E_t(\frac{\lambda_{t+i+1}}{\lambda_{t+i}}\widetilde{R}_{t+i}) = 1(i = 1, ..., n), \tag{1.23}$$

$$E_t\lambda_{t+1}Q_{t+1} = \widetilde{\varphi}_t\omega_t(\bar{\varepsilon}_t) \tag{1.24}$$

$$where \quad \omega_t(\bar{\varepsilon}_t) = \beta\frac{\int_{\varepsilon^*}\varepsilon dF_t(\varepsilon)}{1-\bar{\kappa}}\frac{\bar{\varepsilon}_t^2}{1-\beta(1+\bar{\varepsilon}_t^2)} \tag{1.25}$$

Proposition 4 shows that if condition (1.23) holds, the expected housing price is a function of the current value of housing services (i.e., $\widetilde{\varphi}_t$) and the mean of households' expected marginal utility of housing services growth (i.e., $\bar{\varepsilon}_t$).It is independent of other state variables, for example, the current expected capital return shock (i.e., $E_t(\widetilde{R}_t)$) and current loan-to-value ratio shock (i.e., $\kappa_t$).

This proposition allows me to get the following analytical solution for housing price.

If condition (1.23) holds, the equilibrium house price Euler equation (1.18) can be written as

$$\lambda_t Q_t = \delta_t(e_t)[\beta\widetilde{\varphi}_t\omega_t(\bar{\varepsilon}_t) + \xi(\kappa_t)] \tag{1.26}$$

In the quantitative part, the future capital expected return (i.e., $E_t\widetilde{R}_{t+i}, i = 1, ..., n$) is determined so as condition (1.23) holds (i.e., $E_t(\frac{\lambda_{t+i+1}}{\lambda_{t+i}}\widetilde{R}_{t+i}) = 1, i = 1, ..., n$).

### 1.3.4 Learning process

The households form beliefs over the future value of housing services from the path of realized housing prices growth. A household j's perceived future marginal utility of housing services is given by $\widetilde{\varphi}_{t+1} = \widetilde{\varphi}_t\varepsilon_t^j$, where the belief $\varepsilon_t^j$ is i.i.d. and is drawn from the distribution $F(\bar{\varepsilon}_t, \bar{\varepsilon}_t\sigma_\varepsilon^2)$. $\bar{\varepsilon}_t$ is time-varying, it is determined by the path of realized housing prices growth. It is updated according to the following equation

$$\bar{\varepsilon}_t = \bar{\varepsilon}^{g_t} \tag{1.27}$$

$$g_t = \frac{\bar{g}_{t-5}}{\bar{g}} \tag{1.28}$$

where $\varepsilon$ denotes the long-run average growth of the value of housing services, $\bar{g}$ denotes the long-run average growth of the housing price, $\bar{g}_{t-5}$ denotes the average growth of the housing price during the past 5 years.

In this setting, households are more optimistic about the future value of housing services during the housing boom.

### 1.3.5 Parameter values and Targeted moments in the Calibration

The parameter values and targeted moments in the calibration is shown in the following table. I choose US country-level targets for my calibration. I used the standard values from the literature for the discount rate and degree of risk aversion. The future capital expected return (i.e., $E_t(\widetilde{R}_{t+i}), i = 1, ..., n.$) is determined so as the expected future capital wedge (i.e., $E_t\delta_{t+i}(e_{t+i}), i = 1, ..., n$) is 1. I set the expected consumption growth (i.e., $E_t(\frac{c_{t+i+1}}{c_{t+i}}), i = 1, ..., n$) to the average growth in personal consumption expenditures per capita over the 1970: Q1 to 1999: Q4 period. I set the long-run average housing price growth (i.e., $\bar{g}$) to the average growth in real residential property prices over the 1970: Q1 to 1999: Q4 period. I set the long-run housing utility growth (i.e., $\bar{\varepsilon}$) to the average growth in share of housing in total consumer expenditures over the 1991 to 2000 period. I set the housing utility growth during 2000 to 2006 equal to the long-run housing utility growth (i.e., $\bar{g}$ Following Kaplan et al. (2020), I set home buyers' expected annual real house price growth (i.e.,$E(\varepsilon), for \varepsilon > \varepsilon_*$) during the 2000s housing boom to be 6 percent.

### 1.3.6 Estimating exogenous shocks

There are three exogenous shocks- historical capital return (i.e., $\widetilde{R}_i, i = 1, ..., t-1$), current expected capital return (i.e., $E_t(\widetilde{R}_t)$, current loan-to-value ratio shock $\kappa_t$. I set historical capital return to be the growth of the annual US MSCI index subtracting

Table 1.1: Baseline Calibration

| Parameter | Value | Description | Target |
|---|---|---|---|
| $\beta$ | 0.964 | Discount Rate | Kaplan et al. 2020 |
| $\gamma$ | 2 | Degree of Risk Aversion | Literature(e.g., Chettey 2003) |
| $E_t(\frac{c_{t+i+1}}{c_{t+i}})$ | 1.02 | Expected Consum Growth | Growth Cons Per Capita 70-99 |
| $E_t\widetilde{R}_{t+i}$ | 1.04 | Capital Expected Return | Expected Capital Wedge=1 |
| $\bar{g}$ | 1.01 | LR House Price Growth | Growth Resid Prop Prices 70-99 |
| $\varepsilon$ | 1.01 | LR House Utility Growth | Share Housing in Cons 91-2000 |
| $E(\varepsilon)$ | 6% | Expected Real HP Growth | Kaplan et al. 2020 |

the inflation. I set the current expected capital return to be the survey expected equity return (from Gallup survey expectations) subtracted expected inflation (from Fed Cleveland database) and risk premium. I provide further detail in Appendix Part 4. I set the current loan-to-value ratio shock, $\kappa_t$, to be the annual average loan-to-value ratio of all home purchase loans (from FHFA, National Mortgage Database).

### 1.3.7 Quantitative Decomposition of Housing Price

Based on the equation (1.26)

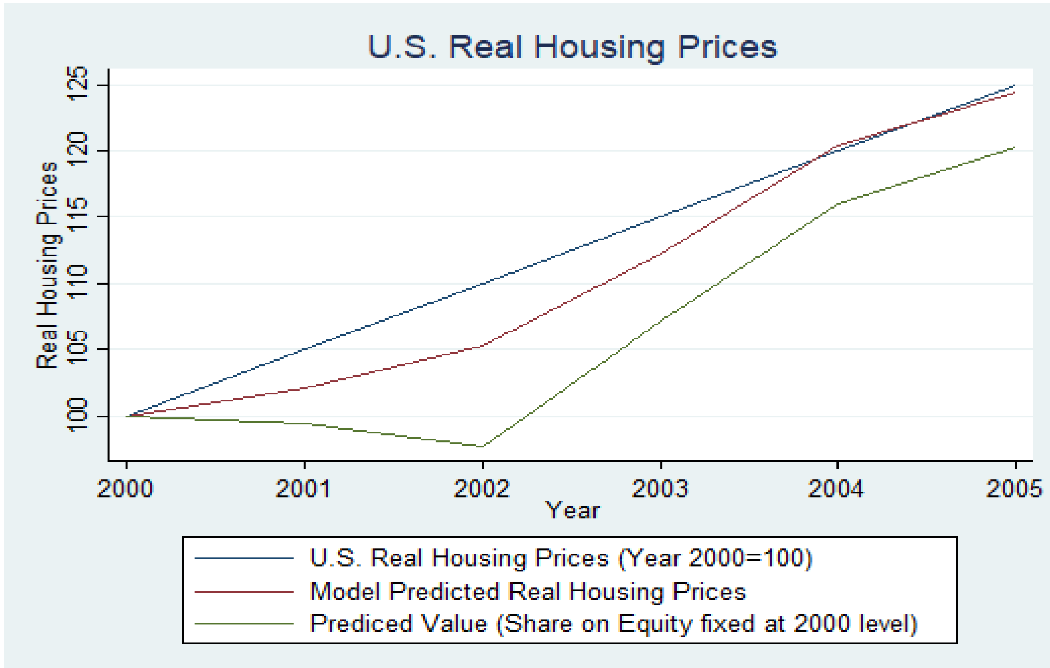
$$\lambda_t Q_t = \delta_t(e_t)[\beta\widetilde{\varphi}_t\omega_t(\bar{\varepsilon}_t) + \xi(\kappa_t)]$$

I do a quantitative decomposition of U.S. real housing price growth during 2000 2006. First, I keep the portfolio share on capital $e_t$ fixed at its 2000 level, I predict the U.S. real housing price, which is shown as the grey line in Figure-1.1. Second, I set the portfolio share on capital $e_t$ to be endogenously determined. Then I predict the U.S. real housing price, which is shown as the red line in Figure-6. The blue line is the U.S. real housing price over 2000 to 2006 period. The growth of the grey line is driven by the shocks to loan-to-value ratio. The growth of the red line is driven by the shocks to both loan-to-value ratio and the shocks to portfolio share on equity. From Figure-1.1, we can see the red line predict real housing price growth very well. Compare the red line with the grey line, we can see the household asset allocation view can explain about 18 percent of the U.S. real housing price growth over 2000 to 2006 period.

There is a divergence between the red line and the grey line during 2001-2002. The decline in the grey line during 2001-2002 is due to the wealth effect. After the Dot.com bubble crash, the pessimistic expectation of capital returns drove housing prices down. However, the red line allows the portfolio share on capital $e_t$ to vary over time. The portfolio share on capital $e_t$ declined after the Dot.com bubble crash, so the households were able to invest more in the housing market (i.e., the flow-of-funds effect). When the flow-of-funds effect dominates, housing prices would increase. This can explain the upward trend in the red line during 2001-2002.

In addition, the learning process is necessary for the model to match the real housing price growth during 2000-2006. In the setting of the learning process, households are more optimistic about the future value of housing services during the housing boom. The stock market was in a bust during 2000-2003, the housing prices went up because of the household asset allocation channel. Then, the households were more optimistic about the housing market. The shifts in belief drove the housing prices up during 2003-2006, although the stock market began to rebound in 2003. In other words, during 2000-2003, households treated housing as an alternative investment vehicle to stocks. However, housing turned to be a speculative asset during 2003-2006 due to optimistic beliefs.

Figure 1.1: Quantitative Decomposition of Housing Price




## 1.4 Discussion and concluding remarks

Despite the profound impact of the dot-com bubble crash and the early 2000s housing boom, there is little causal evidence that the dot-com bubble crash amplified the early 2000s housing boom. This chapter provides such analysis using a quantitative model. I argue that the decline in households' stock market investment driven by the dot.com bubble crash increased the households' housing market investment. This pushed up the housing prices. Thus, a stock market crash was associated with faster housing prices growth in the early 2000s.

The "household asset allocation view" explanation of the housing boom was complementary with the "credit supply view". The "household asset allocation view" focuses on explaining why the household would like to invest more in housing and the "credit supply view" focuses on explaining why the households were able to finance more for their housing purchase. Also, the "expectation view" amplifies the "household asset allocation view". As I show in the quantitative model part, the rapid growth in housing prices during 2000-2003 driven by the "household asset allocation view" strengthened households' confidence in the housing market. The shifts in expectation drove the housing prices up during 2003-2006. In other words, households treated housing as an alternative investment vehicle to stocks during 2000-2003. Then housing turned to be a speculative asset during 2003-2006 due to optimistic beliefs, although the stock market began to rebound in 2003.

# Chapter 2

# Bust to another bust: The Macroeconomic Effects of Households Assets Allocation

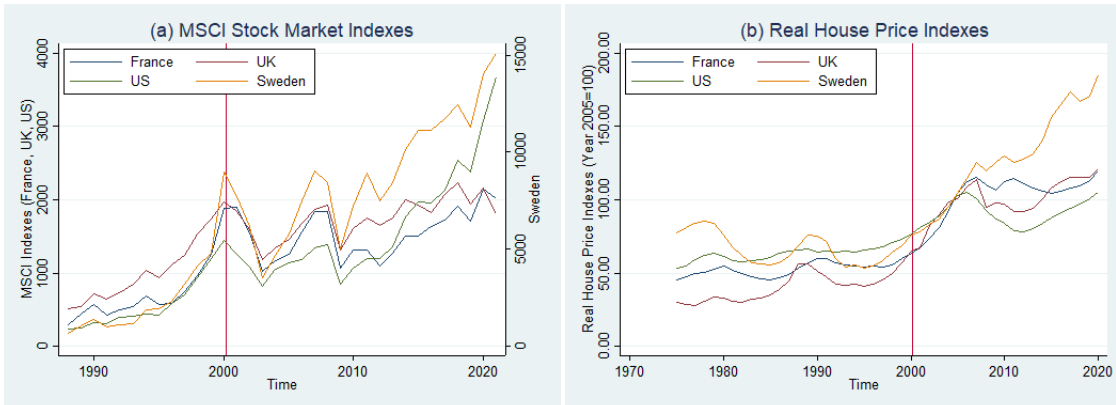
## 2.1 Introduction

This chapter uses empirical methods to test the household asset allocation channel. I argue that after the 2000s dot-com bubble crash,households invested less in stocks and invested more in houses, and this pushed up housing prices of the United States in the early 2000s.

The stock market crash after 2000 and the housing market boom in the early 2000s were not unique to the United States. This was a global phenomenon. Many other larger economies (e.g., France, UK, and Sweden) had similar experiences around the same period (as shown in Figure 2.1).[1]

[1] Guiso and Sodini (2013) reports the direct and indirect stock holding rates of US, UK, Sweden and France. They were 48.9%, 31.5%, 66.2% , and 26.2%, respectively. Data for the US is drawn from the 1998 Survey of Consumer Finances. Data for the UK is drawn from the 1997 to 1998 Financial Research Survey. Data for Sweden and France are computed from the 2004 wave of the Survey for Health.

Figure 2.1: Stock Market Indexes and Real Housing Price Indexes




The left panel shows the MSCI country-level annual stock market indexes from 1988 to 2021. The right panel shows the real house price indexes from 1975 to 2020. Each house price index is seasonally-adjusted and then rebased to 2005=100. The house price indexes are expressed in real terms using the personal consumption expenditure (PCE) deflator of the corresponding country with the same base year of 2005=100.
Source: Bloomberg MSCI indexes, Federal Reserve Bank of Dallas International House Price Database

Methodologically, this work complements existing work in at least two ways. First, this "household asset allocation channel" explains the housing boom from the perspective of the "risky assets view." Housing and stocks are the two asset classes that make up the bulk of household wealth. Both are risky assets. Lian, Ma, and Wang (2019) argue that low interest rates lead to significantly higher allocations to risky assets among diverse populations. The low-interest-rate environment in the early 2000s can explain the strong substitution between housing and stocks during this period. The "risky assets view" is complementary with the "safety asset view" explanation of the housing boom. The "safety asset view" explanation argues that the growing safe assets shortage led to a decline in interest rates (Caballero, Farhi, and Gourinchas, 2017) and an increase in housing credit supply.

Second, instead of studying the average correlation between housing prices and other variables (e.g., Mian and Sufi, 2016)[2], this paper focuses on how a crisis (like

[2] Also, see Favara et al. (2015); Jorda et al. (2015); Adelino et al. (2017); Foote et al. (2020); among

the dot-com bubble crash) was associated with housing prices change. Stock market crashes can significantly affect the beliefs of stock market investors. Vissing-Jorgensen (2003) found that stock market prices and expected returns move together positively during the years, 1998-2002. Investor actions are linked to the beliefs of stock market investors (Vissing-Jorgensen 2003). Hurd et al. (2011) and Kézdi and Willis (2011) found that individuals with low expectations about stock market returns are less likely to participate in the stock market. As I show in the theoretical model section, the mechanism through which a lower stock market participation boosts the housing prices is the flow-of-funds effect: When households invest less in the equity market, they have more internal funds to pay the down payment due to the relaxed flow-of-funds constraint. This boosts housing prices.

