Momentum and Reversion to Fundamentals: Are They Captured by Subjective Expectations of Asset Prices?

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This draft: November 2017

First draft: September 2015

Abstract

Asset-price movements (e.g., stock, real estate, and foreign currency) exhibit momentum and reversion to fundamentals. Investors can be either fundamentalists (aware of the fundamental values of assets and expecting asset prices to converge to their fundamental values) or chartists (extrapolating from past momentum to form future expectations). This paper studies real estate markets and finds that households' subjective house-price expectations capture momentum but not reversion to fundamentals. Moreover, if current house prices are above (below) their fundamental values, households will have even higher (lower) expectations of future appreciation rates. The reason for this pattern is more likely that households do not have accurate estimates of the fundamental value (fundamental-misperception conjecture) than that they do not believe that mispricing will be quickly corrected by the market (mispricing-persistence conjecture).

Keywords: Asset-Price Expectations, Irrational Expectations, Momentum, Reversion to Fundamentals, House-Price Dynamics

JEL Classification codes: E7, G17, G4, R3

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1. Introduction

The movements of asset prices, such as stock prices, foreign exchange rates, and real estate prices, exhibit momentum and reversion to fundamental, which were well documented in the literature. Momentum refers that what was strongly increasing in the past will probably continue to increase in the near future. Reversion to fundamentals refers that when asset prices have deviated from their fundamental values, which are determined by fundamental economic conditions, there is a force driving those asset prices back to their fundamental values.

In the recent literature, asset pricing models with irrational expectations or with heterogeneous expectations across rational and irrational agents have been developed to explain the observed complicated pattern of asset-prices movements, which cannot be explained very well by conventional models (e.g., rational expectation models). In those heterogeneous expectation models, agents are typically classified into two groups: fundamentalists and chartists. Fundamentalists are aware of the fundamental values of assets. Their trading strategies are based on the belief that asset prices will converge to their fundamental values. In contrast, chartists form asset price expectations by extrapolating from historical prices and trade assets accordingly.

The literature have shown that the simulations of heterogeneous expectation models can better match the realized asset prices movements than conventional models. This literature include Huang et al (2010), Branch and Evans (2010), Chiarella et al. (2012), Chiarella et al. (2014), Lof (2012), Lof (2015), and He and Zheng (2016) on stock prices, Manzan and Westerhoff (2007) and de Jong et al. (2009) on exchange rates, Ascari et al. (2013), Dieci and Westerhoff (2012), Burnside et al. (2015), and Glaeser and Nathanson (2015) on real estate prices, and He and Westerhoff (2005) on commodity prices.[2]

However, the literature still lacks empirical evidence from individual subjective expectation data on how agents' asset-price expectations respond to the deviation of asset prices from the fundamental values and whether most ordinary individuals (versus institutional investors or financial specialists) are more like fundamentalists or chartists. In this paper, using Michigan Survey of Consumers (MSC) data and the Case-Shiller survey, I analyze whether households'

[2] Heterogeneous expectation models are also widely used in the macroeconomic and monetary literature, such as Branch (2006) and Branch and Mcgough (2016).

subjective expectations of house-price appreciation rates capture the momentum and reversion-to-fundamental effects that are observed in actual house-price data. The results indicate that households do capture the momentum effect when forming their expectations, i.e., if recent house-price appreciation rates are high (low), they tend to expect high (low) appreciation rates in the near future; however, households do not capture the reversion-to-fundamental effect when forming their expectations, i.e., if the current house-price level is higher (lower) than its fundamental value, households tend to have an even higher (lower) expectation of the house-price appreciation rate in the future, although actual house-price data exhibit reversion to fundamentals. In addition, the expectations of households with lower education or income levels diverge from the fundamental value to a higher degree.

Why select real estate markets to study individuals' subjective expectation formations on asset prices? One reason is that real estate markets are important. First, real estate assets take large percentages in households' total assets, and the fluctuation of housing markets usually leads to the fluctuation of the entire economic and financial system. Therefore, analyzing individuals' expectation formation on real estate prices is important. Second, unlike stock markets and foreign exchange markets, most transactions in the residential real estate market are made by ordinary households rather than institutional investors. Therefore, analyzing individuals' expectation formation is especially important in real estate markets.

Another reason to select real estate markets to study individuals' subjective expectation formations on asset prices is that compared with stock markets, real estate markets have several advantages in answering the research question of whether subjective expectations capture reversion to fundamentals. First, the surveys used in this paper asked about subjective expectations on local-market real-estate prices; as hot markets, cold markets, and stable markets can exist at the same time in different locations, the variations of deviations from fundamental values are not only over-time, but also cross-sectional. In contrast, most surveys asked about subjective expectations only on overall stock market performance rather than individual-stock performance (see Greenwood and Shleifer (2014)); thus, the variations of deviations from fundamental values are only over-time and not cross-sectional.[3] Second, even if there exists satisfactory survey data on subjective expectations on the price appreciations or returns of individual stocks, the regressions at the individual-stock level should be noisy. In the empirical asset pricing literature (e.g., Fama and MacBeth (1973), Fama and French (1993), and Fama and French (1996)) in which the dependent variable is the realized return, all stocks were grouped into 20 to 30 portfolios and the regressions were conducted at the portfolio level. However, it is difficult to ask ordinary survey respondents to form expectations on the returns of Fama-Macbeth or Fama-French portfolios.[4]

The empirical results in this paper are based on individuals' subjective expectations about the real world from survey data covering twelve years and major U.S. metropolitan statistical areas (MSAs).[5] One challenge is that the actual fundamental values of assets are unobservable. However, they can be derived or estimated from economic and econometric models. Following the housing literature (e.g., Capozza et al. (2004), Abraham and Hendershott (1996), Malpezzi (1999), and Gao et al. (2009)), the fundamental housing value of a local housing market is estimated from the long-run relationship between the local house prices and the local economic variables.[6] In the literature on stock prices, some papers derived the fundamental values from the present value of future dividend payments under certain assumptions about dividend growth rates and discount rates (e.g., Chiarella (2012)); other papers estimated the fundamental value from the long-run relationship

[3] The Institutional Brokers' Estimate System (I/B/E/S) asked financial analysts about their subjective expectations on the earnings of individual listed companies, but not the returns or capital gains of individual stocks.

[4] Note that the Gallup survey studied by Greenwood and Shleifer (2014) asked individual investors during 1998-2000 about "the minimum acceptable rate of return" on these individual investors' portfolio over the next year, which can be used as a measure of required returns rather than subjective expectations.

[5] The Case-Shiller survey covers 2003-2012. The Michigan Survey covers 2007-2014.

[6] Those papers estimated error correction models (ECMs) for house price dynamics. In the first stage, they estimated an equation representing a long-run relationship between house prices and other fundamental economic variables, and they used the residuals as a measure of the deviation of house prices from their long-run equilibrium levels or fundamental values. In the second stage, they regressed current house-price changes on the deviation of house prices from their fundamental values, as well as on past-house price changes. They found that both short-run momentum and reversion to the long-run equilibrium had impacts on driving house price dynamics.

between stock prices and dividends in error correction models (e.g., Diba and Grossman (1988) and Psaradakis et al. (2004)). In the literature on foreign exchange rates, fundamental values are estimated from the long-run equilibrium relationship of purchasing power parity in error correction models (e.g., Manzan & Westerhoff (2007), Taylor and Mcmahon (1988), Pesaran et al. (2000), Taylor (2002), Corbae and Ouliaris (1988)).

In this paper, the identification of whether individuals' subjective expectations can capture the reversion to fundamentals in actual house-price movements comes from the cross-sectional and over-time variations of the deviation of local house prices from their fundamental values; similarly, the identification of whether individuals' subjective expectations can capture house-price momentums comes from the cross-sectional and over-time variations in lagged house-price growths. The results in this paper are further supported by Armona et al (2016), who conducted a novel experiment at the beginning of 2015 with approximately 1,200 participants and examined how participants updated their initial house-price expectations after new information on past house prices was provided. They mainly employ two cross-sectional variations to identify whether individuals' subjective expectations can capture mean reversion. One variation is below-median supply elasticity areas vs. above-median supply elasticity areas. They found that participants in below-median supply elasticity areas are less likely to be mean revertors than participants in above-median supply elasticity areas, although actual house prices movements in areas with low elastic supply exhibit stronger mean reversion patterns (as empirically found by Glaeser et al. (2008)). Leveraging the cross-sectional and over-time variations of the deviation of local house prices from their fundamental values, my study find that people's subjective expectations not only fail to accurately capture the reversion-to-fundamentals pattern, but also diverge from fundamentals. In addition, I empirically investigate two conjectures (fundamental-misperception conjecture and mispricing-persistence conjecture) that may generate this expectation pattern.

The most important finding in this paper is that on average, individuals' subjective expectations tend to diverge from actual fundamental values rather than converge to. There are two possibilities underlying the main empirical result in this paper. One possibility is referred as the fundamental-misperception conjecture. Households' expectation pattern is that the expected house prices tend to move toward their perceived fundamental value. However, households' perceived fundamental value is not an accurate estimate of the actual fundamental value. Households may tend to optimistically overestimate the fundamental value during boom times and tend to pessimistically underestimate the fundamental value during times of recession. He and Zheng (2016) built an agent-trading model in which agents have incomplete information about the fundamental value of assets. The model can generate bubbles, crashes, and mean-reverting asset prices and can closely matches the S&P 500.

The other possibility is referred as the mispricing-persistence conjecture. Households do have an accurate estimate of the fundamental value and know whether houses are mispriced, but they do not believe that mispricing will be corrected by the market in the short run. They have a belief that in the market, there exist a number of irrational traders and consequently, speculative opportunities of further capital gains even when assets are currently mispriced.

The empirical results in this paper indicate that the first possibility is more likely. The actual house price dynamics exhibit that the average annual growth rate over the next five years is more likely to move toward the fundamental value than the growth rate over the next year. However, the degree to which households' annualized five-year expectations diverge from the fundamental value is larger than the degree to which their one-year expectations diverge. If households do not believe that mispricing will be corrected by the market in the short run, then the degree to which households do not believe mispricing will be corrected by the market in five years (long run) should be lower than that for one year (short run). This conclusion is consistent with the bubble experiment literature (e.g., Smith et al (1988), Dufwenberg et al. (2005), Moinas and Pouget (2013), and Porter and Smith (1995)). In the real world, people are uncertain about the unobservable fundamental values of assets, but in laboratory environments the fundamental values can be artificially induced. Some experimental studies have indicated that when agents are aware or less uncertain of the fundamental values, asset bubbles are difficult to be generated or to sustain for a long time. Some other experimental studies have indicated that when the mispricing-persistence conjecture was ruled out in the experiment design, bubbles were still observed (e.g. Lei et al (2001)).

This paper also contributes to solving a puzzle in the behavior finance literature. Based on the representativeness bias of Kahneman and Tversky (1982), DeBondt and Thaler (1985) proposed the overreaction hypothesis: in forming expectations, people give too much weight to recent performance of assets in the data and too little weight to the properties of the population that generates the data. Empirically, DeBondt and Thaler (1985) found supporting evidence that when stocks are ranked on three- to five-year past returns, past winners tend to be future losers, and vice versa. Jegadeesh and Titman (1993) found the opposite results in short term stocks with high returns over the past year tend to also have high returns over the following three to six months. To explain the short-term momentum and the long-term reversal observed in the realized asset price data, Barberis et al. (1998) built a behavioral model with representativeness bias and conservatism; and Daniel, at al. (1997) built a behavioral model with overconfidence and biased self-attribution. However, Fama (1998) summarized the limitation of previous studies in testing for behavioral hypotheses as alternatives to the market efficiency hypotheses and noted that the task is daunting. Different from most previous studies, I make use of subjective expectation data complementing realized asset price data. The results that people's subjective expectations tend to diverge from the fundamentals support the overreaction hypothesis of DeBondt and Thaler (1985).

In addition, this paper is related to the theoretical and empirical literature on asset-price bubbles. The fact that households' house-price expectations tend to diverge from fundamentals may affect people's house purchasing and selling decisions and thus can serve as one of the forces that drive house-price bubbles. Previous studies, such as Shiller (1995), Shiller (2008), Shiller (2015), Scheinkman and Xiong (2003), Abreu and Brunnermeier (2003), Froot and Obstfeild (1991), Hong and Stein (1999), and Pearson et al. (2017), have provided several other explanations for asset price bubbles: precipitating events, positive feedback trading, social contagion, overconfidence in future appreciation, the inability of arbitrageurs to temporarily coordinate their selling strategies, the existence of rational bubbles or intrinsic bubbles, the activities of momentum traders, and so on. Studies on econometrically testing for bubbles include Hamilton and Whiteman (1985), Diba and Grossman (1988), Campbell and Shiller (1987), Evans (1991), and so on. Empirical studies of the real estate market, such as Lai and Van Order (2010), Ambrose et al. (2013), Himmelberg et al. (2005), and Fraser et al. (2008), have provided evidence that house-price bubbles can be persistent and long-lasting. Case and Shiller (2003) noted that households' expectations of future house price increases can sustain house-price bubbles. Gao, Sockin and Xiong (2017) examined the role of housing speculation in generating housing bubbles. Glaeser et al. (2008) developed a theoretical model that can generate self-reinforcing house-price bubbles with adaptive expectations assumptions.

Due to the lack of availability of subjective house-price expectation data, only a few studies have empirically analyzed the formation of house-price expectations directly, and they focus on other aspects. Case et al. (2012) analyzed the unbiasedness and efficiency of subjective house-price expectations using their survey data covering households in Alameda County, CA, Milwaukee County, WI, Middlesex County, MA, and Orange County, CA. In addition, as a simple structure of expectation formation, they regressed the expected house-price changes on the past actual house-price changes. Niu and van Soest (2014) studied house-price expectations using the American Life Panel data. Using the Wall Street Journal's economic forecasting survey, Zhang (2015) analyzed the unbiasedness and efficiency of house-price expectations by professional forecasters. Using the Survey of Consumer Expectations by the Federal Reserve Bank of New York, Kuchler and Zafar (2016) studied the effect of past momentum on house-price expectations and the effect of past volatility on the width of the distribution of house-price expectations.[7] Howard and Karagedikli (2012) provided a descriptive analysis of the subjective house-price expectations of households in New Zealand based on data from the Reserve Bank of New Zealand's household survey. Because of the lack of house-price expectation data, many studies analyzed how households formed their house-price expectations using another approach. These studies, including Malpezzi and Wachter (2005), Burnside et al. (2011), Mayer and Sinai (2007), Sommervoll et al. (2010), Adam et al. (2012), Dieci and Westerhoff (2012), and Glaeser and Nathanson (2015), performed simulations and calibrations based on some assumptions about households' house-price expectation formation and then compared the simulated house prices to the realized house prices to see whether their assumptions about house-price expectations could generate house-price dynamics that accurately reflect the real economy. Some conclusions in these studies have been verified by the recent studies using subjective expectation data.

Many studies also rejected the rational expectations hypothesis for other economic variables using survey data on subjective expectations, such as Greenwood and Shleifer (2014) on stock return expectations. Branch (2004) developed and estimated a model that provides rationality for people's irrational expectations. In that model, agents rationally choose a forecasting method from a set of alternatives, comparing both the accuracy and the cost of complexity of each forecasting method. Several studies analyzed other factors that affect households or professional forecasters' expectations, including Malmendier and Nagel (2015) on lifetime experience, Carroll (2003) on news reports, Branch (2007), Coibion and Gorodnichenko (2015), and Coibion and

[7] The Survey of Consumer Expectations by the Federal Reserve Bank of New York also asks respondents to assign a probability to a range of possible house price-changes, whereas the Michigan Survey does not.

Gorodnichenko (2012) on information rigidities, Ehrbeck and Waldmann (1996) on the strategic interactions of professional forecasters, and Rich and Tracy (2010) and Engelberg et al. (2009) on forecast uncertainty. Some studies also provided evidence that individuals' expectations are inconsistent with either existing economic theories or realized economic data. For example, using Michigan Survey data, Dräger et al. (2015) found that only 34% of households had a Phillips curve tradeoff in mind when forming expectations on inflation and unemployment, and only 46% of households formed expectations regarding the interest rate, inflation, and the unemployment rate in line with a Taylor rule relationship.

This paper is also related to the literature on cognitive abilities and irrational behaviors in housing markets, such as Cheng, Raina and Xiong (2014) on Wall-Street managers' awareness of the 2007 housing crisis in 2004-2006, Pope et al. (2015) on the focal-point effect on bargaining in housing markets, Keys et al. (2016) on irrational behaviors in mortgage refinance decisions, Agarwal et al. (2016) on mistakes in mortgage contract selections, and Agarwal and Mazumder (2013) on mistakes in home equity loan or line of credit (HELOC) applications.

Some studies use the Michigan Survey of Consumers to analyze households' expectations about other macroeconomic variables. Branch (2004), Ang et al. (2007), and Ehrmann et al. (2015) studied households' expectations of inflation. Anderson et al. (2013) and Anderson et al. (2011) studied households' expectations concerning gasoline prices. Laxton et al. (1999) estimated the Phillips curve using inflation expectation data from the Michigan Survey. [8]

This paper displays the empirical results in a way similar to that of Anderson et al. (2013). They first conducted an MSA-level analysis on the relationship between local average expectations on gasoline prices in the Michigan Survey and actual local average gasoline prices, and then they conducted an individual-level analysis on the relationship between individual expectations on gasoline prices in the Michigan Survey and actual local average gasoline prices.

The remaining portion of this paper is organized as follows. In Section 2, I describe the data used in this paper. In Section 3, the empirical models are explained. Section 4 first discusses the empirical results of the MSA-level analysis using the Michigan Survey data; next, it discusses

[8] Some studies analyzed the predicting power of the consumer confidence index from the Michigan Survey for future actual economic activities, such as Souleles (2004), Ludvigson (2004), and Lemmon and Portniaguina (2006).

the empirical evidence related to the fundamental-misperception conjecture and the mispricing-persistence conjecture; next, it displays the robustness checks; next, it discusses the empirical results using the Case-Shiller Survey data that have a longer sample period; next, it discusses the empirical results of the individual-level analysis using the Michigan Survey data; next, it discuss the results obtained from an alternative empirical strategy that draws the same conclusion. I conclude in Section 5.

2. Data

The Michigan Survey of Consumers. Starting in 1977, the Michigan Survey of Consumers surveys approximately 500 people each month about their expectations regarding particular economic variables. Beginning in January 2007, the monthly Michigan Survey of Consumers asks households about their expectations for local house-price growth over the next year and over the next five years.[9] The analyses in this paper focus on the top 30 metropolitan statistical areas (MSAs) for which the Michigan Survey has good coverage.[10] Table 1 reports the numbers of Michigan Survey respondents who provide their house-price expectations in each MSA. Panel A in Table 2 reports the descriptive statistics of the respondents' expectations and demographic characteristics.