I do the following exercises in this paper. First, I estimate the causal relationship between the stock market participation rate and housing prices using the U.S. state-level data. I use the stock market participation rate instead of stock market returns, because there was no variation in stock market returns at the state level, and as shown in the model, the stock market returns affect the housing prices by affecting the households' portfolio share on stocks.[3]

Establishing the causal effect of stock market participation on housing prices is difficult for two reasons. First, economic fundamentals simultaneously impact stock market participation and the housing prices. Second, there might be reverse causality.

others.

[3] Also, I use the extensive margin (i.e., the stock market participation rate)instead of the households' portfolio share in stocks, because the drops in all households' average portfolio share in stocks were mainly driven by the change in the extensive margin, as shown in Table-1. The change in the intensive margin (i.e., the stock market participants portfolio share on stocks) was mainly driven by the stock market movements.

The housing prices affect household stock market participation (Yao 2005).[4]

Two ways to address these challenges are as follows. First, this empirical analysis focuses on the period after the dot-com bubble crash. The stock market participation decline during the years, 2001-2003, was due to investor pessimism.[5] This panic scenario distinguishes the setting here from other stock market participation literature that focuses on economic characteristics. To further eliminate the concern that economic fundamentals simultaneously impact stock market participation and housing prices, I include some economic fundamentals into the controls. Second, to deal with the reverse causality concern, I use the state-level stock market participation rate in the initial year (2001) as the instrument variable of the change in the stock market participation during 2001-2003. Intuitively, if the stock market participation rate declines by the same percent across states due to panic, a state with a higher stock market participation rate in the initial year (2001) is more likely to experience a larger drop in stock market participation rate, during the years, 2001-2003.[6] This instrument variable provides a measure of the change in state stock participation driven by the aggregate stock market crash. It is independent of the housing price growth and changes in other local macroeconomic variables during the years, 2001-2003.

The state-level stock market participation rate in the initial year (2001) is not purely random. It only requires randomness with respect to the unobservable location-level characteristics that determine housing prices growth during the years, 2001-2003.

[4] Also, see Fernandez-Villaverde and Krueger (2001), Cocco(2004), Hu(2005), and Lyng et al. (2019).

[5] The growth of U.S. real GDP during 2000-2003 was positive, although it was lower than its long-term trend. In the meantime, Vissing-Jorgensen (2003) found that stock market prices and expected returns move together positively during the years, 1998-2002.

[6] Figure 2 plots the scatter plots of the change in state-level stock market participation rate during 2001-2003 and the state-level stock market participation rate in 2001.

Previous literature points out that wealth and education are two variables that significantly affect both stock market participation and housing choices (see Guiso et al. 2013 and Piazzesi et al. 2016). Thus, I include both into the controls. Also, a threat to a causal interpretation of my analysis is that state-level stock market participation rate in the initial year (2001) was associated with the local housing prices growth before the dot.com crisis. I show that the local housing prices growth during the years, 1996-2001, was not significant in determining state-level stock market participation rate in the initial year (2001). To further eliminate the concern, I include local housing prices growth during the years, 1996-2001, into the controls in the robust analysis.

I use a local-projection setup and find that a decline in the stock market participation during 2001-2003 driven by the dot.com bubble crash increases housing price immediately (2001-2003) and in the medium term (2001-2006).The conclusion is robust to a variety of model modifications (OLS, IV without controls, controlling for debt-to-income ratio, and controlling for the pre-trend of housing prices and the housing supply elasticity), as shown in Figure-2.3, Table-2.3 and Table-2.4. Based on my identifying assumption, the results provide evidence of the effect of the household asset allocation channel on housing prices. Intuitively, households treat housing as an alternative investment vehicle to equity. The dot.com bubble crash changed investors' belief. Households invested less in the stock market and invested more int the housing market. This activity pushed up the housing prices.

Second, to look at the micro-foundation of this story, I provide some micro-evidence for two kinds of home buyers: households who buy houses for investment and households who buy houses as principal dwelling, respectively.

Mian and Sufi (2022) argues that investors amplify the housing cycle. Shiller(2015) shows some evidence from questionnaire surveys that the drops in the stock market in 2000-2003 had made less people believe that stock market was the best investment for them and more people believe that housing was the best investment for them. I estimate the causal relationship between the stock market participation and the investor share[7]. I find that 1 percentage point decline in stock market participation rate during 2001-2003 was associated with 0.06 percentage point increase in housing market investor share during 2001-2003, and 0.12 percentage point increase in housing market investor share during 2001-2006.

To study households who buy houses as principal dwelling, I relied on household-level data. Drawing on the PSID dataset, I find a sharp decline in the stock market participation rate during 2001-2005. It was mainly driven by the decline in entry rate of young households. At the same time, more younger households were buying houses.[8] That means, compared with the period before the dot-com bubble crash (1994-1999), more young households entered the housing market and fewer young households entered the stock market after the dot-com bubble crash (2001-2005). These facts provide some evidence that there was a substitution between stock market inflows and housing market inflows.

[7]The investor share is defined as the fraction of family-owned houses that are not owner-occupied.

[8]The house ownership rate was stable, even though the housing prices grew rapidly. It was because more younger households were buying houses while more elderly were selling houses.

## 2.2 Previous Work

This work belongs to the literature about the 2000s housing boom. There is a large body of empirical work aimed at understanding the effect of the credit on the housing boom during the 2000s. Mian and Sufi (2009) argues that credit supply pushed up house prices in the early 2000s. They find that house price growth was significantly stronger in low credit score zip codes, even though these zip codes experienced a relative decline in income compared to high credit score zip codes within the same city. Adelino et al. (2012) argues that easier access to credit increases house prices significantly. They use exogenous changes in the conforming loan limit as an instrument for lower cost of financing. Similarly, Favara et al. (2015) shows that an exogenous expansion in mortgage credit has significant effects on house prices by using US branching deregulations between 1994 and 2005 as instruments for credit. Jorda et al. (2015) uses data spanning 140 years of modern economic history in the advanced economies. They show that loose monetary conditions lead to booms in real estate lending and house prices' bubbles. Also, a growing body of theoretical models explain the housing boom by relying on changes over time in credit supply and borrowing constraints (e.g., Kiyotaki et al. (2011), Michaelides and Nikolov (2011), Garriga et al. (2012), Landvoigt et al. (2015), Favilukis et al. (2016), Landvoigt et al. (2017), Justiniano et al. (2019)). The broad conclusion from existing studies of the early 2000s housing boom is that expectations played a quantitatively important role (Piazzesi et al. 2016). Case et al. (2003) and Case et al. (2012) finds that homeowners who bought their homes during the 2000s housing boom reported expected house price appreciations that were well above long-run average house price appreciations in their respective metropolitan statistical areas (MSAs). Kaplan et al. (2020) argues that the main driver of movements in house prices in the early 2000s was a shift in beliefs, not a change in credit conditions.

This work also relates to the literature about stock market belief and participation. Within a rational expectation framework, investors' expected (and required) returns are high when the stock price is low relative to dividends and earnings (Vissing-Jorgensen 2003). However, Adam et al. (2017) formally rejects the rational expectation hypothesis in the stocks market. Its model matches the strong positive correlation between the price dividend ratio and survey return expectations. Vissing-Jorgensen (2003) shows that expected equity returns were high at the peak of the market. Also, the evidence in the paper indicates that during the boom many investors thought the market was overvalued but would not correct quickly. Kézdi and Willis (2011) and Hurd et al. (2011) show that survey respondents who report higher expectations for stock market returns are more likely to participate. Malmendier and Nagel (2011) show that the role of personal experience. They find that individuals who have experienced low stock-market returns throughout their lives are less willing to participate in the stock market, and, conditional on participating, invest a lower fraction of their liquid assets in stocks. There is also prior work studying the household stock market position from the perspective of portfolio rebalancing. The popular recommendation of portfolio rebalancing is that household should rebalance towards a stable risky asset share if households do not change risk attitudes and beliefs over time. In other words, the households should buy more stocks after the stock market crash. However, Calvet et al. (2009) find that Swedish investors revised their risky asset target share downwards by about 15% during the bear market of 2001 and 2002.

## 2.3 Data

In the empirical analysis in Section 2.4, 2.5 and 2.6, I use both U.S. cross-state data and household-level data. In the empirical analysis in the Appendix Part 2.8.1, I use cross-country data.

### 2.3.1 Household-level Data

The household level data are from the Panel Study of Income Dynamics (PSID), whose advantage is its panel structure. The PSID is a longitudinal survey of a sample of both the families and the individuals. Since 1968, families had been interviewed each year until 1997 but the survey has been biennial after 1997. The data consists of variables on demographics, marriage, wealth, income, expenditure, and numerous other topics. I am interested in the changes in household home ownership and stock market participation around the Dot-com bubble crash. The 1995, 1996 and 1997 PSID don't include detailed financial asset information. Thus, I focus on 1994, 1999, 2001, 2003, 2005 and 2007 PSID.

When calculating the household home-ownership rate and stock market participation rate of each year, households in PSID are included in the sample if they satisfy the following two criteria (1) The household was interviewed in that year. (2) The household was from the Survey Research Center sample, which is a cross-sectional national sample. When computing the transitions between housing tenures during some periods, I added two more criteria (1) There was no change in the head of the household during the periods. (2) The household had positive total assets (without housing property) in the initial year or in the ending year of the periods.

When comparing the heterogeneity across age quantiles, I consider households whose head's age is between 26 and 85. Then, I divide households into three groups according to the age of the household's head: I construct three age quantiles for each year. That means, the range of ages for each age group varies for each year.

The household-level variables include household income, house ownership, equity holdings (including both direct holdings and indirect holding), wealth without property, home property value, gender of head, education (college) of head, number of children, own business/farm, location (rural), unemployed, married, retired, and age.

### 2.3.2 State-level Data

The state-level variables include two parts. The first part includes some variables that are calculated from the PSID household-level data, including state-level stock market participation rate, home ownership rate, average wealth with property, average wealth without property and average age of households' head based on 1994-2007 PSID. The second part includes some variables that are taken from other data recourses. State-level annual GDP, total non-farm employment, population, per capita disposable personal income, and per capita personal consumption expenditures (PCE) are taken from BEA Regional Economic Accounts. The data of state land unavailability is based on Diamond (2017), it is state-level estimates of housing supply elasticities. Housing supply elasticities was used in earlier work (e.g., Mian et al., 2013; Mian and Sufi, 2014;

M. Guren, 2021) as an instrument for the change in house prices in different states during the housing boom or bust around 2000. The data of state-level CPI is based on Herkenhoff, Ohanian and Prescott (2018). The data of state-level housing price is based on Federal Housing Finance Agency (FHFA) House Price Index. The housing market investor share is calculated based on the Home Mortgage Disclosure Act (HMDA). It is defined as the fraction of family-owned houses that are not owner-occupied.

### 2.3.3 International-level Data

The cross-country data are an unbalanced panel of 40 advanced economies and emerging market economies, covering the years from 1980 to 2007, on an annual basis. The database comprises real and nominal variables, such as real GDP per capita, population, CPI, investment-to-GDP ratio, current-account-to-GDP ratio, bank credit to the non-financial private sector and returns on housing, equities, bonds and bills. The real GDP per capita, population, CPI, investment-to-GDP ratio and current-account-to-GDP ratio are taken from the IMF World Economic Outlook. Short-term interest rate and long-term interest rate are taken from IMF International Financial Statistics. Bank credit to the non-financial private sector is taken from BIS. Country-level annual equity indexes are from MSCI country indexes. Annual real equity capital gains are calculated based on annual equity indexes and annual CPI. The house price indexes are taken from Federal Reserve Bank of Dallas International House Price Database. They are expressed in real terms using the personal consumption expenditure (PCE) deflator of the corresponding country with the same base year of 2005=100.

## 2.4 The causal relationship between Stock Participation and Housing Prices

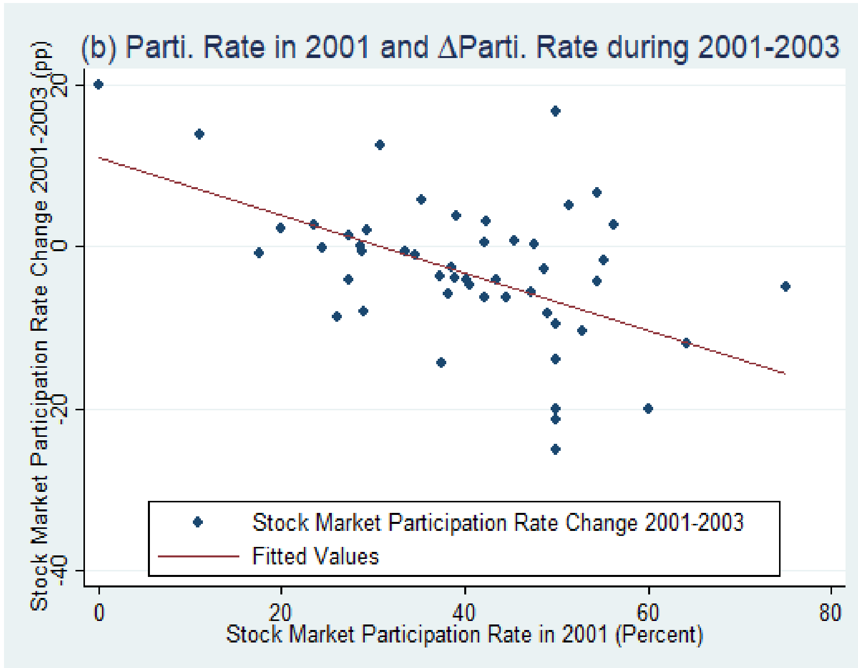
Table 2.1: Stock Market Participation and Mean Stock Holdings of Participants during 2001-2005

| | Year 2001 | Year 2005 | Growth 2001-2005 |
|---|---|---|---|
| MSCI U.S Stock Market Index | 1250 | 1138 | -9% |
| Mean Stock Holdings of Participants | $297.44 | $270 | -9.1% |
| Stock Market Participation Rate | 49% | 44.4% | -9.4% |

”Mean Stock Holdings of Participants” includes both direct stock holdings and indirect stock holdings. Its unit is ”Thousand of 2019 dollars”.”Stock Market Participation Rate” includes both direct stock holdings and indirect stock holdings.
Source: Survey of Consumer Finance (SCF), The Panel Study of Income Dynamics (PSID), MSCI Stock Market Indexes

In this section, I investigate the causal relationship between the stock market participation rate and housing prices using U.S. state-level data. In the theoretical model, the exogenous shock is the stock market return. Here, I use the stock market participation rate instead of stock market returns, because there was no variation in stock market returns at the state level. As shown in the model, the stock market returns affect the housing prices by affecting the households' portfolio share on stocks. The aggregate portfolio share on stocks is determined by both extensive margin (i.e., stock market participation rate) and intensive margin (i.e., the portfolio share on stocks conditional on participation).As shown in Table-1, intensive margin was largely driven by the movements of stock prices. To tease out the change in households' portfolio share on stocks that was driven by households' portfolio reallocation, the exogenous shock in this part is the extensive margin of households' stock market investment (i.e., stock market participation rate).