The Case-Shiller Survey. The Case-Shiller survey asks households about their house price appreciation expectations over the next year in the following four central counties within metropolitan areas: Alameda County, CA (Oakland and much of the East Bay in the San Francisco-Oakland-Fremont MSA); Milwaukee County, WI (the core of the Milwaukee-Waukesha-West Allis MSA); Middlesex County, MA (Cambridge and the areas north and west in the Boston-Cambridge-Quincy MSA), and Orange County, CA (which includes Anaheim and Irvine in the southern part of the Los Angeles-Long Beach-Santa Ana MSA). The Case-Shiller survey chose

[9] The Michigan Survey asks two questions about households' house-price expectations: 1. "By about what percent do you expect prices of homes like yours in your community to go (up/down), on average, over the next 12 months?" 2. "By about what percent **per year** do you expect prices of homes like yours in your community to go (up/down), **on average**, over the next 5 years or so?"

[10] Alternatively, I either restrict the sample to the top 10 MSAs where the Michigan Survey has even better coverage, or expand the sample to all the MSAs covered by the Michigan Survey. The results are robust and are available upon request.

these four locations to represent what were viewed as two “hot” markets (Los Angeles and San Francisco), a “cold” (post-boom) market (Boston), and a relatively stable market (Milwaukee). Case et al. (2012) published the annual average expectations of the respondents within these four locations during 2003-2012, a longer sample period than that of the Michigan Survey of Consumers.[11] I performed an MSA-level analysis using the Case-Shiller Survey data and found that the results obtained from the Michigan Survey data are robust in this longer period.

American Life Panel-Asset Price Expectation Survey (ALP-APE). The American Life Panel is a nationally representative panel of more than 6,000 members who are regularly interviewed over the Internet for research purposes. Multiple surveys are conducted within this panel for different research purposes. One of them is the Asset Price Expectation Survey. This survey first provided respondents with the current house price level in their residing cities, and then asked whether the current house price is just right, too high, or too low as compared to the fair value. Accordingly, the numbers of observations with each of the three answers are 14540, 10230, and 7636, respectively. The survey also asked respondents about their house-price expectations over the next one year, the next one month, and the next three months.

Federal Housing Finance Agency (FHFA) House-Price Index. The data on the quarterly MSA level house-price index come from the FHFA. The FHFA house price index is a weighted, repeat-sales index that is constructed based on single-family properties whose mortgages have been purchased or securitized by Fannie Mae or Freddie Mac since January 1975.

Other Data. The data on the MSA level population and income per capita are collected from the Bureau of Economic Analysis (BEA). The data on the mortgage market interest rate come from the Freddie Mac Primary Mortgage Market Survey (PMMS). The national consumer price index (CPI) are collected from the Bureau of Labor Statistics (BLS). The national level construction cost index (CCI) comes from R.S. Means. The descriptive statistics of the MSA-level macroeconomic variables are reported in Panel B of Table 2.

3. The Empirical Models

Error correction models have been widely used to estimate the fundamental values of assets in the stock price literature (e.g., Diba and Grossman (1988) and Psaradakis et. Al (2004)), the real estate

[11] For more details about the data, please see Case et al. (2012).

literature (e.g., Capozza et al. (2004), Abraham and Hendershott (1996), Malpezzi (1999), and Gao et al. (2009)) , and the exchange rate literature (e.g., Manzan & Westerhoff (2007), Taylor and Mcmahon (1988), Pesaran et al. (2000), Taylor (2002), and Corbae and Ouliaris (1988)). In addition, error correction models have also been widely applied to other financial and economic studies. For example, in the Pairs Trading Strategy, two stocks with similar fundamentals could have a long-run relationship in price movements; investors could short the outperforming stock and long the underperforming one, betting that the "spread" between the two would eventually converge. The deviation from the long-run relationship within the pair could be caused by temporary supply/demand changes, large buy/sell orders for one security, and reaction to important news about one of the companies. Studies on the Pairs Trading Strategy include Liu and Timmermann (2013), Alexander (1999), Gatev, Goetzmann and Rouwenhorst (2006), Jurek and Yang (2007), Hugonnier and Prieto (2015), Rothensal and Young (1990), Tourin and Yan (2013), and Lei and Xu (2015). Harris et al. (1995) studied the long-run relationship among the IBM stock prices across the exchanges in three countries. Arshanapalli (1993) studied international stock market linkages. Kim (2003) studied long-run equilibrium relationships among the aggregate stock price, industrial production, real exchange rate, interest rate, and inflation in the United States. Other studies using error correction models include Miller (1991) and Mehra (1993) on the dynamics of monetary demand and supply, Crowder and Hoffman (1996) on the relationship between nominal interest rates and inflation, Muscatelli et al. (1992) and Chowdhury (1993) on international trade flows and exchange rates, Balcombe and Rapsomanikis (2008) on the relationship among sugar, ethanol, and oil prices, Hall et al. (1992) on the yield to maturity of treasury bills, and so on.

In the real estate literature, several studies have estimated error correction models with slightly different specifications for house-price dynamics. The estimation procedure consists of two stages. In the first stage, an equation representing the long-run relationship between house prices and economic fundamentals, such as equation (1), was estimated using ordinary least squares (OLS). In the second stage, an equation governing the adjustment of house prices, such as equation (2), was estimated.

$$P_{m,t} = \alpha_m + X_{m,t}\beta + \varepsilon_{m,t} \tag{1}$$

$$\Delta P_{m,t+h} = \theta_1 \Delta P_{m,t} + \theta_2 (P_{m,t} - P^*_{m,t}) + \theta_3 \Delta P^*_{m,t+h} + \eta_{m,t+h}, \quad h = 1, 5 \tag{2}$$

In equation (1), $P_{m,t}$ is the natural logarithm of the house price index for MSA m in quarter t. α_m represents the MSA fixed effect. $X_{m,t}$ constitute the fundamental economic variables for MSA m in quarter t. Equation (1) displays the long-run relationship between the house prices and the fundamental economic variables. In the first stage, equation (1) is estimated using OLS. $\hat{\alpha}_m$ and $\hat{\beta}$ denote the estimators of α_m and β, respectively. $P^*_{m,t} = \hat{\alpha}_m + X_{m,t}\hat{\beta}$ is an estimate of the unobserved long-run equilibrium level (or fundamental level) of the house price in MSA m in quarter t. $P_{m,t} - P^*_{m,t}$ measures the deviation of the current house price from its long-run equilibrium level.[12]

When estimating the long-run relationship, previous studies had some variation in their choices of fundamental economic variables. Generally, these fundamental variables can be clustered into demand-side variables and supply-side variables. In this paper, the fundamental demand side variables include per capita income, population, and mortgage market interest rate. If mortgage interest rates are low, then more households will borrow to purchase houses, which will drive house prices up. The supply side variable is the R.S. Means CCI, which is an overall measure taking into account both material costs and labor costs.[13] The CPI is also included because the dependent variable is the nominal house price. Some previous studies have used real house prices

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[12] I estimate equation (1) with $P_{m,t} = \log(house\_price\_index_{m,t})$. The FHFA house price indices only measure the relative prices within an MSA over time. Indices across different cities are not comparable to one another. I can estimate equation (1) with $\log(house\_price\_index_{m,t} \times baseline\_value_m)$ to be the dependent variable, where $baseline\_value_m$ is the absolute dollar value of the standard houses in MSA m in the baseline period. However, $\log(house\_price\_index_{m,t} \times baseline\_value_m) = P_{m,t} + \log(baseline\_value_m)$, and $\log(baseline\_value_m)$ can be absorbed by the MSA-specific fixed effect. Therefore, it is not problematic to estimate equation (1) with the house-price index as the dependent variable. I also employ the National Association of Realtors MSA-level median house prices in the baseline period as $baseline\_value_m$ and re-estimate equation (1) without MSA-specific fixed effects to obtain $P^*_{m,t}$. This does not affect the results in the latter regressions of interest.

[13] Capozza et al. (2004) also used a land supply index developed by Rose (1989) as a supply side variable. This index is a measure of the percentage of land in the city that is available for development. Because it varies across MSAs but not over time, it will be absorbed by the MSA fixed effects in equation (1)

(the nominal house price index deflated by the CPI) to estimate the long-run relationship.[14] This paper uses nominal house prices because both the Michigan Survey and the Case-Shiller Survey asked respondents to provide their expectations for nominal house-price appreciation rates rather than for real rates. Anderson et al. (2013) derived the respondents' subjective expectations for real changes in gasoline prices using the difference between their expectations for nominal gasoline price changes and their expectations for inflation. In this paper, I choose to use nominal terms because households are more likely to form their subjective expectations based on nominal terms than on real terms. Brunnermeier and Julliard (2008) provided empirical evidence that households cannot fully disentangle real and nominal terms in interest rates, mortgage payments, rents, and house prices, which supports the money illusion hypothesis.

Equation (2) is a specification of the house-price adjustment process that Capozza et al. (2004) estimated in the second stage using actual house-price data.[15] When $h = 1$, $\Delta P_{m,t+h} = P_{m,t+1} - P_{m,t}$, and $\Delta P^*_{m,t+h} = P^*_{m,t+1}$ - $P^*_{m,t}$. When $h = 5$, $\Delta P_{m,t+h} = (P_{m,t+5} - P_{m,t})/5$, and $\Delta P^*_{m,t+h} = (P^*_{m,t+5}$- $P^*_{m,t})/5$, i.e., the average annual change over the next five years. θ_1 represents the degree of serial correlation. If there are momentum effects that cause house price changes to exhibit a positive serial correlation, then θ_1 is positive. θ_2 is the extent to which house prices revert to or diverge from their fundamental values. If there are forces pushing house prices back toward their fundamental values, then θ_2 is negative. θ_3 represents the contemporaneous adjustment of house prices to the current change in their fundamental values.

$$E_t\Delta P_{m,t+h} = \lambda_1\Delta P_{m,t} + \lambda_2(P_{m,t} - P^*_{m,t}) + \lambda_3 E_t\Delta X_{m,t+h} + \xi_{m,t+h}, \qquad h = 1, 5 \tag{3}$$

[14] Estimating the long-run relationship using real terms is equivalent to using nominal terms with a restriction on the coefficient of the CPI.

[15] The house-price adjustment process estimated by some other papers (such as Malpezzi (1999) and Abraham and Hendershott (1996)) is specified as $\Delta P_{m,t+1} = \theta_1\Delta P_{m,t} + \theta_2(P_{m,t} - P^*_{m,t}) + \theta_3\Delta X_{m,t+1} + \eta_{m,t}$, where $\Delta X_{m,t+1}$ are changes of some fundamental economic variables. I also estimate this type of specifications and obtain similar results on the coefficients of $\Delta P_{m,t}$ and $(P_{m,t} - P^*_{m,t})$. The results are available upon request.

The innovation of this paper is estimating equation (3) in the second stage. The dependent variable is the subjective expectation of future house-price changes averaged at the MSA level rather than the actual house-price changes. When $h = 1$, $E_t\Delta P_{m,t+h}$ is the expectation on the house-price appreciation rate over next year. When $h = 5$, $E_t\Delta P_{m,t+h}$ is the expectation on the average annual appreciation rate over the next five years, as explicitly asked in the Michigan Survey questions. λ_1 represents the degree to which households' expectations about future house-price changes are related to actual house-price changes in the past. If the momentum effect observed in the actual house-price movement is captured by households' subjective expectations, λ_1 should be significantly positive. λ_2 represents the extent to which households adjust their expectations about future house prices based on the deviation of current actual house prices from their fundamental values. If the revert-to-equilibrium effect observed in actual house-price movement is captured by households' subjective expectations, λ_2 should be significantly negative.

The households' expectations for future house-price changes are also related to their expectations about future changes in fundamental economic variables. In addition to future house-price expectations, the Michigan Survey of Consumers asks respondents about their expectations for several fundamental economic variables, such as the inflation rate and the income growth rate. They are also asked whether they think the unemployment rate and the borrowing interest rate will increase or decrease and whether the economy will be better off or worse off. $E_t\Delta X_{m,t+h}$ in equation (3) include the average expectations for the inflation rate and the income growth rate and the percentage of respondents who think that the unemployment rate will increase, who think the borrowing interest rate will increase, and who think the economy will be better off, for each MSA and quarter combination.[16]

Because the Michigan Survey sample used to calculate the average subjective expectation in an MSA is much smaller than the sample of house transactions used by the FHFA to calculate the house price index in an MSA, one concern is that the average expectation of the households in an MSA surveyed by the Michigan survey is a noisy measure of the true average expectation of

[16] When $h = 1$, $E_t\Delta X_{m,t+1}$ include expectations of fundamental economic variables for the next year. When $h = 1$, in $E_t\Delta X_{m,t+5}$ only the expectations of CPI are for the next five years, as the Michigan Survey only asks expectations of CPI for both the next year and the next five years.

the entire population in the MSA. Suppose that the true average expectation of the entire population in MSA m in quarter t is

$$\tilde{E}_t \Delta P_{m,t+1} = E_t \Delta P_{m,t+1} - v_{m,t},$$

where $v_{m,t}$ is the measurement error and follows $N(0, \sigma_{m,t}^2)$. The equation governing the movement of $\tilde{E}_t \Delta P_{m,t+1}$ is

$$\tilde{E}_t \Delta P_{m,t+1} = \lambda_1 \Delta P_{m,t} + \lambda_2 (P_{m,t} - P_{m,t}^*) + \lambda_3 \Delta P_{m,t+1}^* + u_{m,t},$$

where $u_{m,t}$ reflect only the errors associated with the specification of the model. Then, in equation (3), $\xi_{m,t}$ will be a mixture of $u_{m,t}$ and $v_{m,t}$. The measurement error of the dependent variable will increase the total error variance in the estimation of equation (3), but it will not bias the coefficient estimates. Similar arguments can be found in Campello (2003). Because the numbers of respondents in the Michigan Survey differs across MSAs and quarters, the levels of noise for the measurement are different across MSAs and quarters, i.e., $\sigma_{m,t}^2$ should be different across different m and t. Therefore, the standard errors of the coefficients in equation (3) are estimated using White's heteroscedasticity-consistent estimator. I also estimate the standard errors using the cluster-robust estimator to capture the possible serial correlations of the error term within each MSA. The results are similar.

Equation (1) is estimated using the FHFA house price index from 1980Q1 to 2014Q3.[17] Equation (3) is estimated using data on households' subjective expectations from the Michigan Survey from January 2007 to June 2014 and from the Case-Shiller Survey from 2003 to 2012, respectively. The fundamental house value in equation (3) is obtained from the estimates of equation (1) using the actual house price index during 1980-2014 in order to obtain more reliable estimates of the long-run relationship and fundamental house values with a longer sample period.[18]

This paper also estimates equation (4) using individual-level data, where $Z_{i,t}$ are the demographic characteristics of individual i. Equation (4) allows λ_2 (the extent to which households adjust their expectations of future house prices based on the deviation of current actual

[17] Gao et al. (2009) also only used the FHFA index after 1980 because the data before 1980 are thin.

[18] I also use 2007-2014 house price index data in the estimation of the long-run relationship and the house fundamental values to match the sampling period of the Michigan Survey, as well as use 2003-2012 house price index data in the estimation of the long-run relationship and the house fundamental values to match the sampling period of the Case-Shiller Survey. The results in this paper are robust to these changes.

house prices from their fundamental values) in equation (3) to vary across individuals with different demographic characteristics.

$$E_t^i \Delta P_{m,t+h} = \gamma_1 \Delta P_{m,t} + \gamma_2 (P_{m,t} - P_{m,t}^*) + \gamma_3 Z_{i,t} (P_{m,t} - P_{m,t}^*) + \gamma_4 E_t^i \Delta X_{m,t+h} + \gamma_5 Z_{i,t} + \xi_{i,t+h}, \qquad h = 1, 5 \tag{4}$$

4. Empirical Results

In this section, I first report the results of the estimation of the error correction model (equation (1) as the long-run relationship and equation (2) as the dynamic adjustment of actual house prices) using the actual house prices, which has been conducted by previous studies in the literature. Next, I report the estimates of the equations for the adjustment of households' subjective expectations about future house prices at the MSA level (equation (3)) and at the individual level (equation (4)). The results of the adjustment of households' subjective expectations about future house prices are compared with the results of the dynamic adjustment of actual house prices.

4.1. The MSA-level Analysis for the Michigan Survey

Table 3 reports the estimates of equation (1) for the long-run relationship between realized house prices and fundamental economic variables. The results are consistent with theory and intuition. House prices are increasing in per capita income, population, construction cost index, and CPI, and decreasing in the mortgage market interest rate.

Table 4 displays the estimates of equation (2) for the dynamic adjustment of realized house prices. $P_{m,t} - P_{m,t}^*$ are the residuals generated from the estimation in Table 3 using the data from the top 30 MSAs. In Panel A of Table 4, the dependent variable is the house-price appreciation in the next year. Models I and II are specifications without and with the one-year change of fundamental value ($\Delta P_{m,t+h}^*$), respectively. In Model I, the coefficient of $P_{m,t} - P_{m,t}^*$ is -0.0174, significantly negative at a 1% level, and $\Delta P_{m,t}$ is 0.5311, significantly positive at a 1% level; in Model II, the coefficient of $P_{m,t} - P_{m,t}^*$ is -0.0170, significantly negative at a 1% level, and $\Delta P_{m,t}$ is 0.4967, significantly positive at a 1% level. The results indicate that actual house price movements are driven by both momentum (or short-horizon serial correlation) and reversion to fundamentals (long-horizon mean reversion), which is consistent with the existing literature estimating error correction models for actual house prices, such as Capozza et al. (2004), Abraham and Hendershott (1996), Malpezzi (1999), and Gao et al. (2009). In Model III of Table 4, I allow the coefficient of the deviation from fundamentals when the deviation is positive to be different from the coefficient when the deviation is negative. An F test shows that the two coefficients are not significantly different from each other.[19]

In Panel B of Table 4, the dependent variable is the average annual growth rate over the next five years. Similarly, in Model I, the coefficient of $P_{m,t} - P^*_{m,t}$ is -0.0552, significantly negative at a 1% level, and $\Delta P_{m,t}$ is 0.1243, significantly positive at a 1% level; in Model II, the coefficient of $P_{m,t} - P^*_{m,t}$ is -0.0481, significantly negative at a 1% level, and $\Delta P_{m,t}$ is 0.1122, significantly positive at a 1% level. Moreover, the coefficient of $P_{m,t} - P^*_{m,t}$ in Panel B is larger in magnitude than that in Panel A, which indicates that in the actual house-price dynamics, the average annual growth rate over the next five years is more likely to move toward the fundamental value than the growth rate over the next year. The coefficient of $\Delta P_{m,t}$ in Panel B is smaller in magnitude than that in Panel A, which indicates that in the actual house price dynamics, current momentums have larger effects on future appreciations in the short run than in the long run.[20]

Figure 1 displays the deviations of actual house prices from the fundamental values for the top 30 MSAs during 2000-2014. In addition to the significant cross-sectional variation, there is a national-level common over-time variation. 2000-2006 is the housing boom period in which not only the house price levels but also their deviations from the fundamental values were increasing continuously. Both the house price levels and their deviations from the fundamental values reached

[19] Johansen cointegration tests show the house prices and the fundamental economic variables in equation (1) are cointegrated with a full rank at a 5% significance level. Many previous studies tested the cointegration relationship between house prices and fundamental economic variables with different specifications and selections of fundamental economic variables (e.g., Malpezzi (1999), Meen (2002), Gallin (2006), and Zhou (2010)). Most of them found that house prices and fundamental economic variables are cointegrated.