Figure 2.2: U.S. Stock Market Participation Rate




This figure plots the scatter plots of the change in state-level stock market participation rate during 2001-2003 and the state-level stock market participation rate in 2001.
Source: The Panel Study of Income Dynamics (PSID)

As shown in Table 2.1, the U.S. aggregate stock market participation rate dropped by 9.4 percent during 2001-2005. Figure-2.2 shows the correlation between the change in state-level stock market participation rate during 2001-2003 and the state-level stock market participation rate in 2001. It indicates that a state with a higher stock market participation rate in the initial year, 2001, is more likely to experience a larger drop in stock market participation rate, during 2001-2003. This fact motivates the instrument variable in section 2.4.1.

### 2.4.1 Framework

The goal of the empirical analysis in the section is to estimate the causal relationship between the stock participation rate during 2001-2003 and housing prices immediately (i.e., 2001-2003) and in the medium-run horizons (i.e., between 2001 to 2004, 2005, 2006). I relate the growth of housing price $\Delta_{2001,2003+n} ln(h_j), n = 0, ..., 3$ between 2001 to 2003 (2004, 2005, 2006) at state j, measured in percent, to the change in stock market participation in the same period, $\Delta_{2001-2003} Participation_j$, measured in the percentage points. The model specification is

$$\Delta_{2001,2003+n} ln(h_j) = \alpha_n + \gamma_n \Delta_{2001-2003} Participation_j + \Pi_n^{'} X_j + \epsilon_{i,n} \tag{2.1}$$

where $\Delta_{2001,2003+n} ln(h_j) = ln(h_{j,2003+n}) - ln(h_{j,2001}), n = 0, ..., 3$ indicates the housing price growth in state j between 2001 and 2003 (2004, 2005, 2006), $\Delta_{2001-2003} Participation_j = Participation_{j,2003} - Participation_{j,2001}$ indicates the change in stock participation rate in state j between 2001 and 2003. $X_j$ collects included covariates. $\gamma_n$ and $\Pi_n$ are coefficients. $\epsilon_{i,n}$ contains unmodeled determinants of the outcome variable.

Let $\widehat{\gamma_n}$ and $\widehat{\pi_n}$ denote the coefficients from treating $\epsilon_{i,n}$ as unobserved and equation (2.1) as Jorda (2005) local projection to be estimated by OLS. This local projection setup allows the model to estimate not only the immediate effects but also medium-run effects of stock market participation on housing prices.

Identifying $\gamma_n$ from equation (2.1) is challenging because there might be reverse causality: The housing prices affect households' stock market participation (Yao, 2005). I overcame this challenge by using an instrument variable. I use the stock market participation rate in the initial year (i.e., 2001) as the instrument variable of the change in the stock market participation during 2001-2003. The stock market participation decline during 2001-2003 was due to investors' pessimistic belief.[9] This panic scenario distinguishes the setting here from other stock market participation literature that focus on economics characteristics such as macroeconomic fundamentals and households' wealth.

Intuitively, if the stock market participation rate decline by the same percent across states, a state with a higher stock market participation rate in the initial year (i.e., 2001) is more likely to experience a larger drop in stock market participation, measured in percentage points, during 2001-2003, as shown in Figure-2.2. This instrument variable provides a measure of the change in state-level stock market participation driven by the aggregate stock market crash. It is independent of the housing price growth and changes in other local macroeconomic variables during 2001-2003.

### 2.4.2 The instrument is relevant

I estimate the following IV local projection.

$$\begin{aligned}\Delta_{2001,2003+n} ln(h_j) =& \alpha_n + \theta_n \Delta_{2001-2003} \widehat{Participation}_j \\ & + \Omega_n^{'} X_{j,2001} + \Phi_n^{'} X_{j,2001-2003} + \epsilon_{j,n}, \end{aligned} \tag{2.2}$$

which can be compared to the OLS form at (2.1), $X_{j,2001}$ collects included state-level characteristics determined as of year 2001, $X_{j,2001-2003}$ collects included state-level macroeconomic variables determined during 2001-2003, and where the estimates of $\Delta_{2001-2003}\widehat{Participation}_j$ come from the first stage regression:

[9] The growth of U.S. real GDP during 2000-2003 was positive, although it was lower than its long-term trend. In the meantime, Vissing-Jorgensen (2003) found that stock market prices and expected returns move together positively during the years, 1998-2002.

$$\Delta_{2001,2003}\widehat{Participation}_j = \alpha + \delta Participation_{j,2001} + \Lambda^{'} X_{j,2001} + K^{'} X_{j,2001-2003} + \nu_j \tag{2.3}$$

As a first check, I evaluate the strength of the instrument. I estimate the first stage regression of expression (2.3). The following Table-2.2 shows the results.

Table 2.2: First Stage, Regression of $\Delta_{2001-2003}Participation_j$ on $Participation_{j,2001}$ and other regressors

| | Without Controls | With Controls |
|---|---|---|
| IV Coefficient | **-0.3549*** ** | **-0.5824*** ** |
| | (0.0902) | (0.118) ) |
| R-square | 0.24 | 0.418 |
| F-statistics | 15.48 | 24.343 |
| Observations | 51 | 47 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The dependent variable is the change in participation rate during 2001-2003 (percentage points) regressed on the level of participation rate in the year 2001 and controls. The vector of control variables includes (i) the average age of household heads in 2001; (ii) the average total wealth with property in 2001; (iii) price level growth during 2001-2003; (iv) real per-capita disposable income growth during 2001-2003; (v) employment-to-population ratio growth during 2001-2003; (vi) population growth during 2001-2003.

It shows that states with larger than average stock market participation rate in the year 2001 was predictive of a larger than average drop in the stock market participation during 2001-2003.

### 2.4.3 Validity of the Instrumental Variable Estimation

The identifying assumption is that if the instrumental variable satisfies the standard exclusion restriction: $E(\Delta_{2001-2003}Participation_j * \epsilon_j) = 0$ The equation is immediately satisfied if stock market participation rates in the initial year (2001) are randomly assigned, but it does not require it.

The less restrictive requirement is that the instrument will be valid if the stock market participation rates in the initial year (i.e., 2001) are uncorrelated with the unobservable location-level characteristics that determine housing prices growth during 2001-2003. The identifying assumption is that stock market participation rates in the initial year (i.e., 2001) did not sort to locations such that location characteristics were correlated with both stock market participation rates in the initial year (i.e., 2001) and housing prices growth during 2001-2003. One example of problematic sorting is that if more households participated in stock markets in the states that experienced faster housing price growth before 2001. The states that experienced faster housing price growth before 2001 are more likely to witness faster housing price growth during 2001-2003 because housing prices are auto-correlated (Kuchler et al. 2022). However, to the extent that the housing prices growth before 2001 are observable, it is possible to test for systematic sorting to address this concern. In the Appendix Part 2.8.2, I show the correlation between equity share in the initial year (i.e., 2001) and the housing price growth during 1996-2001. The results show that the housing price growth during 1996-2001 does not significantly affect equity share in the initial year (i.e., 2001).

### 2.4.4 Threats to Identification and Motivation for Covariates

A large literature has been trying to explain the "participation puzzle". It finds that participation in stock markets is increasing with wealth (Guiso et al. 2013). Also, age affects stock market participation (Chodorow-Reich et al. 2021). At the same time, housing choices depend significantly on age and net worth (Piazzesi et al. 2016). I include wealth and age into control variables vector $X_{j,2001}$ because they were correlated with both stock market participation rates in the initial year (i.e., 2001) and housing prices growth during 2001-2003.

Also, I include some variables that measure the change in local macroeconomics characteristics during 2001-2003 into the control variables vector $X_{j,2001-2003}$ because they were correlated with both stock market participation (Chodorow-Reich et al. 2021) and housing prices (Mian et al. 2020). These variables include CPI growth rate, the growth rate of per capita disposable personal income, the growth rate of employment-to-population ratio, and the growth rate of population. In addition, I include the pre-trend of housing price growth before the dot-com crisis into the control variables in the robustness (see Table-2.4) because it is strongly correlated with local housing prices during 2001-2006 (Piazzesi et al. 2016), and it is potentially correlated with the stock market participation rates in the initial year (i.e., 2001).

My identifying assumption is that after the dot-com bubble crash, areas with sharper decline in stock market participation rate do not experience unusually rapid housing price growth—conditional on the included covariates—for reasons other than the households asset allocation channel.

### 2.4.5 Results of IV Local Projection

Figure-2.3 and Table-2.3 present the Local projection housing prices responses for a 1 pp decline in stock market participation rate during 2001-2003. The results show that the decline in the stock market participation during 2001-2003 driven by the dot-com bubble crash increased housing prices immediately (i.e., 2001-2003) and in the medium-term (i.e., between 2001 and 2004, 2005, and 2006). It indicates that the dot.com stock market crash persistently increased the housing prices during the housing boom 2000-2006, although the stock market began to rebound in 2003. I report additional robustness along a number of dimensions, including (i) using a OLS specification (ii) IV without control variables (iii) controlling for debt-to-income ratio (iv) controlling for the pre-trend of housing prices (i.e.,housing prices growth during 1996-2001) and the housing supply elasticity. Table-4 reports the results of robustness. The conclusion is robust to a variety of model modifications. What is the micro-foundation of the story? Was the increase in housing prices driven by housing market investors (i.e., second-house buyers) or first-house buyers? I will discuss them in Section 2.5 and Section 2.6, respectively.

## 2.5 Housing Market Investors

Local housing market investors amplified the housing boom and bust (Mian and Sufi, 2022). Figure-2.4 panel (a) shows the investor share[10] in the U.S. housing market. The investor share doubled during the housing boom (2000-2006). Then it be-

[10] The investor share is defined as the fraction of family-owned houses that are not owner-occupied.

Table 2.3: Responses of Housing Prices to 1 pp Decline in Stock Market Participation during 2001-2003

| | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|
| Housing Prices Response (percent) | **0.223**** | **0.433**** | **0.714**** | **1.033**** |
| | (0.1) | (0.171) | (0.299) | (0.406) |
| Observations | 51 | 51 | 51 | 51 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results of IV(2SLS) estimation were shown. The dependent variables are the housing price growth (percent) between 2001 and 2003(2004, 2005 and 2006). The dependent variables are regressed on the estimated change in stock participation rate during 2001-2003 (estimated from the first stage) and controls. The vector of control variables includes (i) the average age of household heads in 2001; (ii) the average total wealth with property in 2001; (iii) price level growth during 2001-2003; (iv) real per-capita disposable income growth during 2001-2003; (v) employment-to-population ratio growth during 2001-2003; (vi) population growth during 2001-2003.

gan to decline in 2006 when the housing price started to decline. In addition, Figure-2.4 panel (b) shows that the states experienced a faster increase in investor share during 2001-2006 also experienced a larger decline in investor share during 2006-2010. It provides further evidence that investors amplified the housing boom and bust. The goal of this section is to estimate the causal relationship between the stock market participation and the investor share. I relate the change in investor share $\Delta_{2001,2003(2006)} Investor_j$ between 2001 to 2003 (2006), at state j, measured in percentage points, to the change in stock market participation in the same period, $\Delta_{2001,2003} Participation_j$, measured in the percentage points. As in Section 2.4, I use the state stock market participation rate in the initial year (i.e., 2001) as the instrument variable of the change in the stock market participation during 2001-2003.

Table 2.4: Robustness: Responses of Housing Prices 2001-2003 (percent) to 1 pp Decline in Stock Market Participation during 2001-2003

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Specification | OLS | IV w/o cont | IV w/ debt | (3)+trend+ supply |
| HP Response (01-03) | **0.19**** | **0.3*** | **0.23**** | **0.299***** |
| | (0.076) | (0.158) | (0.092) | (0.099) |
| R-square | 0.41 | 0.04 | 0.41 | 0.47 |
| Observations | 51 | 51 | 51 | 47 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

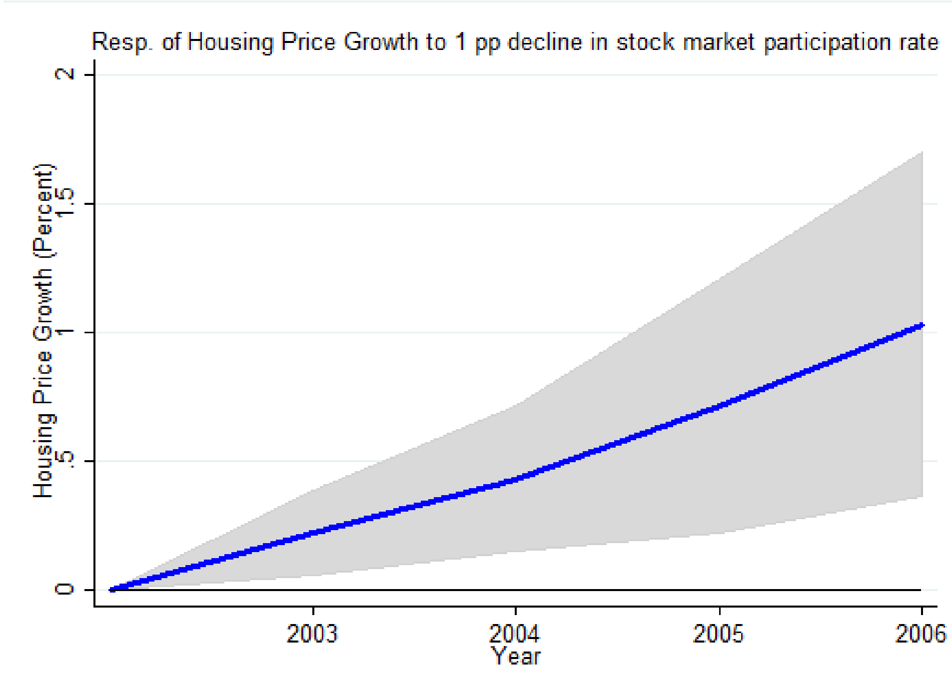
The dependent variables are the housing price growth (percent) between 2001 and 2003. In the baseline specification (IV-2SLS), the dependent variables are regressed on the estimated change in stock participation rate during 2001-2003 (estimated from the first stage) and controls. The vector of control variables includes (i) the average age of household heads in 2001; (ii) the average total wealth with property in 2001; (iii) price level growth during 2001-2003; (iv) real per-capita disposable income growth during 2001-2003; (v) employment-to-population ratio growth during 2001-2003; (vi) population growth during 2001-2003. In specification (3), "debt" refers to state-level debt-to-income ratio growth during 2001-2003. The controls in specification (4) include the variables in specification (3), housing price growth during 1996-2001 (i.e., HP 96-01), and state-level housing supply elasticity (i.e., supply).