[20] In panel A of Table 4, the coefficient of $P_{m,t} - P^*_{m,t}$ is much smaller in magnitude than that of $\Delta P_{m,t}$. This does not mean that reversion-to-fundamental effects are not important in driving the actual house-price dynamics, as momentum will decay in long run and reversion-to-fundamental effects will persist and accumulate in the long run. As can be seen from Panel B of Table 4 in which the dependent variable is annualized five-year changes, the gap between the coefficients of $P_{m,t} - P^*_{m,t}$ and $\Delta P_{m,t}$ is much smaller.

their peaks in 2006. As the 2007 financial crisis was triggered by mortgage defaults, the housing market crashed first in 2007, followed by the recession of the fundamental economy (e.g., falling in GDP growth and income and rising in unemployment rates) in 2008. Therefore, the deviation of actual house prices from the fundamental values started to fall in 2007. In 2008, as the house prices hit the bottom and the fundamental economy continued to deteriorate, the deviation of actual house prices from the fundamental values started to increase. During 2009-2012, as the fundamental economy was recovering but the housing market remained in recession, the deviation of actual house prices from the fundamental values was decreasing. In 2013, as the housing market started to recover, the deviation of actual house prices from the fundamental values started to increase. In summary, although 2007-2014 includes one cycle of house price levels, it includes two cycles of the deviation of actual house prices from the fundamental values.

The estimates of equation (3) are shown in Table 5. The dependent variable is the average subjective expectation of house-price appreciation by the Michigan Survey respondents within an MSA. For Panel A, the dependent variable is the expectation for house-price appreciation next year. For Panel B, the dependent variable is the expectation for average annual house-price appreciation over the next five years. $P_{m,t} - P^*_{m,t}$ are the residuals generated from the estimation in Table 3 using the data from the top 30 MSAs during 1980-2014.[21] Models I and II of Table 5 are specifications without and with controlling for respondents' expectations on other economic fundamental variables, respectively. In Model III of Table 5, I allow the coefficient of the deviation from fundamentals when the deviation is positive to be different from the coefficient when the deviation is negative.

The most important result in this paper is that, the coefficient of $P_{m,t} - P^*_{m,t}$ in Table 5 is significantly positive at a 1% level rather than negative, which is different from that in Table 4,. These results are robust regardless of whether expectations on other fundamental economic

[21] Although the dependent variable in equation (3), households' expectations for house-price appreciation rates, is only available after 2007, the regressor $P_{m,t} - P^*_{m,t}$ used in equation (3) is the residual generated from the estimation of equation (1) (the long-run relationship equation) using the actual house price data during 1980-2014 rather than during 2007-2014. The reason is that it is more appropriate to view the estimates of equation (1) using data during 1980-2014 as the long-run relationship than those using data during 2007-2014.

variables are controlled. This finding indicates that households' house-price expectations tend to diverge from the fundamental values of house prices, while the actual house prices exhibit reversion to their fundamental values. In other words, when current house prices are above (below) the fundamental values, households tend to have an even higher (lower) expectation for future house-price appreciation.[22] [23] Households' house-price expectations are more likely to overshoot than the realized house prices.

The coefficients of $\Delta P_{m,t}$ in Table 5 are significantly positive at a 1% level, which is consistent with that in Table 4. This indicates that the momentum (or short-horizon serial correlation) exhibited in actual house price movements is captured by households' subjective expectations. This finding is consistent with the results obtained by Case et al. (2012) using their survey and Kuchler and Zafar (2016) using the Survey of Consumer Expectations by the Federal Reserve Bank of New York. Moreover, the coefficients of $\Delta P_{m,t}$ in Table 4 are larger than the corresponding counterparts in Table 5. This indicates that the momentum effect in the actual house-price dynamics is greater than perceived by subjective expectations. Case et al. (2012) and Armona et al. (2016) also obtained similar under-extrapolation results.[24]

The coefficients of households' expectations for other fundamental variables are mostly consistent with intuition or theory. An MSA's average expectation for house-price appreciation rates will be higher either if people expect higher incomes or higher inflation or if more people expect that the economy will improve or that unemployment will decrease. The R^2 in Panel A of Table 5 is above 22%, while the R^2 in Panel B of Table 5 is below 10%. These results indicate

[22] I also use different specifications of the long-run relationship to estimate equation (1), and then plug the residuals generated from those specifications as $P_{m,t} - P^*_{m,t}$ into equations (2) and (3). The results are similar.

[23] I note that the error correction model in equation (2) provides a better prediction for future house prices than average survey respondents do. The mean squared error of the prediction by MSA-level average subjective expectations of respondents is four times as high as the mean squared error of the prediction by the error correction model in equation (2).

[24] Guren (2016) developed a house-price dynamics model with strategic complementarity as a mechanism that can amplify momentum caused by a class of sources, including gradual learning (Anenberg (2014)), search friction (Head et al. (2014)), gradual information spread (Burnside et al. (2015)), and under-react to news due to behavior bias (Barberis et al. (1998) and Hong and Stein (1999)).

that the regressors have higher explanatory power for households' short-run house price expectations than for their long-run house price expectations.

Another interesting result shown in Table 5 is that households' house-price expectations are positively correlated with their borrowing interest rate expectations. In the real economy, house-price appreciation is negatively rather than positively correlated with interest rates, because if mortgage interest rates are low, then more households will borrow mortgages to purchase houses, which will drive house prices up. The results in Table 3 in this paper and other studies confirmed this finding. One reason for why households' house-price expectations are positively correlated with their borrowing-interest-rate expectations could be that households do not have rational expectations. The borrowing interest rate is positively correlated with the rate of return on people's assets in the bank, and the house-price appreciation rate is the rate of return on people's housing investments. Perhaps people simply think that these two variables should be positively correlated with each other.[25]

4.2. Fundamental-Misperception Conjecture vs. Mispricing-Persistence Conjecture

The most important finding in this paper is that on average subjective expectations tend to diverge from the actual fundamental values rather than converge to. This conclusion does not require interpreting the fundamental values estimated from realized data as proxies for the fundamental value in people's beliefs, which are unobservable to researchers.

There are two possibilities underlying the main empirical result in this paper. The first possibility is the fundamental-misperception conjecture. Households' expectation pattern is that the expected house prices tend to move toward their perceived fundamental value. However, households' perceived fundamental value is not an accurate estimate of the actual fundamental value. Households may tend to optimistically overestimate the fundamental value during boom

[25] Previous research has shown that people's expectations for economic variables are not always consistent with theory or reality. For example, using the Michigan Survey data, Dräger et al. (2015) found that only 34% of households had a Phillips curve tradeoff in mind when forming expectations on inflation and unemployment, and only 46% of households formed expectations regarding the interest rate, inflation, and the unemployment rate in line with a Taylor rule relationship. They also found that central bank communication and news about monetary policies could improve households' forecasting consistency with the Phillips curve and the Taylor rule. Carvalho and Nechio (2014) conducted a similar study.

times and tend to pessimistically underestimate the fundamental value during times of recession. Consequently, in the empirical evidence, households' house-price expectations tend to diverge from the actual fundamental value. In this case, households do not know whether assets are mispriced. He and Zheng (2016) built an agent-trading model in which agents have incomplete information about the fundamental value of assets. The model can generate bubbles, crashes, and mean-reverting asset prices and can accurately matches the S&P 500.

The second possibility is the mispricing-persistence conjecture. Households' expectation pattern is that house prices tend to diverge from the perceived fundamental value, although the perceived fundamental value could be an accurate estimate of the actual fundamental value. In this case, households know whether houses are mispriced but do not believe mispricing will be corrected by the market in the short run. They believe that there are irrational participants in the market who would still buy assets even when the prices are highly above the fundamental values or would sell assets even when the prices are deeply below the fundamental values.

Although the fundamental value in households' beliefs are unobservable, the following results provide indirect evidence that the first case is more likely. In Panel A of Table 5 for the one year expectation regression, the coefficient of $P_{m,t} - P^*_{m,t}$ is 0.0178, while, in Panel B of Table 5 for the five year expectation regression, the coefficient of $P_{m,t} - P^*_{m,t}$ is 0.0416. The difference is significant at a level of 1%. This finding indicates that households' 5-year-horizon expectations for house prices are more strongly positively correlated with the current deviation from fundamentals than their 1-year-horizon expectations are, although in the real economy, actual house prices are more likely to revert to fundamentals in the long run than in the short run (as indicated by the empirical results in Table 4 that the coefficients of $P_{m,t} - P^*_{m,t}$ in Panel B are more negative than in Panel A and the difference is significant at a level of 1%).

If the second conjecture is the main driving factor, then the coefficient of $P_{m,t} - P^*_{m,t}$ for the five-year expectation regression should be smaller than that for the one-year expectation regression. The reason is that the degree to which households do not believe mispricing will be corrected by the market in five years (long run) should be lower than that in one year (short run). Although not fully rational, households' expectations should be somewhat consistent with the pattern in the realized house prices that the reversion to fundamentals is stronger in five years than in one year (Table 4).

If the first conjecture is the correct one, then the coefficient of $P_{m,t} - P^*_{m,t}$ for the five-year expectation regression should be larger than that for the one-year expectation regression. The reason is that along with people's optimistic overestimation of the fundamental value during boom times, house prices could be below households' perceived fundamental value although above the actual fundamental value; consequently, the degree to which households expect house prices to increase toward the perceived fundamental value in five years (long run) should be higher than the degree to which households expect house prices to increase toward the perceived fundamental value in one year (short run). To summarize, the empirical result is consistent with the first conjecture.

The coefficient of $\Delta P_{m,t}$ for one-year expectations as in Panel A of Table 5 is 0.3878, while the coefficient of $\Delta P_{m,t}$ for annualized five-year expectations as in Panel B of Table 5 is 0.1148. The difference is significant at a level of 1%. This finding indicates that households' short-run house-price expectations are more dramatically affected by actual house-price movements in the recent past than their long-run expectations are. This is consistent with the actual house-price dynamics that current momentum has a larger effect on future appreciations in the short run than in the long run. This result is the opposite of the result for the effect of house-price deviations from the fundamental values on the expectations discussed previously, which further indicates that the more likely reason for the expectations diverging from fundamentals is that households do not have accurate estimates of the fundamental value rather than that households do not believe the mispricing will be corrected by the market in the short run.

To provide further evidence on which reason causes expectations diverging from fundamentals, I analyze the ALP-APE data. This survey first provided respondents with the current house price level in their residing cities, and then asked whether the current house price is just right, too high, or too low as compared to the fair value.[26] The survey also asked respondents about their house-price expectations over the next one year, the next one month, and the next three months. Although we still do not observe the fundamental values in respondents' beliefs, we do observe whether the current house prices are below or above the fundamental values in respondents'

[26] The survey question is: "Do you believe that current housing prices are: Enumerated: 1 just right (in the sense that housing prices are in line with what you personally regard to be fair), 2 too high, 3 too low as compared to the fair value?"

beliefs. I create a categorical variable $compared\_to\_fundamental$. It equals 1, 0, and -1 if the respondent thought the current house price is above, at, and below the fair value, respectively.

I run the regression of house-price expectations on $compared\_to\_fundamental$ and lagged actual house-price appreciations. The results are displayed in Table 6. The dependent variables in columns I, II, III are respondents' expectation on house-price appreciation rates over the next one year, expectations on annualized appreciation rates over the next three months, and expectations on annualized appreciation rates over the next one month, respectively. The coefficient of $compared\_to\_fundamental$ is all significantly negative across the three columns. This result indicates that even respondents' short-run (less than or equal to one year) house-price expectations revert to their perceived fundamental values. This result further supports the previous argument that the reason why subjective expectations diverge from the actual fundamental value is more likely to be households' misperception of fundamental values rather than that households do not believe that mispricing will be corrected by the market in the short run.[27] The coefficient of $\Delta P_{m,t}$ is significantly positive, which indicates that respondents' expectations capture the momentum effect.

This conclusion is consistent with the bubble experiment literature (e.g., Smith et al. (1988), Dufwenberg (2005), Moinas and Pouget (2013), and Porter and Smith (1995)). In the real world people are uncertain of the unobservable fundamental values of assets, but in laboratory environments the fundamental values can be artificially induced. Some experimental studies have indicated that when agents are aware or less uncertain of the fundamental values, asset bubbles are difficult to be generated or to sustain for a long time. Some other experimental studies have indicated that when the mispricing-persistence conjecture can be ruled out in the experiment design, bubbles were still observed (e.g., Lei et al. (2001)).

The results also contribute to solving a puzzle in the behavior finance literature. Based on the representativeness bias of Kahneman and Tversky (1982), DeBondt and Thaler (1985) proposed the overreaction hypothesis: in forming expectations, people give too much weight to recent performance of assets and in the data and too little weight to the properties of the population that generates the data. Empirically, DeBondt and Thaler (1985) found supporting evidence that

[27] The ALP-APE data only cover 2011-2013. Therefore, the variation of housing market conditions is mainly cross-sectional.

when stocks are ranked on three- to five-year past returns, past winners tend to be future losers, and vice versa. Jegadeesh and Titman (1993) found the opposite results in short term that stocks with high returns over the past year tend to also have high returns over the following three to six months. To explain the short-term momentum and the long-term reversal observed in the realized asset price data, Barberis et al. (1998) built a behavioral model with representativeness bias and conservatism; and Daniel et al. (1997) built a behavioral model with overconfidence and biased self-attribution. However, Fama (1998) summarized the limitation of previous studies in testing for behavioral hypotheses as alternatives to the market efficiency hypotheses and noted that the task is daunting.

Different from those studies, I make use of subjective expectation data complementing to realized asset price data. The results that people's subjective expectations tend to diverge from the fundamentals support the overreaction hypothesis of DeBondt and Thaler (1985). As people give too much weight to recent performance, when the market is hot (cold), they will optimistically overestimate (pessimistically underestimate) the fundamentals rather than estimate the fundamentals from the long-run equilibrium relationship underlying the population that generates the data.

4.3. Robustness Check

One concern is that equation (1) has omitted variables and thus that the estimated fundamental values of house prices $P^*_{m,t}$ have measurement errors. This may bias the estimates of θ_2 in equation (2) and λ_2 in equation (3). First, in the regression results discussed above, I included MSA fixed effects in equation (1), which capture omitted local time-invariants. Second, the R-squares in the regression of equation (1) are approximately 90%, indicating that the economic fundamental variables included have a satisfactory explanatory power on house prices. I also added alternative economic fundamental variables (e.g., GDP and unemployment rates) and change the functional specifications (e.g., adding quadratic and interacting terms); the R-squares for equations (1) are not improved significantly; the corresponding results of equation (2) and equation (3) are robust.[28]

[28] The results are available upon request.

Third, I also include linear, quadratic, and cubic time trends to control omitted time trends such as the liberalization of the mortgage market, which may have an influence on fundamental values of house prices. The results are reported in Table 7. In column I, I control MSA fixed effects in equation (1) to obtain estimates of $P^*_{m,t}$, the same as before; in column II, I also control the linear time trend; in column III, I also control the quadratic time trend. Panel B displays the key parameters in equation (2). Panel C display the key parameters in equation (3) for the one-year expectations. Panel D displays the key parameters in equation (3) for the 5-year expectations. It turns out that the key parameters in equations (2) and (3) are robust.

As the subjective expectation data used to estimate equation (3) is during 2007-2014, there is a tradeoff in selecting the period in 1980-2014 (for which actual house price data are available) to estimate the long-run relationship in equation (1). On the one hand, the longer period, the more reliable the estimates of the long-run relationship are. On the other hand, the structure may be different between early in 1980-2014 and late in 1980-2014. To mitigate this concern, I also estimate equation (1) using data during 2000-1014 and 2006-2014 to obtain the estimated fundamental values to be plugged into equations (2) and (3). The results of equations (2) and (3) are robust to these changes.[29]

Admittedly, there are still omitted variables in equation (1) that can cause the regressor $P_{m,t} - P^*_{m,t}$ in equations (2) and (3) to have measurement errors. However, according to the econometric theory of classical measurement errors, the bias is downward in magnitude. With classical measurement errors in the regressor, if the estimate of the coefficient is positive, then the true value of the coefficient should be more positive; if the estimate of the coefficient is negative, then the true value of the coefficient should be more negative. The main empirical results in this paper that the coefficient of $P_{m,t} - P^*_{m,t}$ switches from negative to positive from equation (2) to equation (3) should not be driven by the measurement errors in $P_{m,t} - P^*_{m,t}$ caused by omitted variables in equation (1).

4.4. The MSA-level Analysis for the Case-Shiller Survey

The Michigan Survey of Consumers asks the respondents about their house-price expectations only after 2007. To check whether the results are robust in a longer sample period, I also use house-

[29] The results are available upon request.

price expectation data from the Case-Shiller survey during the 2003-2012 period. I use those data as the dependent variables to re-estimate equation (3). The results are reported in Table 8. There is still significant evidence that households' house-price expectations tend to diverge from fundamentals rather than reverting to fundamentals. Because the use of different data sources, the magnitude of key parameters in Table 8 is different from those in Table 5 using the Michigan Survey. However, the patterns are similar: first, in Model II with full specification, the coefficient of $P_{m,t} - P^*_{m,t}$ in Panel A of Table 8 for the short run expectation (one year) is 0.0598, smaller than that in Panel B of Table 8 for the long run expectation (ten years), 0.0671; second, the coefficient of $\Delta P_{m,t}$ in Panel A of Table 8 for the short run expectation (one year) is 0.7232, larger than that in Panel B of Table 8 for the long run expectation (ten years), 0.2516.

I also run regressions in which the coefficients of $P_{m,t} - P^*_{m,t}$ in the two hot markets are allowed to differ from those in the cold market and the relatively stable market. F tests show that the two coefficients are not significantly different from each other.[30]

Besides a longer sample period, another advantage of the Case-Shiller survey is that it has much better coverage (more respondents) of those four local areas than the Michigan Survey. Because those four local areas are chosen to include two "hot" markets (Los Angeles and San Francisco), a "cold" (post-boom) market (Boston), and a relatively stable market (Milwaukee), there is a certain level of cross-sectional variations in the actual house-price movements.

4.5. The Individual-Level Analysis

The empirical results above are based on MSA average expectations. There is heterogeneity in individual expectations. Table 9 reports the estimates of equation (4), in which individual-level data from the Michigan Survey are used. The dependent variable is households' expectations for house-price appreciation rates over the next year. Model I include the same regressors as in the MSA-level analysis plus MSA fixed effects. In Models II through IV, individual demographic characteristics are included. In addition, $P_{m,t} - P^*_{m,t}$ are interacted with the households' demographic characteristics, which allows the households' house-price expectations to have heterogeneous degrees of diverging from the equilibrium. The results indicate that the one-year house-price expectations of households with higher education levels or higher income levels

[30] The results are available upon request.

diverge from fundamentals to a less degree.[31] There is also weak evidence that the house price expectations of Asians diverge from fundamentals to a less degree.[32]

In Table 10, the dependent variable is households' expectations for average annual house-price appreciation rates over the next five years. The long-run expectations do not show significant heterogeneity in the degrees of diverging from the equilibrium across households with different education and income levels. There is still weak evidence that the house-price expectations of Asians diverge from fundamentals to a less degree.