Like equation (2.2), I estimate the following IV local projection.

$$\Delta_{2001,2003(2006)} Investor_j = \tau_s + \rho_s \Delta_{2001-2003} \widehat{Participation}_j + E_s^{'} M_{j,2001} + H_s^{'} M_{j,2001-2003} + \varpi_{j,s} \qquad (2.4)$$

where $\Delta_{2001,2003(2006)} Investor_j = Investor_{j,2003(2006)} - Investor_{j,2001}$ denotes the change in investor share between 2001 to 2003 (2006), at state j, measured in percentage points, $M_{j,2001}$ collects included state-level characteristics determined as of year 2001, $M_{j,2001-2003}$ collects included state-level macroeconomic variables determined during 2001-2003, $\rho_s$, $E_s^{'}$, and $H_s^{'}$ denote coefficients, s=2003 and 2006, and where the estimates of $\Delta_{2001-2003} \widehat{Participation}_j$ come from the first stage regression:

Figure 2.3: Response of Housing Price to 1 pp decline in Stock Market Participation Rate

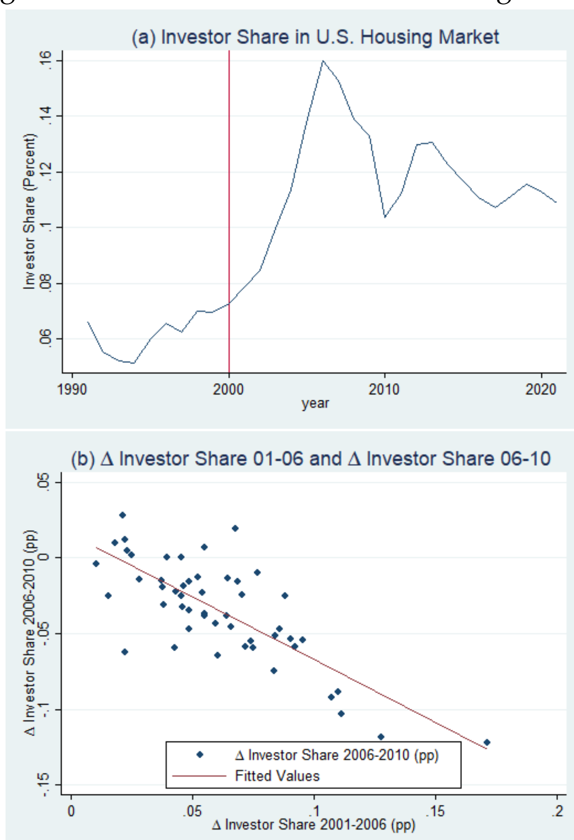



Local projection responses for a 1 pp decline in stock market participation rate. The shadow area shows 90% confidence intervals.

$$\Delta_{2001,2003}\widehat{Participation}_j = \alpha + \varrho Participation_{j,2001} + A^{'} M_{j,2001} + B^{'} M_{j,2001-2003} + \o_j \quad (2.5)$$

Table-2.5 reports the results from estimating equation (2.4). The results show that 1 percentage point decline in stock market participation rate during 2001-2003 was associated with 0.06 percentage point increase in housing market investor share during 2001-2003, and 0.12 percentage point increase in housing market investor share during 2001-2006. It indicates that housing market investors' speculation is a channel through which stock market participation affects the housing market.

Figure 2.4: Investor Share in U.S. Housing Market




The left figure plots the investor share in the U.S housing market during 1991-2021. The investor share is defined as the fraction of family-owned houses that are not owner-occupied. The right figure plots the scatter plots of the (percentage points) change in state-level housing market investor share during 2001-2006 and the change in state-level housing market investor share during 2006-2010.
Source: The Home Mortgage Disclosure Act (HMDA)

Table 2.5: Responses of Investor Share to 1 pp Decline in Stock Market Participation during 2001-2003

| | 2001-2003 | 2001-2006 |
|---|---|---|
| Investor Share Response (percentage points) | **0.059*** | **0.12*** |
| | (0.0334) | (0.069) |
| Centered R-square | 0.3 | 0.42 |
| Observations | 47 | 47 |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The dependent variable is the change in invest share (percentage points) regressed on the change in stock market participation rate during the year 2001-2003 and controls. The vector of control variables includes (i) the average age of household heads in 2001; (ii) the average total wealth with property in 2001; (iii) the average total wealth without property in 2001; (iv) housing supply elasticity; (v) housing price growth during 1999-2001; (vi)real per-capita disposable income growth during 2001-2003; (vii) employment-to-population ratio growth during 2001-2003; (viii) change in house ownership rate during 2001-2003.

## 2.6 Household-level Empirical Analysis

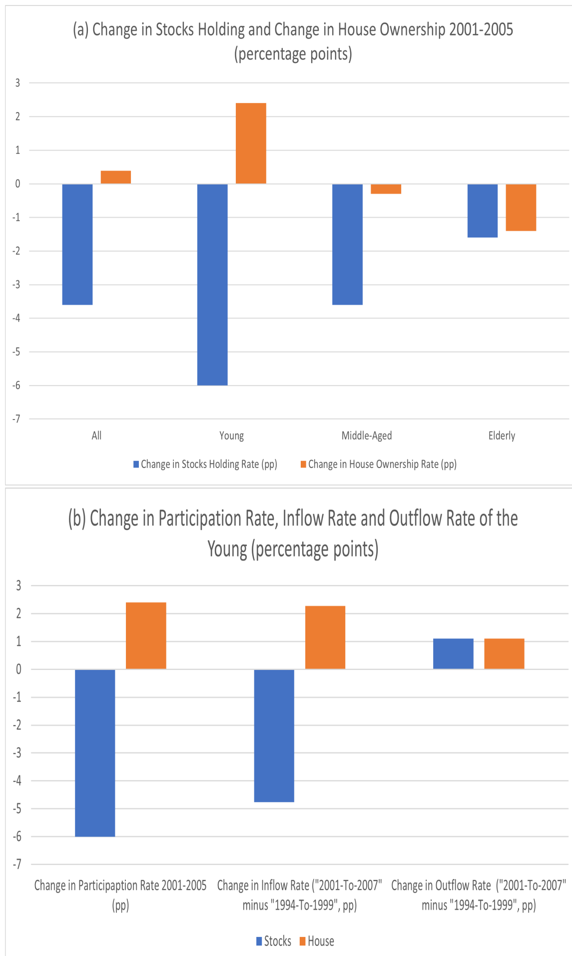
### 2.6.1 Trends of Aggregate Home-ownership Rate and Stocks Participation Rate

To study households who buy houses as principal dwelling, at first, I show some facts.

Figure-2.5 Panel (a) shows the change in the aggregate home-ownership rate and stocks participation rate of the U.S. during 2001-2005. The stocks participation rate dropped a lot, it fell by 3.6 pp during this period. The aggregate home-ownership rate did not change much, it grew by only 0.4 percentage points. Previous literature also finds that the housing boom in the early 2000s was not associated with increases in home-ownership rates (see Acolin et al. 2016, Foote et al. 2016, and Adelino et al. 2017).

Also, Figure-2.5 Panel (a) shows that the decline in aggregate stocks participa-

Figure 2.5: Change In Stocks Holding, House Ownership and The Inflow Rate of The Young




The left figure shows the change in stocks holding rate and in house ownership rate during 2001-2005 (percentage points). The right figure shows the (percentage points) change in participation rate, inflow rate and outflow rate in the stock market and housing market of the young. The total sample are the households (from PSID) whose head's age is between 26 and 85. I divide total households into three groups (the young, the middle-aged and the elderly) according to the age of the household's head: I construct three age quantiles for each year. That means, the range of ages for each age group varies for each year.
Source: Panel Study of Income Dynamics (PSID) and author's calculation.

tion rate was driven by the young. The change in home-ownership rates were heterogeneous across age groups. The home-ownership of the young increased, but that of the elderly declined. That means, after the dot-com bubble crash, more young households owned houses and fewer young households held stocks. At the same time, less elderly households owned houses. These facts indicate that there was a substitution between housing and stocks in the young households' portfolio after the Dot.com bubble crash.

Figure-2.5 Panel (a) indicates that the young households play an important role in the substitution between housing and stocks. Are the changes in the young households' stock market participation rate and home-ownership rate driven mainly by outflow or inflow into the pools, respectively? To investigate this, I next compute transitions of stocks and housing tenure of the young in two periods:1994-1999 and 2001-2007. Figure-2.5 Panel (b) shows the results.

Two findings emerge. First, the sharp decline of the stock market participation of the young was mainly driven by the inflows (i.e., non-participation to participation transitions). The "non-participation to participation rate" of the young dropped by 4.77 percentage points (31 percent) after the dot-com bubble crash. Second, the increase in the home-ownership of the young was also mainly driven by the inflows (i.e., renter to owner transitions). This finding is consistent with previous literature. Ma and Zubairy (2021) finds that the variations in the home-ownership rates are relatively large for the young, which is mostly driven by renter-to-owner transitions during 1995-2015. These results indicate that, compared with the period 1994-1999, more young people entered the housing market and fewer young people entered the stock market after the dot-com bubble crash.

### 2.6.2 A bivariate probit models of stock market and housing market inflow

The facts in Section 5.2 indicate that the renter-to-owner transitions (especially the young) drove the home-ownership rate after the dot-com bubble crash. Motivated by these facts, I estimate the causal relationship between the state-level stock market participation and the housing market renter-to-owner transitions probability, relying on a bivariate probit model. I use the panel data from the 1994-1999 and 2001-2007 PSID. I pooled the sample from the two time periods (1994-1999 and 2001-2007).

The samples I observe are the households who were not house owners at the beginning of each period (1994 or 2001). Dependent Variables $Y_{i,s,t}$ denote if house renter i from state s turned into house owner during the period t (1994-1999 or 2001-2007). $Y_{i,s,t}$ is a dummy variable. Each is generated by a probit equation. Thus, I have the following model:

$$\begin{aligned} Y^*_{i,j,t} =& X_{i,j,t}\beta + \beta_{Crisis} * Crisis_t + \beta_{Participation} * \Delta Participation_{j,t} \\ &+ \beta_{interaction} Crisis_t X \Delta Participation_{j,t} + \alpha_j + \epsilon_{i,j,t} \end{aligned} \tag{2.6}$$

where $Y^*_{i,j,t}$ are unobservable, and are related to the binary dependent variables $Y_{i,j,t}$ by the rule:

$$Y_{i,j,t} = \begin{cases} 1, Y^*_{i,j,t} > 0 \\ 0, Y^*_{i,j,t} \leqslant 0 \end{cases}$$

$X_{i,j,t}$ denotes a vector of control variables, $Crisis_t$ denotes a post-crisis time dummy variable, it equals 0 (1) for the period 1994-1999 (2001-2007), $\Delta Participation_{j,t}$ denotes the percentage points change in the stock market participation rate of state j during the period t. $\alpha_s$ denotes state fixed effect, $Crisis_t X \Delta Participation_{j,t}$ denotes the interaction term of $Crisis_t$ and $\Delta Participation_{j,t}$, $\beta$, $\beta_{Crisis}$, $\beta_{Participation}$, and $\beta_{interaction}$ denote the coefficients.

There is a natural exclusion restriction in my research design because state-level stock market participation is an aggregate level variable and housing market inflow probability is household level variable. My identifying assumption is that the aggregate-level variables affect the household-level variables, but the household-level variables cannot affect the aggregate-level variables. Identification of this exercise does not rely on the function form of the probit model.

Results from the bivariate probit model of housing market inflow show that the interaction term of post-crisis-time dummy and change in the state level stock market participation rate is significantly positive, only for the young. That means, the effects of state-level stock market participation on the housing market inflow probability were heterogeneous over time and across age groups. A decline in the U.S. state-level stock market participation was associated with a higher housing market inflow

Table 2.6: Bivariate Probit of housing market inflow across all accounts: 1994-1999 and 2001-2007 PSID

| | (a) Young | | (b) Middle-Aged | | (c) Elderly | |
|---|---|---|---|---|---|---|
| | Coeff. | S.E. | Coeff. | S.E. | Coeff. | S.E. |
| $Crisis_t$ | 0.026 | 0.135 | 0.067 | 0.19 | 0.061 | 0.27 |
| $\Delta Participation_{j,t}$ | 1.13 | 1.61 | 1.54 | 2.58 | -2.93 | 3.02 |
| $Crisis_t X \Delta Participation_{j,t}$ | **-6.33**** | 2.58 | 1.13 | 4.22 | 0.47 | 6.12 |
| Observations | 759 | | 383 | | 258 | |
| R-squared | 0.148 | | 0.197 | | 0.28 | |

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

$Crisis_t$ is post-crisis time dummy, it equals 0 (1) for the period 1994-1999 (2001-2007). $\Delta Participation_{j,t}$ refers to the change in state level stock market participation rate (pp) during 2001-2003. $Crisis_t X \Delta Participation_{j,t}$ refers to the interaction term of $Crisis_t$ and $\Delta Participation_{j,t}$. The control variables include household income, wealth without property, home property value, gender of head, education (college) of head, number of children, own business/farm, location (rural), unemployed, married, retired, house ownership in the initial year, age group, and state-level land supply elasticity. The total sample are the households (from PSID) whose head's age is between 26 and 85. I divide total households into three groups (the young, the middle-aged and the elderly) according to the age of the household's head: I construct three age quantiles for each year. That means, the range of ages for each age group varies for each year.

probability, only for the young, and only for the period after the dot-com bubble crash (2001-2007).[11] Intuitively, the dot-com bubble crash changed the young's belief about the stock market. They moved to the housing market when they forecasted the housing market return would be higher than stock market return. This finding is consistent with some previous literature. Hurst (2018) argues that it was young individuals with a bachelor's degree or more that experienced the biggest shifts in home-ownership rates during the early 2000s housing boom period. Also, the heterogeneous effects on the housing market over time indicate that investors treated houses as alternative investment vehicles of stocks only when housing was booming.

[11] I also tested the joint significance of $\Delta Participation_{j,t} + Crisis_t X \Delta Participation_{j,t}$ for the young. It is significantly negative at a significance level of 0.05.

## 2.7 Discussion and concluding remarks

This chapter provides some empirical evidence to support the ”Household Asset Allocation View” proposed in the Chapter One. This article uses a salient historical setting to explain why this kind of cross feedback from the stock market to the housing market happens during the early 2000s. The real world in the early 2000s serves as a laboratory where there is a “triple coincidence”. First, the dot-com bubble made the stocks less attractive for households. Second, the low interest environment made the government bond less attractive and led to significantly higher allocations to risky assets (Lian, Ma and Wang, 2019). Third, the steady housing prices growth during 1995-2000 made households be more optimistic about housing and would like to invest more in housing. The “triple coincidence” generates the negative correlation between housing and stocks in the early 2000s. The housing market initiated the Global Financial Crisis (GFC). Thus, the GFC is endogenously connected to the previous crisis, the dot-com bubble crash.

# Chapter 3

# International Capital Flows

## 3.1 Introduction

The global financial crisis of 2008 put financial linkages between countries at the center stage of many economic discussions among academics and policymakers. Understanding what drives international capital flows and, even more important, what leads to their reversals is key to predicting, preventing, and mitigating consequences of financial crises. Literature on emerging market crises has grappled with this question, but the involvement of advanced economies during the global financial crisis and growing financial interconnectedness of the world made it a mainstream question.

The literature analyzing, predicting, and modeling international capital flows is vast, and since 2010 it has brought together fields of international economics, macroeconomics, and finance. This article does not attempt to provide a full literature review or to cite all key papers. Instead, we refer the reader to recent survey articles and primarily discuss new studies published since 2010. The nature, patterns, and composition of international capital flows change quite rapidly over time, due to financial liberalization in many emerging markets, increasing trade linkages, changes in monetary policy frameworks, and major events, such as the introduction of the euro or worldwide financial crises. Together with these changes, economists' understanding of drivers of capital flows and of policies that may be useful to stabilize them also evolves.

Empirical analysis of international capital flows is probably one of the most challenging empirical questions in international economics due to scarcity and complexity of the data. Studies that rely on different data sources tend to produce conflicting results because patterns change depending on the set of countries in consideration, time periods, financial instruments and markets analyzed, and the level of aggregation. Because data availability is such a key issue in understanding international capital flows, our discussion begins with the description of data challenges and available data sources. The National Bureau of Economic Research (NBER) hosts a special data sharing page and a data sharing session during its Summer Institute that focuses on the data pertaining to this and other empirical questions in international macroeconomics.

We then turn to describing generally accepted stylized facts about dynamics and patterns of international capital flows. We describe long-term trends, cross-country differences, volatility, and instrument and currency composition of capital flows. We proceed with summarizing empirical literature on determinants of these stylized facts. While there is no uniform explanation for all the observed patterns and dynamics, we highlight the areas in which there is a well-established consensus: the importance of gravity variables, push and pull factors, global financial cycles, extreme volatility of capital inflow and outflows to specific countries, role of capital controls, home bias, and interconnectedness. We also discuss the dearth of research and lack of clear consensus regarding drivers of the composition of international capital flows.