Comparing Model I in Table 7 and Model I in Table 8, the coefficient of $P_{m,t} - P^*_{m,t}$ for annualized five-year expectations is more positive than that for one-year expectations. These results from the individual level analysis are the same as the results of the MSA-level analysis for expectations, which is inconsistent with the actual house-price dynamics that actual house prices are more likely to revert to fundamentals in the long run than in the short run. In contrast, the coefficient of $\Delta P_{m,t}$ for annualized five-year expectations is less positive than that for one-year expectations. These results from the individual level analysis are the same as the results of the MSA-level analysis for expectations, which is consistent with the actual house price dynamics that current momentums have larger effects on future appreciations in the short run than in the long run.

4.6. An Alternative Empirical Strategy

The analyses above on whether individuals' subjective house price expectations capture the reversion to fundamentals rely on the comparison of the coefficient of $P_{m,t} - P^*_{m,t}$ in the regression of actual house price dynamics and that in the regression of subjective expectation

[31] The pattern here is similar to the results in Dräger et al. (2015), which indicates that households with higher education and income levels have inflation and unemployment expectations that are more consistent with the Phillips curve, and have interest, inflation, and unemployment expectations that are more consistent with the Taylor rule.

[32] Using Michigan Survey data, Souleles (2004) analyzed how households' forecast errors for the CPI inflation rate are correlated with their demographic characteristics. He found the forecast errors tend to be more positive for older, higher-income, and higher-education households and more negative for divorcees and minorities. My study takes this analysis a further step, investigating how the extent to which households' house price forecasts diverge from fundamentals is correlated with their demographic characteristics.

formations. That coefficient is significant negative in the former regression but is significant positive in the latter regression, which indicates that individuals' subjective expectations diverge from the actual fundamental values.

In this section I explore an alternative empirical strategy analyzing whether individuals' subjective house price expectations capture the reversion to fundamentals. I first estimate equation (2) (the actual house price dynamics) allowing θ_2 (the coefficient of $P_{m,t} - P^*_{m,t}$) to be different across MSAs. Then I divide the MSAs into two groups: Group A are MSAs with stronger reversion to fundamentals (larger θ_2 in magnitude); Group B are MSAs with weaker reversion to fundamentals (smaller θ_2 in magnitude). Then I estimate equation (3) (subjective expectation formation) allowing λ_2 (the coefficient of $P_{m,t} - P^*_{m,t}$) to be different across the two groups.

Table 11 reports the results. In the regression of the actual house price dynamics, the group-average θ_2 is significantly different across the two groups, both in the regression of appreciation in the next year and in the regression of average annual appreciation over next five years. In the regression of subjective expectations on average annual appreciation over next five years, λ_2 of Group A is positive and significantly higher than λ_2 of Group B. This result indicates that in MSAs in which the actual house price dynamics exhibit stronger reversion to fundamentals, individuals' subjective long-run expectations exhibit stronger diverging from the actual fundamental values. From a different perspective, this result supports the conclusion that subjective expectations do not well capture reversion to fundamentals observed in actual asset-price movements

This empirical strategy leverages the cross-sectional variation in the strength of reversion to fundamentals in the actual house price dynamics. Armona et al (2016) used a similar identification strategy with a novel experimental design. They conducted an experiment at the beginning of 2015 for approximately 1200 participants and examined how participants updated their initial house price expectations after new information on past house prices was provided. They define extrapolators as participants who revise up (down) their expectations if the new information about current house prices is above (below) their previous perception; they define mean reverters as participants who revise down (up) their expectations if the new information about current house prices is above (below) their previous perception. They mainly employ two cross-sectional variations to identify whether individuals' subjective expectations can capture mean reversion. One variation is below-median supply elasticity areas vs. above-median supply elasticity areas.[33] They found that participants in below-median supply elasticity areas are less likely to be mean revertors than participants in above-median supply elasticity areas, although actual house prices movements in areas with low elastic supply exhibit stronger mean reversion patterns (as empirically found by Glaeser et al. (2008)). Regarding the question whether individuals' subjective expectations capture reversion to fundamentals, the results in my work (drawn from several survey datasets covering 2003-2014) and the results in Armona et al. (2016) (drawn from a novel experimental design) well consolidate each other. In addition, leveraging the cross-sectional and over-time variations of the deviation of local house prices from their fundamental values, my study find that people's subjective expectations not only fail to accurately capture the reversion-to-fundamentals pattern, but also tend to diverge from fundamentals.

In the subjective expectation literature, there are other research topics on which studies using subjective survey data on the real world and studies using experimental approaches with clean controls supplemented each other. Schmalensee (1976) studied the subjective probability distributions and uncertainty (or confidence) of forecasts using experimental approaches; while Engelberg et al. (2009) and Rich and Tracy (2010) studied the subjective probability distributions and uncertainty (or confidence) of forecasts using subjective survey data. Branch (2004) used the Michigan survey data to estimate a model of expectation formation in which agents form their forecasts by selecting a forecasting strategy from a set of costly alternatives; while Sonnemans el al. (2004) used experimental approaches to analyze agents' selections of forecasting strategies.

4.7. Further Discussion

The subjective expectations diverging from fundamentals could be one reason driving housing bubbles. However, one concern is that how could this expectation pattern generate the actual house-price dynamics with reversion to fundamentals observed in the realized house-price data. The following are several explanations. First, the actual house prices are directly determined by agents' property purchasing and selling decisions that affect the demand and supply in the housing market. Agents' subjective expectations can affect their purchasing and selling decisions only to a certain degree. For example, if the current house prices are above the fundamental value

[33] Another variation Armona et al. (2016) used is the dependence of future house price appreciation on the previous 5 year's house price appreciation in a local area. The identification strategy is similar.

and households believe that the house prices will continue to increase, they would like to purchase houses but may not actually purchase. When the fundamental economic condition is not very good (e.g., low income growth, high unemployment rates, and low mortgage credit supply), households cannot afford to purchase houses at such a high price even though they believe that house prices are going to increase. Second, there are two types of housing demand: demand for investing and demand for using. The demand for investing is dramatically driven by subjective expectations, whereas the demand for using may not. Third, the respondents of the Michigan Survey is only part of the players in the housing market. On the one hand, the Michigan Survey asks only homeowners about their expectations for future house prices and does not ask renters, who are another important group of players on the demand side of the housing market. On the other hand, homeowners are not the only players on the supply side. Newly constructed houses are another important source of supply. In summary, the overreaction of households' house-price expectations only decelerate the reversion to fundamentals in the movements of actual house prices, instead of causing the actual house prices diverge from fundamentals forever. Thoroughly analyzing how subjective expectations drive the actual house-price dynamics is beyond the scope of this paper.

5. Conclusion

The movements of asset prices, such as stock prices, foreign exchange rates, and real estate prices, exhibit momentum and reversion to fundamentals, which were well documented in the literature. Previous studies have shown that the simulations of heterogeneous agent models with both chartists and fundamentalists can better match the realized asset-prices movements than conventional models. However, the literature still lacks empirical evidence from individual subjective expectation data on how agents' asset-price expectations respond to the deviation of asset prices from the fundamental values and whether most ordinary individuals are more like fundamentalists or chartists.

Using subjective expectation data from multiple surveys, this paper finds that households' subjective house-price expectations capture momentum but not reversion to fundamentals. Instead, their expectations diverge from the actual fundamental value. If recent house price-appreciation rates are high (low), they tend to expect high (low) appreciation rates in the near future; however, if the current house price level is higher (lower) than its long-run equilibrium level, households tend to have an even higher (lower) expectation of the house-price appreciation rate in the future.

The individual-level analysis shows that the expectations of households with lower education or income levels diverge from the fundamental to a greater degree.

There are two possibilities underlying the main empirical result in this paper. One possibility is referred as the fundamental-misperception conjecture. Households' expectation pattern is that the expected house prices tend to move toward the perceived fundamental value. However, households may tend to optimistically overestimate the fundamental value during boom times and tend to pessimistically underestimate the fundamental value during times of recession. The other possibility is referred as the mispricing-persistence conjecture. Households do have an accurate estimate of the fundamental value and know whether houses are mispriced, but they do not believe that mispricing will be corrected by the market in the short run. The empirical results in this paper suggest that the fundamental-misperception conjecture dominates the mispricing-persistence conjecture.