International capital flows present many theoretical challenges. The modeling of international investment decisions is complex from analytical and computational points of view. It is also difficult to explain more than a couple of stylized facts in a given theoretical framework. We describe these challenges and review advances in the theories of international capital flows. Successful models tend to be quite complex and incorporate elements such as productivity and preference shocks, imperfect information, or explicit modeling of the behavior of global financial intermediaries.

Finally, we discuss the timeless question of the desirability of free capital mobility for individual countries. Long-term history and textbook theory suggest that countries that close their financial accounts completely fail to benefit from access to global capital markets and therefore experience slower economic growth. At the same time, it is difficult to establish sizable economic gains from financial liberalization empirically or theoretically. While benefits from international capital flows are likely to accumulate slowly over time, costs of financial openness in terms of capital flow reversals and susceptibility to global shocks are immediate and apparent. The consensus has shifted from belief in free and open capital mobility to a more nuanced view that allows the use of capital controls and macroprudential policies to reduce the costs resulting from destabilizing volatility of international capital flows.

Improvements in data availability as well as empirical and theoretical advances provide a solid foundation on which future research can be built toward a more complete understanding of international capital flows. This will allow for better policies to prevent or mitigate financial crises and international financial contagion and to allow more macroeconomic autonomy for small open economies. Successful analysis will require continuing collaboration across fields of international economics, finance, and macroeconomics.

## 3.2 Data Sources

Documenting and empirically analyzing international capital flows is quite a challenge for a variety of reasons. While stocks of foreign claims and liabilities are usually recorded in the balance of payments data, these do not paint a complete picture. These data are generally formulated in terms of net-gross positions; that is, assets and liabilities are not netted out. Instead, the repayments are subtracted from the outstanding balances for each asset class or liability type. Moreover, all assets are valued at current market values. As a result, deducing capital flows from balance of payments stock data is a complex and imprecise undertaking. Moreover, balance of payments data do not usually provide breakdown by currency denomination or maturity, nor do they give information on institutions or sectors that issue or buy cross-border assets.

To supplement balance of payments data, researchers have relied heavily on data sources collected by international organizations, such as the Coordinated Portfolio Investment Survey (CPIS), provided by the International Monetary Fund (IMF), and International Banking Statistics (IBS), provided by the Bank for International Settlements (BIS). These databases, however, are limited to specific asset classes (portfolio debt and equity in the case of CPIS) or specific institutional investors (large banks in reporting countries in the case of IBS). Private data sources commonly used include EPFR Fund Flows and Allocation Data collected from mutual funds, Dealogic data on international bond issuance and cross-border syndicated bank loans, and Bloomberg data on bond issuance and secondary market transactions. Cerutti et al. (2015) provided analysis of the share of Dealogic's cross-border syndicated bank lending in total international banking flows reported in the IBS data.

There are also confidential data sources available to researchers at central banks and international financial institutions. Since these data cannot generally be shared, any crosscountry analysis relying on individual central banks' confidential information is impossible. To overcome this hurdle, the International Banking Research Network ¡https://www.newyorkfed.org/ ibrn¿ conducts coordinated studies across numerous central banks to address many questions in international banking in global context.

Additional difficulties arise due to the existence of offshore financial centers and tax havens that make it difficult to properly identify the nationalities of transacting parties, not only for individual transactions but also for aggregates that are based on a locational approach to accounting (as is the case with CPIS and locational IBS). Consolidated IBS and the latest improvements in the IBS data allow researchers to overcome this hurdle, but these data do not go as far back historically. Coppola et al. (2020) allowed for taking tax havens into account and properly allocating firms to the countries of their operations when working with firm-level data. Conceptually, the growing importance of multinational corporations makes country-level analysis even more complex.

The External Wealth of Nations project (EWN) pioneered by Philip Lane and

Gian Maria MilesiFerretti (2007) and regularly updated by the IMF combines all available data to paint the most complete picture possible. Other contributions include Kaminsky et al. (2020), which extended emerging markets' international capital flows data back to the early 1970s, and Bénétrix et al. (2019), which provided currency composition of external assets and liabilities.

## 3.3 Facts

International movement of capital has been documented since the late 19th century (Obstfeld & Taylor, 2003). The emergence of the classical gold standard in 1880–1914 gave rise to the first wave of international capital mobility. World War I disrupted this wave and, after a brief period of recovery of international capital flows in the interwar period, the international capital flows were brought to a halt by the Great Depression and World War II. A high degree of international capital mobility was not recovered until the early 1970s, after which international capital flows grew exponentially until the beginning of the global financial crisis that followed the collapse of the Lehman Brothers in the fall of 2008. The 200-year history of international capital flows is documented in Reinhart et al. (2016). Against the backdrop of long-term trends global capital markets as well as the individual economies and regions experienced a series of boom-bust cycles, which were described and analyzed by Kaminsky (2019).

Two developments in the global financial architecture had a profound impact on patterns of international capital flows. First was the introduction of the euro in 1999, and the second was the global financial crisis. The introduction of the euro created a new and vast single currency area, removed formal and informal barriers to international capital flows, and increased trade between member countries, leading to an increase in financial integration within the euro area (KalemliOzcan et al., 2010). This altered assessment and price of country risk for the countries on the periphery of the euro area. These developments led to important changes in the geography of international capital flows, producing a rapid increase in capital flows from global financial centers to the euro area periphery that was intermediated by commercial banks located in the core countries of the euro area (Acharya & Steffen, 2015; Hale & Obstfeld, 2016). The global financial crisis affected all aspects of international capital markets by demonstrating that advanced economies are not immune to financial crises, sovereign defaults, and international financial contagion. It also substantially altered banking regulation and financial stability policies around the world, including through the Basel III framework.

Historically, the focus of the literature on international capital flows was on countries' net positions (net borrowers and net lenders), but the importance of gross positions has been emphasized since the beginning of the 21st century. This is the case for two reasons: First, gross positions increased dramatically, even for countries with small net positions (the data from EWN shows that between 1995 and 2007 the ratio of global external assets to the world gross domestic product [GDP] increased from 70% to 240%); and second, large gross positions are important for international transmission of shocks, valuation effects of changes in asset prices and exchange rates, and ability of small open economies to conduct independent macroeconomic policies.

The gross positions tend to be very volatile for individual countries, especially emerging markets. Forbes and Warnock (2012) identified episodes of capital surges, stops, flights, and retrenchments for each country in their study. They showed the importance of global factors and only limited importance of domestic factors in explaining these extreme episodes. Yet, these episodes have profound effects on business cycles of individual economies. Take, for example, a "taper tantrum" episode in May 2013, when a sharp increase in the long-term U.S. Treasury rates led to a rapid reversal of capital flows to a number of emerging economies, starving their economies of access to global capital markets for investment and government debt financing (Nechio, 2014).

In terms of net positions, the fact remains that capital does not flow from rich to poor countries, but mostly from rich to rich countries (Wei, 2008). The United States, the United Kingdom, and much of Western Europe have become net borrowers in the global capital markets, while Japan, China, much of East Asia, and oil-producing countries are net lenders. Prior to the Global Financial Crisis of 2008-09, U.S. current account deficits and Japanese and Chinese current account surpluses reached such high levels that they gave rise to the discussion of "global imbalances" and the potential risks associated with them. The magnitude of these imbalances subsided, but the direction of net capital flows across countries remained much the same in the years after the crisis.

The least explored dimension of international capital flows is their instrument composition. There are a number of ways in which financial instruments can be categorized. The most common approach is to distinguish between debt and equity instruments. Equity instruments can be split into portfolio equity and foreign direct investments, although statistically the line between these two instruments is blurred. Debt instruments include cross-border bank loans and deposits as well as sales and purchases of bonds. Debt instruments can further be split into short and long term. In addition to these traditional asset classes, there is a large volume of global trade in currencies in spot and forward markets as well as active trade in other financial derivatives. Data on these transactions are very limited (one exception is a triennial survey published by the BIS, with the latest survey published in 2019 (BIS, 2019)) and there is very little empirical analysis of these markets.

Over the waves of financial globalization, different instruments played key roles at different times. For example, rapid accumulation of emerging market sovereign debt in the 1970s was achieved mostly through bank loans, while in the 1990s and more recently the bond market took the central stage. Eichengreen et al. (2018) showed the importance of understanding the instrument composition of international capital flows because their fickleness or stability vary substantially across instruments. Claessens's (2017) survey of the empirical literature found that long-term debt flows are less volatile and that foreign banks with larger presence, more domestic funding, and closer relationships provide more finance and share risks better. Moreover, while restrictions on capital flows have not historically been able to alter the total volume of crossborder transactions, they have been quite effective in altering their composition.

Since the introduction of the Bretton Woods System, the U.S. dollar became the dominant currency in international financial markets. Dollar dominance continued after the demise of the Bretton Woods System. Hale and Spiegel (2012) showed that the introduction of the euro, a currency with an equally large "home base," put only a small dent in the share of dollardenominated international bonds issued by private companies. Bénétrix et al. (2019) has documented currency composition for total external assets and liabilities for 50 countries between 1990 and 2017 and showed that the share of total external assets and liabilities of all types denominated in U.S. dollars was about 45% in 1990 and had declined to about 35% by 2017. Some of this decline was due to an increased share of euro-denominated external assets and liabilities compared to the combined share of the legacy currencies.

## 3.4 Empirical Evidence on Determinants of International Capital Flows

A vast empirical literature studies factors that determine international capital flows. Gourinchas and Rey (2014) surveyed the literature with the focus on valuation effects, global imbalances, and the allocation puzzle. It is clear that there is no uniform explanation for different time periods, different sets of countries, and different financial instruments. A few patterns do emerge, however. First, similar to the flows of goods and services, "gravity" factors, such as the size of the economy and physical, cultural, and economic distance between them, play an important role. Second, there are global "push" factors that help explain total cross-border capital flows globally and "pull" factors that explain inflow of capital into individual countries. The discussion of the push factors has morphed into a discussion of the global financial cycle and its drivers. Third, capital flows are volatile and are subject to sudden stops and rapid reversals, which could be triggered by rapid shifts in pull factors, global factors, or their combination. Fourth, from an optimal portfolio standpoint, there is a clear home bias in investment decisions. Fifth, the global financial network is increasingly interconnected and has a tiered structure.

A gravity framework is shown to explain international trade flows. The intuition is that larger economies will export and import more, and the greater the distance and the differences between countries the less they will trade. Physical transportation costs as well as legal and cultural trade barriers offer a ready explanation for such patterns. In the context of international capital flows, for which the gravity pattern was first documented by Portes and Rey (2005), the intuition is not as straightforward because no physical goods need to be transported. The most accepted explanations include costs of information acquisition and perceived risk of assets that increase with physical distance, as well as with legal, regulatory, and cultural differences. Similar reasoning applies to home bias observed in portfolio allocation decisions by wholesale and retail investors.

The role of push and pull factors is most clearly distinguishable in understanding patterns of capital flows to emerging markets. This is because major advanced economies' macroeconomic fundamentals that may be among pull factors tend to be closely correlated with global push factors. Koepke (2019) provided a survey of the literature studying determinants of capital flows to emerging markets. The survey revealed that the importance of push and pull factors depends on the instrument being analyzed. In particular, portfolio debt and equity flows are explained more by global factors, such as global risk aversion and global interest rates. However, banking flows are less responsive to global factors. Pull factors, such as the domestic output growth rate, rate of return on assets, and measures of country risk, matter for all capital flows considered, but they are relatively more important for banking flows. While recent literature shows a diminishing explanatory power of pull factors, this analysis mostly applies to noncrisis periods. Evidence clearly shows that sovereign debt crises and currency crises lead to a major disruption in firms' access to global capital markets that may last as long as two years (Arteta & Hale, 2008; Hale & Arteta, 2009).

One important breakthrough in understanding the drivers of international capital flows is the discovery of the "global factor" that is responsible for much of the patterns observed in recent decades. The global factor arises very prominently as a driver of international capital flows and appears to be highly correlated with a number of financial indicators in the United States, such as the Chicago Board Options Exchange's volatility index (the VIX). The importance of the global factor—or global financial cycle—is still a subject of debate in the literature. Some studies show that the global financial cycle is the only factor that has a substantial role in explaining capital flow patterns, while others show that the global factor only has a limited role. More nuanced studies point out that the importance of the global factor varies over time, across countries, and across the financial instruments in question.

Special attention in the literature is devoted to the impact of the U.S. monetary policy on international capital flows. Empirical literature shows no consensus because this impact is quite nuanced. For example, Avdjiev et al. (2020) showed that the role of U.S. monetary policy as a global factor increased substantially after the global financial crisis, but the patterns differ across financial instruments. For banking flows, Avdjiev and Hale (2019) showed that over the previous three decades the impact of U.S. monetary policy on international bank lending varied depending on the reason for monetary policy rate change, on destination of bank flows, and on the time period.

They found that during international bank lending booms, the relationship between the federal funds rate and cross-border bank lending is positive and mostly driven by the macroeconomic fundamentals component of the federal funds rate. During stagnation episodes, the relationship between the federal funds rate and bank lending is negative, mainly due to the monetary policy stance component of the federal funds rate. The latter set of results is most pronounced for lending to emerging market economies.

Emerging markets' experience with sudden stops demonstrates the unreliable nature of international capital flows. It has become clear that capital flows to advanced economies are also unreliable. Volatility in international capital flows and related asset price movements have real macroeconomic effects on target markets as well as financial institutions worldwide. Focus on gross flows is key to understanding underlying factors. Forbes and Warnock (2012) documented four types of extreme events in capital flow dynamics: surges (or rapid increases in capital inflows); sudden stops (or reversal of capital inflows); flight (or rapid increase in capital outflows); and retrenchment (or reversal of capital outflows). While different factors explain different types of these extreme episodes, the authors found that global risk is important for all of them. Financial contagion plays an important role for stops and retrenchments, while domestic factors are less important.

Not all financial instruments are equally volatile, however. Eichengreen et al. (2018) analyzed capital flows since the 1990s and found that foreign direct investment (FDI) inflows are more stable than non-FDI inflows. Among non-FDI inflows, portfolio debt and bank-intermediated flows remain the most volatile. They also pointed out the important role that debt instruments' maturity plays in their susceptibility to sudden stops.

There are only a handful of studies that focus specifically on determinants of instrument and currency composition of international capital flows, which remain difficult to pin down. To the extent that pull factors have different effects on different financial instruments, they have impact on the composition of capital flows (Hale, 2007), but the effect of pull factors in normal times is relatively weak. Currency composition, in contrast, is driven to some extent by global financial developments, such as the introduction of the euro (Hale  Spiegel, 2012) and the global financial crisis (Hale et al., 2020). The most persistent stylized fact remains that most economies are still unable to borrow internationally in their own currencies, the phenomenon dubbed "original sin" by Eichengreen and Hausmann (1999).

Capital controls are policies designed to restrict or otherwise alter international capital flows. However, the literature has shown time and time again that the total amount of capital flows tends to not be affected by capital controls. Capital controls (and some macroprudential policies) do affect instrument and maturity composition of capital flows and also have distributional effects by temporarily constraining access to capital for small and medium firms. Magud et al. (2018) surveyed over 30 empirical studies and found that controls on capital inflows alter the composition of capital flows, while they do not reduce the volume of net flows. Controls on capital outflows do not seem to have any effect, with the exception of a unique case in Malaysia.

Globalization of capital flows brought with it globalization of financial intermediaries, such as global banks, and led to increased global interconnectedness of financial institutions and markets. This interconnectedness is hard to document at the institutional level because, with the exception of limited banking data, there is generally no information on both sides of an international financial transaction. However, some progress has been made in the literature to map international financial networks. The topology of these networks provides additional insight into patterns of international capital flows.

At the country level, financial interconnectedness increased substantially between 2000 and 2007 and is widely thought to have contributed to a rapid spread of the global financial crisis. Hale (2012) showed that financial crises at the country level stall the growth of the global financial network by temporarily halting formation of new bank linkages. The global financial crisis of 2008–2009 was a great example of the lack of formation of new linkages as well as the destruction of the existing ones. Following the crisis, some, albeit slow, recovery of international financial linkages was observed. There is evidence that financial interconnectedness at the country level is a tiered system, with key financial centers at the center of the global network linked to regional financial centers to which other countries then link up.

The global banking network exhibits a similar tiered pattern (Craig & Von Peter, 2014). Global banks are closely interlinked with each other, forming the core of the global banking system. These are banks that are designated to be global systemically important financial institutions (GSIFI). These banks are closely linked with large regional banks that intermediate the flow of capital from the core of the network to national banks on the periphery. To the extent that banks engage in trading on portfolio debt and other asset markets, a similar pattern can be observed in their bond purchases.

## 3.5 Models of International Capital Flows

The textbook economic model will predict that capital should flow from rich countries that have more capital, and therefore lower return on capital, to poor countries with less capital and higher return on capital (Lucas, 1990). A dynamic version of this statement is that more capital should flow into countries with higher productivity growth. As previously noted, however, this is not the predominant pattern of international capital flows. This discrepancy is frequently referred to as an "allocation puzzle" in international economics (Gourinchas & Jeanne, 2013). Many explanations have been offered for the puzzle. These include institutional barriers to investing in poor countries, risks, various aspects of investors' behavior, and, of course, home bias in investment decisions.

Another theoretical challenge arises from the fact that most canonical models have predictions about net capital flows between countries but fail to pin down or even explain patterns and dynamics of gross capital flows. The simple explanation of interest rate differentials between countries fails to explain bidirectional gross capital flows, fluctuating volumes of these flows, or the boom-bust cycles at both the global and the country level. Apart from international risk sharing, it is not easy to find an explanation for growing external assets and liabilities in many countries, and risk sharing alone fails to produce the patterns of international capital flows observed in the data. Tille and Van Wincoop (2010) described challenges that arise in modeling portfolio choices and gross capital flows and offered methodology to address them.

A recent explanation that matches the data well is based on return on capital.

Colacito et al. (2018) combined the Backus et al. (1994) model with Epstein-Zin preferences and demonstrated that, on the one hand, the productivity channel suggests that resources should move from the least productive to the most productive country, and on the other hand, the risk-sharing channel suggests that resources should flow from the low-marginal-utility country to the highmarginal-utility country. The relative intensity of these two channels depends on the relative relevance of short- and long-run shocks in the determination of marginal utilities across countries. In this model the productivity channel always dominates with respect to short-run growth shocks—that is, the most productive country receives resources from abroad and invests more.

While this analysis fits well with the patterns of international capital flows observed between developed economies, it does not explain the dearth of capital flows into emerging economies. Buera and Shin (2017) offered an explanation that relied on less developed financial markets in emerging economies, which lead to less efficient capital allocation and also increase domestic savings reducing the need for foreign capital.

Most models formulated in real terms, however, fail to predict sharp swings in international capital flows. To explain these and understand their impact on target economies, a concept of "fickleness," or instability, of international capital flows has been introduced in recent papers. For example, Caballero and Simsek (2020) showed that in the world with asymmetric economies, reach-for-yield and reach-for-safety motives can destabilize receiving countries and increase potential for rapid reversals of capital inflows that might result from asset fire sales. Importantly, instability of international capital flows gives rise to potential for destabilizing negative effects to counteract conventional benefits from optimal capital allocation and risk sharing.

Instability, home bias, and quick reversals observed in the data can all be explained by models of imperfect information, as shown by Malmendier et al. (2020). In their model investors do not have full information about foreign markets and are learning from observed shocks. As a result, they may overreact to innovations (which explains instability and retrenchment) and are overall less likely to venture into foreign markets (which explains home bias).

Despite recent advances in theoretical understanding of the drivers behind observed patterns in international capital flows, the literature is still far from a cohesive theoretical framework and further work is needed. In particular, the emergence of the global factor, and its nature and timevarying importance, are yet to find strong theoretical justification. Most successful modeling approaches in this area rely on the introduction of global banks, following the framework by Bruno and Shin (2015) that was extended by Morelli et al. (2019; see an informal discussion of this framework in Cohen et al., 2017). This framework delivers the mechanism by which push factors may have strong effects on capital flows. Its empirical relevance, however, is limited to the analysis of capital flows that are intermediated by the global banking system at some stage.

Instrument and currency composition of international capital flows and cross-border portfolios of individual global investors is another issue that is difficult to pin down from a theoretical point of view. Given that capital controls mostly affect the composition of capital flows, theoretical underpinnings of how capital controls work and when their use might be most effective is also very limited. Farhi and Werning (2014) showed theoretically how optimal capital controls could be used to smooth volatility in international capital flows.

## 3.6 Costs and Benefits of International Capital Flows

Economic history shows that an open financial account is important for economic growth and development. Peter Henry (2007) found that financial liberalization is associated with lower cost of capital, higher investment, and higher economic growth rate. Moreover, openness to foreign investment can bring institutional improvements and, especially in the case of foreign direct investments, positive technological spillovers. Kaminsky and Schmukler (2008) showed long-run gains from financial liberalization that are manifested in more stable markets, albeit at a cost of more pronounced boom-bust cycles in the short run. That said, studies that quantify the benefits of financial liberalization in a theoretical framework tend to produce zero to negligible gains. Gourinchas and Jeanne (2013), for example, showed that the welfare gain from switching from financial autarky to perfect capital mobility is very small, roughly equivalent to a 1% permanent increase in domestic consumption for the typical emerging economy. Stulz (2005) provided an explanation for this observation based on agency problems in countries that receive international capital flows.

At the same time, there are costs of opening borders to international capital flows. Capital flows can be an unreliable source of capital because of their volatility, and they can spread real and financial shocks across countries. In particular, costs of sudden stops can be dramatic, especially for emerging economies. Not only do they lead to rapid decline in investment due to an increase in the cost of capital but they also lead to decline in consumption through the need for current account reversal that is usually accomplished through currency depreciation or internal devaluation. Moreover, as shown in Calvo et al. (2006), they can have long-term growth effects because funding is diverted from growth investment to short-term operational needs. In contrast to this view, Rancière et al. (2008) documented that countries that experience crises tend to grow faster on average than countries that do not. They explain this observation with benefits of risk taking in countries with weak financial institutions that lead to higher economic growth and occasional crises.

Outside of sudden stop episodes, in normal times, international capital flows may help finance investment opportunities but may have destabilizing effects by transmitting idiosyncratic shocks internationally. There is no consensus in the literature on whether financial linkages between countries produce diversification of idiosyncratic shocks or whether they lead to further synchronization of business cycles. Empirical evidence is inconclusive and very much depends on the definitions of idiosyncratic and common shocks, financial integration, and synchronization measures (Cesa-Bianchi et al., 2019). For example, Hale, Kapan, and Minoiu (2020) showed that international bank linkages transmit country-specific shocks across countries. Theory also provides different predictions depending on the nature of shocks and the way structure of global banking is modeled.

Thus, there is a trade-off between benefits that access to international capital markets can bring to a growing economy and costs associated with sudden stops and, more generally, dependence on the global business cycle. Before the Asian financial crisis of 1997–1998, there appeared to be a consensus in the literature and in international policy institutions that, on balance, an open financial account is the best policy for emerging economies, since it worked well for advanced economies in the post-Bretton Woods era. Since then, and especially in the aftermath of the global financial crisis, the thinking has evolved quite substantially. Blanchard and Ostry (2012) summarized the change in thinking that led to the IMF's endorsement of capital controls in certain circumstances as second-best policies to correct distortions or to address externalities.

Given the evidence on the lack of effectiveness of capital controls in restricting international capital flows, it is well understood that they can only be used to alter their composition or as a temporary measure. In this, the definition of capital controls is becoming more and more blurred with macroprudential policies that are aiming at maintaining stability of the domestic financial system. While the IMF is trying to keep the definitions of the two sets of policies separate, they are intimately linked for small open economies in which stability of the domestic financial system depends on the global financial cycle and generally unreliable capital inflows. The difficulty of ensuring financial stability of small open economies is exacerbated by the growing importance of portfolio flows and financial derivatives. While international organizations such as the Basel Committee on Banking Supervision can work with a large number of regulators worldwide to reduce the volatility of banking flows, it is very difficult to regulate cross-border portfolio flows and derivatives trading. Further understanding of their dynamics is key to developing much-needed policies aimed at stabilizing whole markets rather than individual institutions.

## 3.7 Research Opportunities and Challenges

The history of international capital flows can be described by global boom-bust cycles as well as vast changes in the geography of capital flows. Increasing availability of detailed data and more disaggregated empirical analysis show that international capital is not a monolith, but rather a collection of different asset classes and various institutional investors that exhibit unique patterns and dynamics and have different implications for macroeconomic development of recipient countries. With improved data availability, data sharing, and advances in econometric inference techniques, there are many opportunities for deeper and more detailed empirical analysis of various components of international capital flows. Breakthroughs in empirical understanding of the nuances of international capital flows will provide opportunities for careful theoretical modeling of changing composition of international capital flows, both globally and for specific countries. These are areas in which progress can be made toward understanding international capital flows.

The main challenge of research in international capital flows lies in their ever-changing nature. While some dynamics appear to repeat themselves, changes in the pattern of international capital flows mean that many empirical findings, even if they appear general at the time of their analysis, do not necessarily survive the test of time. The correlations that were observed prior to the global financial crisis, for example, may no longer be relevant in its aftermath. Similarly, a model that may have fit the data well in the past may not be able to explain more recent data. As a result, policy recommendations need to be based on current analysis. Changes in the consensus policy recommendations demonstrate intellectual flexibility of policymaking institutions as well as their ability to adapt to the changing global economic environment. It is important to realize that the economic profession may never have a final unified theory of international capital flows given their ever-changing dynamics. The good news is that studying international capital flows will continue to be relevant for years to come.

# Chapter 4

# Estimating broad job searchers in the US Labor Market

## 4.1 Introduction

During recessions, unemployment is usually concentrated in some specific industries. For example, the rise of unemployment was concentrated in manufacturing and construction during the Great Recession. The unemployed search for jobs in other industries during and after recessions, when job opportunities in their prior industries are limited.

However, most surveys, such as the US Census Bureau Current Population Survey (CPS), for the unemployed make their evaluations based on the industries of the last job they held, which may or may not reflect their current job searches. Except for a few papers (e.g., Veracierto, 2011), most previous analysis of the US labor market in the matching-function framework has taken unemployment as the measure of job searchers (Hall et al, 2018). This means that the amount of job searchers is underestimated in the industries that are less affected during recessions. A correct estimation of the industrial job searchers is crucial for both researchers and policy makers. This paper proposes a model- based method to estimate the job searchers in selected industries after the Great Recession (2008- 2015). The focus is on selected industries because the model-based method used in this paper is not suitable for all industries. The model-based method assumes that quit rate is a linear function of job finding rate, but the relationships between industrial quit rate and industrial job finding rate are not clear in some industries.

Data used in this paper is mainly from the US Bureau of Labor Statistics Job Openings and Labor Turnover Survey (JOLTS), a public-use program that reports monthly national level industrial employment, job openings, hires, quits, layoffs and discharges, and other separations. In addition, I use monthly national level unemployment and annual industry level unemployment data from the CPS. Monthly industry level unemployment of each industry is estimated based on the monthly national level unemployment and annual industry level unemployment.

The industry classification is based on a 3-digit Standard Industrial Classification level. Industries are classified into two groups based on the relationship between industrial quit rate and industrial job finding rate. The first group includes professional and business services, leisure and hospitality, construction, and trade, and transportation and utilities. For these industries, quit rate is a clear and stable linear function of job finding rate. The second group includes mining, manufacturing, information, finance, Education and health services, and other services. The relationships between industrial quit rate and industrial job finding rate are not clear in these industries.

## 4.2 Previous Work

This chapter relates to literature on labor reallocation. Lilien (1982) asserts that sectoral shifts can account for the majority of unemployment fluctuations in the 1970s. However, Abraham and Katz (1986) challenge this viewpoint. Lilien (1982) reaches its conclusion based on the assumption that economic downturns coincide with increased restructuring. In contrast, my argument centers around the concept of Broad Job Searchers. Chodorow-Reich (2020) argues that reallocation contributes to higher unemployment during crises. Nevertheless, I propose that in the presence of Broad Job Searchers, lower reallocation rates can lead to higher unemployment."

Also, my work relates to the literature on labor market changes since the Great Recession. Bloom et al. (2009) emphasize the significance of policy uncertainty, while Mian et al. (2010) discuss the role of housing prices. Building on the ideas of Sahin et al. (2014), who argue that industry and spatial mismatch contribute to a higher unemployment rate, my paper takes this notion as its starting point. Specifically, I explore how the existence of mismatch, which leads to a large number of broad job searchers, influences the efficiency of reallocation and, consequently, impacts the speed of economic recovery."

In addition, from a methodological perspective, my paper draws on existing literature concerning trade shocks, exemplified by Autor et al. (2013), Autor et al. (2016), and Charles et al. (2017), to apply industry shocks to local labor markets.

Moreover, my approach is influenced by studies on matching functions, such as Davis et al. (2013), Elsby et al. (2014), and Hall et al. (2017).

## 4.3 Model

Two kinds of job searchers are in each industry: broad job searchers and narrow job searchers. Broad job searchers are the unemployed who search in selected industries after losing their jobs in their prior industries. Narrow job searchers are the unemployed people who search for jobs in their prior industries. The model normalizes the base level of broad searchers before a recession to zero for simplicity.

The assumption that the base level of broad searchers before a recession is zero seems strict because there were job transitions between industries before a recession. However, during normal times, there should be an equilibrium about the broad job searchers among industries. For example, to guarantee the relative size of manufacturing and trade stability during a normal time, the number of broad job searchers in manufacturing who come from trade should be equal with the number of broad job searchers in trade who come from manufacturing as they offset each other. Thus, it is reasonable to assume that the base level of effective broad searchers before a recession is zero. However, recessions make things different. For example, the rise of unemployment was concentrated in manufacturing and construction during the Great Recession, as the number of broad searchers that flowed from manufacturing to trade was much greater than the number of broad searchers that flowed from trade to manufacturing. The net increase of broad searcher flows of these industries are what is studied in this paper.

The measure of matches in a given time period is given by a matching function M (u, v), where u and v are the measures of unemployed workers and vacancies. I assume that the matching function has the Cobb-Douglas form,

$$M(u,v) = mu^{\alpha}v^{1-\alpha} \tag{4.1}$$

where $m > 0, \alpha \in (0,1)$.

The ratio between vacancies and unemployed workers is labeled as the "tightness" of the labor market. Before recessions, tightness in industry s is $\theta_s^{before}$. During and after recessions, tightness in industry s is $\theta_s^{after}$.

$$\theta_s^{before} = \frac{v_s}{u_s^{narrow}} \tag{4.2}$$

$$\theta_s^{after} = \frac{v_s}{u_s^{narrow} + u_s^{broad}} \tag{4.3}$$

where $v_s$ denotes the vacancy of industry s, $u_s^{narrow}$ denotes the narrow job searchers in industry s, $u_s^{broad}$ denotes the broad job searchers in industry s.

I can write the probability of finding a job in industry s as

$$f_s(\theta_s) = \frac{M_s(u_s, v_s)}{u_s} = \frac{m_s u_s^{\alpha} v_s^{1-\alpha}}{u_s} = m_s \theta_s^{1-\alpha} \quad (4.4)$$

Following the spirit of Hoffmann et al. (2020), I set quit rate as a linear function of job finding rate,

$$q_s(\theta_s) = \varphi_s f_s(\theta_s) + b_s \quad (4.5)$$

where $\theta_s$ measures the fraction of on-job searchers in industry s, and $b_s$ is the constant.

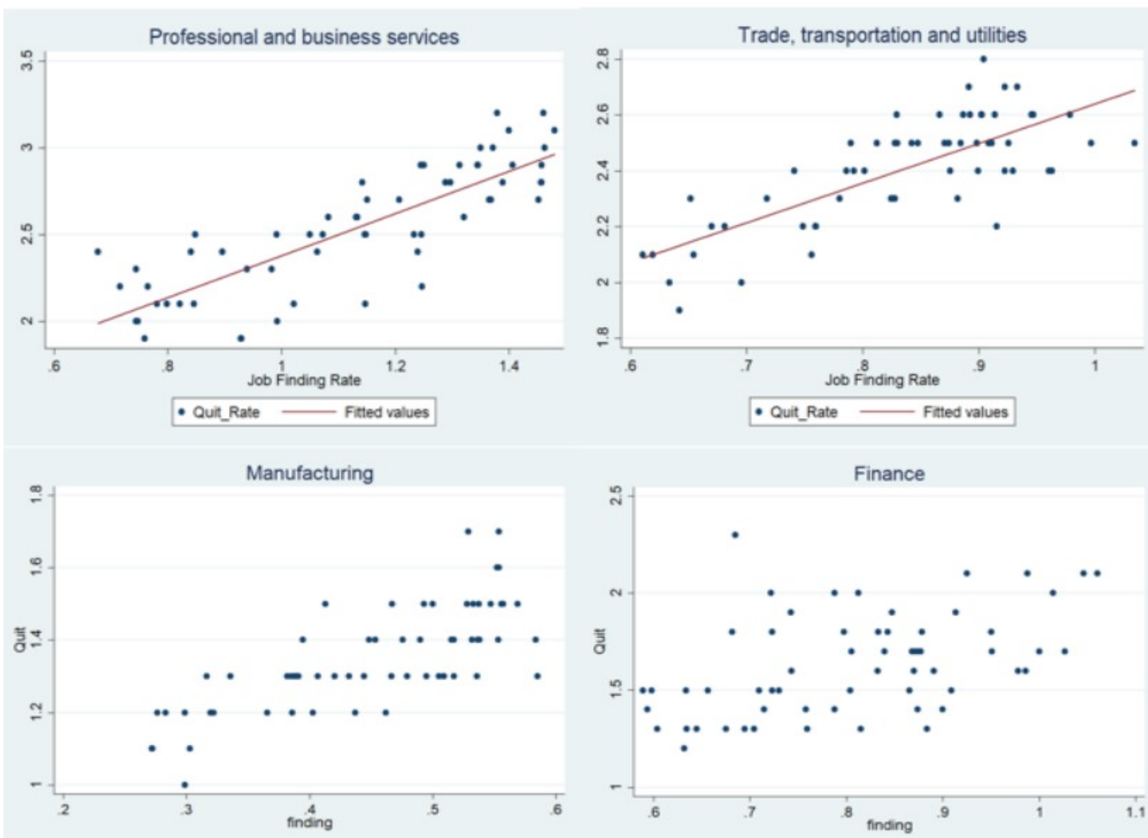
Figure 4.1 shows the scatter plot of monthly job finding rate and quit rate in selected industries from 2003 to 2007. The linear relationships of job finding rate and quit rate are clear and stable on the industrial level for Group One industries (e.g., Professional and business services, and Trade, transportation and utilities). However, the linear relationship of job finding rate and quit rate are not stable in Group Two industries (e.g., Manufacturing and Finance).

Then, by combining equations (4.4) and (4.5), I get the following.

$$q_s(\theta_s) = \varphi_s m_s \theta_s^{1-\alpha} + b_s \quad (4.6)$$

Using equation (4.6), broad job searchers can be estimated in each Group One

Figure 4.1: Job Finding Rate and Quit Rate in selected industries




Source: US Bureau of Labor Statistics, Job Openings and Labor Turnover Survey industry s, which is a three-step estimation.

### 4.3.1 Step 1

The monthly data of tightness, job finding rate and quit rate of each industry before the recession (2003-2007) is used to estimate the values of $m, \alpha, \varphi$, and $b$ in each Group One industry s. The values of $\alpha, \varphi$, and $b$ are fixed for each industry, and the value of matching efficiency $m$ is time varying.

### 4.3.2 Step 2

Given the values of $m, \alpha, \varphi$, and $b$, the data of quit rate recessions (2008-2015) is used to estimate the tightness of industry s, $\theta_s^{after}$. The value of matching efficiency $m$ to be time-varying is allowed. Hall et al. (2018) calculated the trend of aggregate matching efficiency from 2001 to 2013. I apply their results, and I assume the trend extends to 2015.The growth rate of industrial level matching efficiency was assumed to be equal with the growth rate of aggregate level matching efficiency from 2008 to 2015. This assumption is reasonable, because Hall et al. (2018) find a mild downward trend of matching efficiency at close to a constant rate in most job seeker categories. Then, the value of the time-varying industrial matching efficiency was calculated.

### 4.3.3 Step 3

Given the estimated $\theta_s^{after}$, observed $v_s$ and $u_s^{narrow}$, base on equation (4.3), the value of $u_s^{broad}$ can be estimated.

## 4.4 Estimation Results and Conclusion

Based on the estimation method above, the number of broad job searchers for Group One industries after the Great Recession (2008-2015) were estimated. Table 4.1 reports the average ratio between broad searchers and narrow searchers of each industry from 2008 to 2015. Figure 3.2 plots the ratio between broad searchers and narrow searchers of each of the industry from 2008 to 2015.

The ratios between broad searchers and narrow searchers are relatively high in trade, transportation and utilities, leisure and hospitality, and government. These industries are more attractive because people who were unemployed from more affected industries are more likely to find jobs in these industries. The negative ratio between broad searchers and narrow searchers in professional and business services implies that jobs in these sectors are not attractive to the unemployed and it also implies that some narrow searchers of professional and business services did not search effectively in their previous industries.

The results also show that the ratio between broad searchers and narrow searchers dramatically increased from 2008 to 2009, and then fell back quickly. In addition, the ratio between broad searchers and narrow searchers in construction, leisure and hospitality, and trade, transportation and utilities showed obvious seasonality. The ratios are high in construction and leisure and hospitality from March to October, while the ratio is high in trade, transportation and utilities from September to March. This indicates that many of the unemployed flowed seasonally among several industries.

Figure 4.2: The ratio between broad searchers and narrow searchers 2008-2015

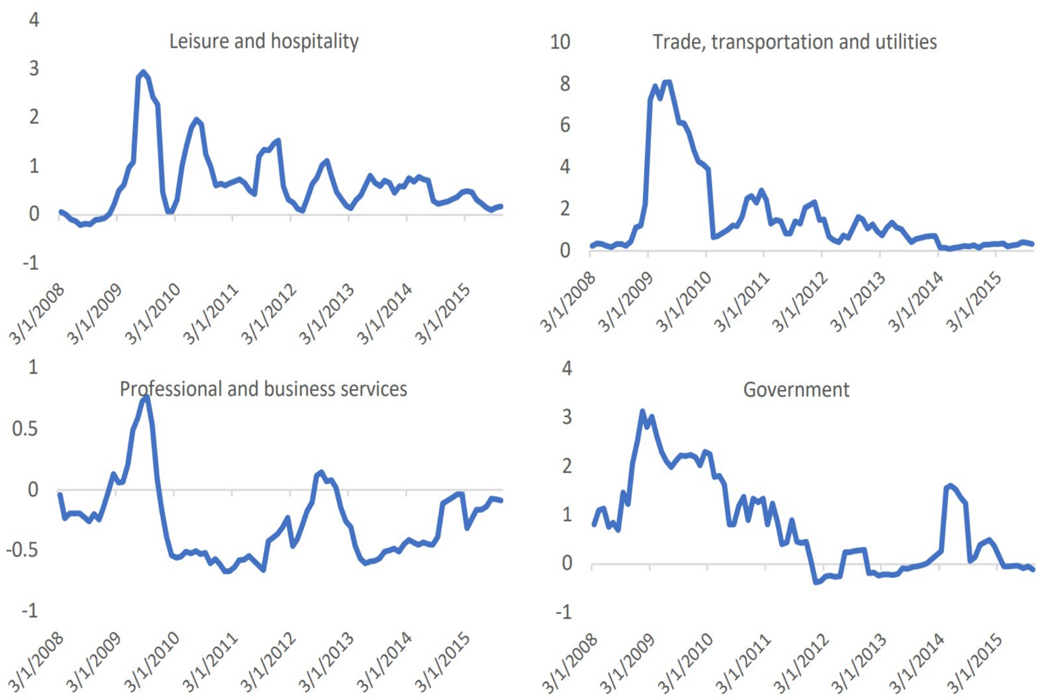


Table 4.1: The average ratio between broad searchers and narrow searchers from 2008 to 2015

| | Trade, trans, utili | Construc | Leisure, hospita | Profess, business |
|---|---|---|---|---|
| $\frac{u^{broad}}{u^{narrow}}$ | **1.65** | **-0.04** | **0.66** | **-0.26** |

# Appendix A

# Model Proof

## A.1 Proof of Lemma 1

Proof: For households with $\varepsilon_t \geq \varepsilon_t^\star$, the collateral constraint and the flow-of-funds constraint are both binding, I can get

$$Q_t h_t(\varepsilon_t) \leq \frac{a_t(1-e_t)}{1-\kappa_t} \tag{A.1}$$

Imposing the market clearing conditions (19)-(22), I can get $(1-e_t)a_t = Q_t$. Thus, for all $\varepsilon_t \geq \varepsilon_t^\star$, the housing quantity is given by

$$h_t(\varepsilon_t) \leq \frac{1}{1-\kappa_t} \tag{A.2}$$

Thus, households with $\varepsilon_t \leq \varepsilon_t^\star$ are not house buyers with $h(\varepsilon_t) = 0$. Households with $\varepsilon_t \geq \varepsilon_t^\star$ are house buyers and the quantity of house that they buy are the same.

Following the house market clearing condition that

$$\frac{1}{1-\kappa_t}\int_{\varepsilon_t^\star} dF(\varepsilon) = 1 \tag{A.3}$$

So I can get

$$F(\varepsilon^\star) = \kappa_t \tag{A.4}$$

Then I can get

$$\frac{\partial F(\varepsilon^\star)}{\partial \kappa_t} > 0 \tag{A.5}$$

Equation (A.5) shows that $\varepsilon_t^\star$ increases with $\kappa_t$. Intuitively, a credit supply expansion that raises $\kappa_t$ allows the marginal trader to borrow more from the bond market Thus, it raises the marginal household's perceived future utility value of housing $\varepsilon_t^\star$.

## A.2 Proof of Proposition 2

Proof: For a house buyer with $\epsilon_t \geq \epsilon_t^\star$, his housing Euler equation can be written as

$$\begin{aligned}\eta(\varepsilon_t)Q_t &= \beta E_t\eta_{t+1}Q_{t+1} + \beta E_t[\tilde{\varphi_{t+1}} s_{h,t+1}^{-\theta}|\tilde{\varphi}_{t+1} = \varepsilon_t] + \kappa_t Q_t \pi_t(\varepsilon_t) \\ &= \beta E_t\eta_{t+1}Q_{t+1} + \beta\varepsilon_t + \kappa_t Q_t\pi_t(\varepsilon_t), \forall\varepsilon_t \geq \varepsilon_t^\star\end{aligned} \tag{A.6}$$

where I plugged in the market clearing equation for rental housing that $s_{ht} = 1$. The household's bond Euler equation can be written as

$$\eta(\varepsilon_t) = \beta R_t E_t \lambda_{t+1} + \pi_t(\varepsilon_t), \forall \varepsilon_t \geq \varepsilon_t^\star \tag{A.7}$$

From (A.6) and (A.7), I can get

$$\pi_t(\varepsilon_t) = \frac{\beta}{1-\kappa_t}[\frac{\varepsilon_t + E_t \lambda_{t+1} Q_{t+1}}{Q_t} - R_t E_t \lambda_{t+1}], \forall \varepsilon_t \geq \varepsilon_t^\star \tag{A.8}$$

Similarly,

$$\pi_t(\varepsilon_t^\star) = \frac{\beta}{1-\kappa_t}[\frac{\varepsilon_t^\star + E_t \lambda_{t+1} Q_{t+1}}{Q_t} - R_t E_t \lambda_{t+1}], \tag{A.9}$$

Thus, I can get

$$\pi_t(\varepsilon_t) - \pi_t(\varepsilon_t^\star) = \frac{\beta}{1-\kappa_t} \frac{\varepsilon - \varepsilon_t^\star}{Q_t} \tag{A.10}$$

Because $\pi_t(\varepsilon_t^\star) = 0$, I can get

$$\pi_t(\varepsilon_t) = \frac{\beta}{1-\kappa_t} max(0, \frac{\varepsilon - \varepsilon_t^\star}{Q_t}) \tag{A.11}$$

The first-order condition for $a_t$ implies that

$$\lambda_t = (1-e_t) \int \eta_t(\varepsilon_t) dF(\varepsilon_t) + E_t(\lambda_{t+1} \widetilde{R_t}) e_t \tag{A.12}$$

Since $\pi(\varepsilon_t^\star) = 0$, Equations (A.6) and (A.7) imply that

$$\eta(\varepsilon_t^\star)Q_t = \beta E_t \lambda_{t+1} Q_{t+1} + \beta \varepsilon_t^\star \tag{A.13}$$

$$\eta(\varepsilon_t^\star) = \beta R_t E_t \lambda_{t+1} \tag{A.14}$$

Substituting Equations (A.13) and (A.14) into (A.12), I can get

$$\lambda_t = (1 - e_t)[\beta R_t E_t \lambda_{t+1} + \frac{\beta}{1 - \kappa_t} \frac{1}{Q_t} \int_{\varepsilon^\star} [\varepsilon - \epsilon_t^\star] dF(\varepsilon)] + E_t(\lambda_{t+1} \widetilde{R_t}) e_t \tag{A.15}$$

Thus, I can get

$$\lambda_t Q_t = (1 - e_t)[\beta E_t \lambda_{t+1} Q_{t+1} + \xi(\kappa_t)] + E_t(\lambda_{t+1} \widetilde{R_t}) e_t Q_t \tag{A.16}$$

where $\xi(\kappa_t) \equiv \beta \frac{1}{1 - F(\varepsilon_t^\star)} \int_{\varepsilon_t^\star} \varepsilon dF(\varepsilon)$ is a function of $\kappa_t$, because Lemma 1 states that $F(\varepsilon_t^\star) = \kappa_t$. Then, I can get

$$\lambda_t Q_t = \delta_t(e_t)[\beta E_t \lambda_{t+1} Q_{t+1} + \xi(\kappa_t)] \tag{A.17}$$

where

$$\delta_t(e_t) = \frac{1 - e_t}{1 - E_t(\frac{\lambda_{t+1}}{\lambda_t} \widetilde{R_t}) e_t} \tag{A.18}$$

## A.3 Proof of Proposition 3

Proof: Let me rewrite Equation (A.18)

$$\delta_t(e_t) = \frac{1 - e_t}{1 - E_t(\frac{\lambda_{t+1}}{\lambda_t}\widetilde{R_t})e_t} \tag{A.19}$$

The sign of $\frac{\partial Q_t}{\partial e_t}$ is the same as that of $\frac{\partial \delta_t(e_t)}{\partial e_t}$.

$$\frac{\partial \delta_t(e_t)}{\partial e_t} = \frac{E_t(\frac{\lambda_{t+1}}{\lambda_t}\widetilde{R_t}) - 1}{(1 - E_t(\frac{\lambda_{t+1}}{\lambda_t}\widetilde{R_t})e_t)^2} \tag{A.20}$$

From the first-order condition with respect to $c_t$, I can get

$$E_t(\frac{\lambda_{t+1}}{\lambda_t}\widetilde{R_t}) = E_t((\frac{c_t}{c_{t+1}})^\gamma \widetilde{R_t}) \tag{A.21}$$

Thus,

$$\frac{\partial Q_t}{\partial e_t} < 0, E_t(\frac{c_t}{c_{t+1}})^\gamma > E_t\widetilde{R_t} \tag{A.22}$$

$$\frac{\partial Q_t}{\partial e_t} > 0, E_t(\frac{c_t}{c_{t+1}})^\gamma < E_t\widetilde{R_t} \tag{A.23}$$

# Appendix B

# State-Dependent Correlation between Equity Return and Housing Prices Growth

I provide a motivating fact for my theoretical model and empirical model through an examination of the correlation between equity capital gain and housing prices after stock market crashes. I use state-dependent-local-projection methods, controlling for some macroeconomic fundamentals, and conditional on the severity of the stock market crash and the pre-trend of housing prices before stock market crashes.

Housing market expectations are strongly related to recent housing price development (Kucheler, 2022). The effect of equity return to housing price depends on the pre-trend of housing prices. If the housing market was growing before the stock market crash, households may invest more in the housing market when they invest less in the stock market because of the stock market crashes. However, if the housing market was falling, households would not treat housing as an alternative investment vehicle.

## B.1 Econometric Methodology

The local projection method proposed in Jordà (2005) is a linear projection model, which computes a series of impulse responses for each horizon, h. The specification of the linear model is

$$\Delta_s h_{it-1} = \alpha_{i,s} + \beta_s \Delta\gamma_{it} + \Delta V_{it}\Gamma_s + \Delta X_{it-1}\phi_s + \mu_{it+s}$$

where $i = 1, ..., N$ denotes the country. $\Delta_s h_{it-1} = h_{it+s} - h_{it-1}$ denotes the change in house price (measured as the log of the ratio of real house price to income per capita) from the year t-1 up to year t+s with $s = 0, 1, ..., S.\Delta\gamma_{it}$ denotes the real equity capital gain. $\alpha_{i,s}$ denotes country-fixed effects.

Next, $\Delta V_{it}$ and $\Delta X_{it-1}$ denote two vectors of variables. The vector $\Delta V_{it}$ includes all the control variables observed at time t for country i except for $\Delta\gamma_{it}$. $\Delta V_{it}$ includes (i) the growth rate of real GDP per capita; (ii) the CPI inflation rate; (iii) the investment to GDP ratio; (iv) the ratio of credit to the non-financial sector to GDP; (v) long-term interest rate; and (vi) short-term interest rate (vii) the current account to GDP ratio. $\Delta X_{it-1}$ includes the lags of all the variables in $\Delta V_{it}$, and the lags of $\Delta\gamma_{it}$ and $\Delta_s h_{it}$. I use the notation $\Delta$ because the variables in the model are expressed as first differences.

By pooling the data, I estimate the average response to the equity return shock across all countries and time. The country fixed effect $\alpha_{i,s}$ captures time invariant country heterogeneity, such as land supply etc. By adding $\Delta V_{it}$ and $\Delta X_{it-1}$ into the model, I isolate the selection mechanism based on observables. $\Delta V_{it}$ controls the country-level conditions observed in the same year as $\Delta\gamma_{it}$ as they have the same timing. In the estimations below I use country-based cluster-robust small-sample standard errors.

The effect of equity return to housing price is potentially state varying. For example, a mild fall in equity return may not affect the stock market participation, it may only affect people's preference among different stocks. However, a sharp fall may be associated with a drop in stock market participation. Also, if the housing market is in a boom when the stock market crash happens, more potential stock market participants may enter the housing market. However, if the housing market is in a recession as well, potential stock market participants may not enter the housing market.

Due to the reasons above, I allow the parameters to change according to the states of the economy. Thus, I extend the linear local projection model in (1) to a non-linear, state-dependent model:

$$\Delta_s h_{it-1} = \sum_{k=A}^{K} I_{i,t}^{k}[\alpha_{i,s}^{k} + \beta_s^k \Delta\gamma_{it} + \Delta V_{it}\Gamma_s^k + \Delta X_{it-1}\phi_s^k] + \mu_{it+s}$$

where $I_{i,t}^{k}$ denotes the state of the economy in country i when the equity returns shock hits.

Previous literature (e.g., Ramey and Zubairy, 2018, and Alpanda et al., 2021) has used state dependent local projection, among others, to study the effects of monetary and fiscal policy shocks. The states in the literature are defined based on business cycles, credit cycles, and interest rate cycles (Alpanda et al., 2021).

## B.2 Definitions of States

In this paper, I define the states based on two conditions: The average housing price growth in the previous years before equity returns shock hit (i.e., Condition 1), and the real equity returns in the year that equity returns shock hit (i.e., Condition 2). Condition 1 can indicate the trend in the housing market, because house prices have strong momentum and exhibit long-run reversal (Piazzesi and Schneider, 2016). Condition 1 is relevant because households were more willing to invest in the housing market only when they forecast the housing market will continue to rise. Condition 2 can indicate if the stock market is in a crash or not in the current year. It is relevant because households may want to invest less in the stock market only when the stock market fell sharply. If there was only a mild drop in the stock price, people may just rebalance their stocks portfolio.

Combining the two conditions, we can define 4 states. The state we are interested in this paper is the state when there is a stock market crash, and the housing market was growing before the stock market crash.

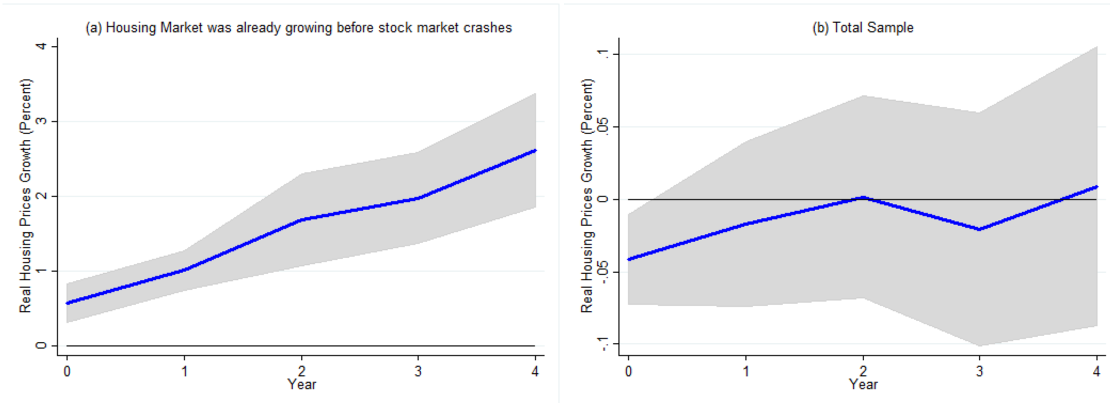
## B.3 State-Dependent Effects of Real Equity Return Shocks

I report the results for the state dependent local projection model in Table-1 for the state when there is a stock market crash, and the housing market was growing before the stock market crash. I show the state-dependent impulse responses to a 0.01 percent positive real equity return shock in Figure-2. The results show that the impact of stock market capital gain on housing price growth is negative and strong, if the housing market was in boom before a stock market crash.

Panel (a) in Figure-2 presents the impulse responses to a 1 percent negative real equity return shock, conditional on the stock market experiencing a crash (i.e., real equity return is smaller than -15%) and the housing prices were on the rise before a stock market crash. I find that a stock market crash is negatively correlated with housing price growth if the housing prices were on the rise before the stock market crash. Panel (b) shows the results of impulse responses that include the total sample. There is no significant correlation between real equity return and housing prices in this case.

However, this relationship cannot be interpreted as a causal relationship. A main threat to a causal interpretation is that stock market prices are forward looking. Therefore, an anticipated decline in future economic fundamentals could affect both the stock market and the housing market. In addition, there are some potential channels other than the households asset allocation channel through which the stock market can affect the housing market. An example of other channels would be the monetary policy channel. Rigobon et al. (2003) argues that monetary policy reacts significantly to stock market movements. The monetary policy reaction would affect the housing market.

Figure B.1: Response of Real Housing Price to 1 percent negative shock to Real Equity Capital Gain




Local projection responses for a 1 pp negative shock to the real equity capital gain. Country-based cluster-robust small-sample standard errors are calculated. Panel (a) shows the results of the regression includes the sample that real equity capital was smaller than -15% and the average real housing price growth was positive during the past two years. Panel (b) shows the results of the regression including the total sample. The shadow area shows 90% confidence intervals.

Table B.1: Local-projection. Responses of Real Housing Prices to Stock Market Crashes

| | h=0 | h=1 | h=2 | h=3 | h=4 |
|---|---|---|---|---|---|
| Real HP Response (percent) | **0.572*** ** | **1.012*** ** | **1.684*** ** | **1.982*** ** | **2.618*** ** |
| | (0.159) | (0.161) | (0.374) | (0.370) | (0.462) |
| Observations | 32 | 32 | 32 | 32 | 32 |

*** p<0.01, ** p<0.05, * p<0.1.

Country-based cluster-robust small-sample standard errors in parentheses. The dependent variable is the log real housing prices regressed on the equity capital gain, fixed effects and controls. The vector of control variables includes (i) the growth rate of real GDP per capita; (ii) the CPI inflation rate; (iii) the investment to GDP ratio; (iv)the ratio of credit to the non-financial sector to GDP; (v) long-term interest rate; and (vi) short-term interest rate (vii) the current account to GDP ratio. I include contemporaneous terms and one lag. The sample starts in 1980 and ends in 2007.This regression includes the sample that real equity capital were smaller than -15% and the average real housing price growth were positive during the past two years.

# Appendix C

# Exclusive Restriction Checking

To test the exogeneity of stock market participation rate in 2001 and housing prices growth before the Dot.com bubble crash, I check the correlation between the housing prices growth before the Dot.com crisis (1996-2000) and stock market participation rate in the initial year (2001).

Table C.1: OLS. Correlation between Housing Prices Growth (1996-2000) and stock market participation rate (2001)

| Independent Variables | Coefficient | Standard Error |
|---|---|---|
| Housing Prices Growth (1996-2000) | -0.000455 | 0.00376 |
| Constant | **0.41*** ** | 0.0.059 |

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

The results indicate that the local housing prices growth before the Dot.com crisis was not significant in determining state-level stock market participation rate in the initial year (2001).

# Appendix D

# Estimation of Current Expected Capital Return

This section of the appendix provides the details about the estimation of current expected capital return (i.e., $E_t(\widetilde{R}_t)$. ). I set the current expected capital return to be the survey expected equity return (from Gallup survey expectations) subtracted expected inflation (from Fed Cleveland database) and risk premium.

To calculate the risk premium, I refer to the following function of calculating absolute risk premium of CRRA utility function.

$$\pi_A \approx \frac{1}{2} A(\bar{X}) \sigma_X^2$$
$$A(\bar{X}) = -\frac{U^{"}(\bar{X})}{U^{'}(\bar{X})}$$

where $\pi_A$ denotes the absolute risk premium, $\bar{X}$ denotes average consumption, $A(\bar{X})$ denotes the absolute risk-aversion, $\sigma_X^2$ denotes the variance of consumption. Then, we can get

$$\pi_A \approx \frac{1}{2}\gamma \bar{X} \sigma_X^2$$

In the theoretical model, I assume consumption equals the family's return from their investment in the capital market in the last period. Thus, I set $\bar{X}$ equal to future capital expected return (i.e., 1.04). I set $\sigma_X^2$ to the conditional variance of capital based on the results from Bekaert et al. (2013). They decompose the VIX into two components, a proxy for risk aversion and expected stock market volatility ("uncertainty").

# Appendix E

# Decision about Share On Capital $e_t$

This section of the appendix provides the details of the family's decision about portfolio share on capital $e_t$.

In the beginning of period t, the large family decides the capital share $e_t$ based on the capital return $\widetilde{R}_i, i = 1, ..., t-1$. Assume portfolio share on capital $e_t$ and log accumulated historical return $ln(Stocks - Index)_t$ are cointegrated. $\Delta e_t$ is determined based on the error correction model.

$$A(L)\Delta e_t = \omega + B(L)\widetilde{R}_t + \tau(e_{t-1} - \theta_0 - \theta_1 ln(StockIndex)_{t-1}) + \nu_t$$

where $StockIndex$ denotes the stock market index, $ln(StockIndex)_t$ denotes the log accumulated historical capital return, $\widetilde{R}_i = ln(StockIndex)_t - ln(StockIndex)_{t-1}$ denotes capital return.

To regress this error correction model, I use directly and indirectly held corporate equities as a percentage of total assets to measure the capital share.

At first, I used the Dicker-Fuller test to check the order of stationary of $e_t$ and $ln(StockIndex)_t$. Both are I(1) processes.

Table E.1: Dickey-Fuller test for unit root

| Variables | Z(T) | P-value for Z(T) |
|---|---|---|
| $ln(StockIndex)_t$ | -0.402 | 0.9098 |
| $\Delta ln(StockIndex)_t$ | **-11.206*** ** | 0.000 |
| $e_t$ | -1.7 | 0.4313 |
| $\Delta e_t$ | **-11.913*** ** | 0.000 |

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

The second step is then to estimate the long-run model using OLS.

$$e_t = \theta_0 + \theta_1 ln(Stocks - Index)_t + \mu_t \tag{E.1}$$

Table E.2: Results for long-run model

| Independent Variables | Coefficient | Standard Error |
|---|---|---|
| $ln(StockIndex)_t$ | **6.84*** ** | 0.279 |
| Constant | **-29.09*** ** | 1.969 |

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

Then the predicted residuals $\hat{\mu_t}$ from this regression are saved and I use the Dicker-Fuller test to check the order of stationary of $\hat{\mu_t}$. It is an I(0) process.

Table E.3: Dickey-Fuller test for unit root, $\hat{\mu}_t$

| Variable | Z(T) | P-value for Z(T) |
|---|---|---|
| $\hat{\mu}_t$ | **-4.245*** ** | 0.0006 |

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

Then, the following error-correction model was estimated:

$$A(L)\Delta e_t = \omega + B(L)\widetilde{R}_t + \tau(\hat{\mu}_{t-1}) + \nu_t \tag{E.2}$$

Table E.4: Results for Error-Correlation Model

| Independent Variables | Coefficient | Standard Error |
|---|---|---|
| $\widetilde{R}_t$ | 1.655 | 1.4549 |
| $\hat{\mu_{t-1}}$ | **-0.129** ** | 0.0578 |
| Constant | 0.126 | 0.118 |

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

Finally, based on the estimated error-correction model. The portfolio share on capital $\hat{e}_t$ was predicted.

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