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Table 1 Number of observations in the Michigan Survey

MSA name	Frequency of house-price expectations
New York-Jersey City-White Plains, NY-NJ	935
Chicago-Naperville-Arlington Heights, IL	865
Los Angeles-Long Beach-Glendale, CA	590
Atlanta-Sandy Springs-Roswell, GA	536
Minneapolis-St. Paul-Bloomington, MN-WI	527
Washington-Arlington-Alexandria, DC-VA-MD-WV	514
Houston-The Woodlands-Sugar Land, TX	455
Phoenix-Mesa-Scottsdale, AZ	402
Warren-Troy-Farmington Hills, MI	402
St. Louis, MO-IL	401
Pittsburgh, PA	337
Seattle-Bellevue-Everett, WA	328
Tampa-St. Petersburg-Clearwater, FL	328
Nassau County-Suffolk County, NY	326
Montgomery County-Bucks County-Chester County, PA	320
Denver-Aurora-Lakewood, CO	319
Cambridge-Newton-Framingham, MA	315
Baltimore-Columbia-Towson, MD	314
Riverside-San Bernardino-Ontario, CA	314
Dallas-Plano-Irving, TX	313
Cincinnati, OH-KY-IN	298
Charlotte-Concord-Gastonia, NC-SC	295
Cleveland-Elyria, OH	294
San Diego-Carlsbad, CA	290
Kansas City, MO-KS	289
Portland-Vancouver-Hillsboro, OR-WA	286
Newark, NJ-PA	281
Anaheim-Santa Ana-Irvine, CA	267
Oakland-Hayward-Berkeley, CA	267
Indianapolis-Carmel-Anderson, IN	264

Table 2 Descriptive statistics

Variable	Mean	Std Dev
MSA-level variables		
Expectation: house-price appreciation rate over the next year	0.0054	0.0601
Expectation: annual house-price appreciation rate over the next 5 years	0.0295	0.0524
Expectation: inflation next year	0.0343	0.0426
Expectation: average annual inflation over the next 5 years	0.0314	0.0287
Expectation: % of income change next year	0.0179	0.1562
Expectation: economy better next year	0.0979	0.7157
Expectation: interest increases next year	0.3128	0.691
Expectation: unemployment rate increases next year	0.1454	0.7047
Female	0.5347	0.4988
American African	0.0749	0.2632
Hispanic	0.0493	0.2166
American Indian	0.0054	0.0730
Asian	0.0360	0.1863
Married	0.6575	0.4746
With children	0.3109	0.4629
Education	14.8145	2.0901
Age	55.0378	15.9938
Income quantile (self-reported)	3.6569	1.2683
Home value quantile (self-reported)	3.5964	1.3419
Panel B		
House-price appreciation (quarterly)	0.0097	0.0212
Income per capita	30,245	12,941
Population	3,206,175	2,434,518

Table 3 Long-run relationship between realized house prices and fundamentals

$$P_{m,t} = \alpha_m + X_{m,t}\beta + \varepsilon_{m,t}$$

	All the MSAs, 1980–2014		Top 30 MSAs, 1980–2014	
	Est.	S.E.	Est.	S.E.
Log of real per capita income	1.2392***	0.0583	1.7415***	0.2023
Log of population	0.1663***	0.0407	0.0499	0.1799
Mortgage interest rate	-0.2657***	0.0745	-0.8744***	0.1712
Log of CCI	0.2014***	0.0326	0.5021***	0.0894
Log of CPI	0.6462***	0.0294	0.4892***	0.1121
MSA fixed effect	Yes		Yes	
	R-square=0.8863	N=44839	R-square=0.9031	N=4080

The dependent variable is the log of realized house prices. *Denotes significance at a 10% level. **Denotes significance at a 5% level. ***Denotes significance at a 1% level.

Table 4 Dynamic adjustment of realized house prices

$$\Delta P_{m,t+h} = \theta_1 \Delta P_{m,t} + \theta_2 (P_{m,t} - P^*_{m,t}) + \theta_3 \Delta P^*_{m,t+h} + \eta_{m,t+h}, \quad h = 1, 5$$

	Model I		Model II		Model III	
	Est.	S.E.	Est.	S.E.	Est.	S.E.
Panel A: $h = 1$, $\Delta P_{m,t+h} = P_{m,t+1} - P_{m,t}$						
Intercept	0.0045***	0.0004	0.0026***	0.0004	0.0023***	0.0005
$P_{m,t} - P^*_{m,t}$	-0.0174***	0.0022	-0.0170***	0.0022		
$[P_{m,t} - P^*_{m,t}]^+$					-0.0150***	0.0041
$[P_{m,t} - P^*_{m,t}]^-$					-0.0195***	0.0037
$\Delta P_{m,t}$	0.5311***	0.0274	0.4967***	0.0275	0.4958***	0.0276
$\Delta P^*_{m,t+1}$			0.2298***	0.0204	0.2293***	0.0204
Significance $[P_{m,t} - P^*_{m,t}]^+ \neq [P_{m,t} - P^*_{m,t}]^-$					49.53%	
R-square	0.3004		0.3306		0.3307	
N	4050		4050		4050	
Panel B: $h = 5$, $\Delta P_{m,t+h} = (P_{m,t+5} - P_{m,t})/5$						
Intercept	0.0089***	0.0002	-0.0017***	0.0002	-0.0022**	0.0002
$P_{m,t} - P^*_{m,t}$	-0.0552***	0.0012	-0.0481***	0.0008		
$[P_{m,t} - P^*_{m,t}]^+$					-0.0447***	0.0011
$[P_{m,t} - P^*_{m,t}]^-$					-0.0529***	0.0019
$\Delta P_{m,t}$	0.1243***	0.0084	0.1122***	0.0064	0.1098***	0.0065
$\Delta P^*_{m,t+5}$			1.0318***	0.0169	1.0410***	0.0165
Significance $[P_{m,t} - P^*_{m,t}]^+ \neq [P_{m,t} - P^*_{m,t}]^-$					0..11%	
R-square	0.4549		0.7331		0.7339	
N	3630		3480		3480	

The dependent variable is the change in the log of realized house prices. $P_{m,t} - P^*_{m,t}$ are the residuals generated from the estimation in Table 3 using the data from the top 30 MSAs. *Denotes significance at a 10% level. **Denotes significance at a 5% level. ***Denotes significance at a 1% level.

Table 5 Subjective house-price expectations: MSA-level analyses

$$E_t \Delta P_{m,t+h} = \lambda_1 \Delta P_{m,t} + \lambda_2 (P_{m,t} - P^*_{m,t}) + \lambda_3 E_t \Delta X_{m,t+h} + \xi_{m,t+h}, \qquad h = 1, 5$$

	Model I		Model II		Model III	
	Est.	S.E.	Est.	S.E.	Est.	S.E.
Panel A: dependent variable is 1-year expectation						
Intercept	0.0062***	0.0009	0.0016	0.0025	0.0028	0.0027
$P_{m,t} - P^*_{m,t}$	0.0093*	0.0057	0.0178***	0.0059		
$[P_{m,t} - P^*_{m,t}]^+$					0.0084	0.0115
$[P_{m,t} - P^*_{m,t}]^-$					0.0272***	0.0091
$\Delta P_{m,t}$	0.4450***	0.0426	0.3878***	0.0404	0.3867***	0.0403
$E_t \Delta X_{m,t+1}$:						
Expectation: % change of CPI			0.0550	0.0467	0.0593	0.0468
Expectation: % change of income			0.0321**	0.0148	0.0332**	0.0148
Expectation: Economy better			0.0089*	0.0045	0.0085*	0.0045
Expectation: Interest up			0.0094***	0.0030	0.0092***	0.0030
Expectation: Unemployment up			-0.0135***	0.0036	-0.0139***	0.0036
Significance $[P_{m,t} - P^*_{m,t}]^+ \neq [P_{m,t} - P^*_{m,t}]^-$					26.93%	
R-square	0.1558		0.2267		0.2280	
N	840		840		840	
Panel B: dependent variable is expectation on average annual appreciation rate over the next five years						
Intercept	0.0310***	0.0008	0.0297***	0.0022	0.0301***	0.0025
$P_{m,t} - P^*_{m,t}$	0.0400***	0.0058	0.0416***	0.0063		
$[P_{m,t} - P^*_{m,t}]^+$					0.0387***	0.0136
$[P_{m,t} - P^*_{m,t}]^-$					0.0446***	0.0090
$\Delta P_{m,t}$	0.1288***	0.0334	0.1148***	0.0338	0.1145***	0.0339
$E_t \Delta X_{m,t+5}$:						
Expectation: % change of CPI			-0.0309	0.0447	-0.0296	0.0436
Expectation: % change of income			0.0131	0.0156	0.0134	0.0159
Expectation: Economy better			0.0085**	0.0043	0.0084*	0.0043
Expectation: Interest up			0.0039	0.0030	0.0038	0.0030
Expectation: Unemployment up			-0.0002	0.0034	-0.0003	0.0033
Significance $[P_{m,t} - P^*_{m,t}]^+ \neq [P_{m,t} - P^*_{m,t}]^-$					76.20%	
R-square			0.0930		0.0931	
N			840		840	

The dependent variable is the average subjective expectation for house-price appreciation by the Michigan Survey respondents within an MSA. $P_{m,t} - P^*_{m,t}$ are the residuals generated from the estimation in Table 3 using the data from the top 30 MSAs. The standard errors of the coefficients are estimated using White's heteroscedasticity-consistent estimator. *Denotes significance at a 10% level. **Denotes significance at a 5% level. ***Denotes significance at a 1% level.

Table 6 Subjective house-price expectations: ALP-APE data

$$E_t \Delta P_{i,t+h} = \gamma_1 \Delta P_{m,t} + +\gamma_2 Compared\_to\_fundamental_{i,t} + \xi_{m,t+h},$$
$$h = 1\ year, 3\ months, 1\ month$$

	Expected Appreciation next year		Annualized Expected Appreciation next 3 months		Annualized Expected Appreciation next months	
	Est.	S.E.	Est.	S.E.	Est.	S.E.
Intercept	-0.0005	0.0009	-0.0164***	0.0012	-0.0235***	0.0013
$\Delta P_{m,t}$	0.1522**	0.0751	0.3410***	0.0973	0.2636***	0.0930
Compared_to_funda	-0.0218***	0.0014	-0.0239***	0.0019	-0.0226***	0.0020
R-square	0.0156		0.0112		0.0091	
N	18768		18432		18157	

The dependent variable is the individual households' subjective expectations for house-price appreciation rates by the ALP-APE respondents. $compared\_to\_fundamental$ equals 1, 0, and -1 if the respondent thought the current house price is above, at, and below the fair value, respectively.. *Denotes significance at a 10% level. **Denotes significance at a 5% level. ***Denotes significance at a 1% level.

Table 7 Robustness Check

	I	II	III
Panel A: Additional controls in equation (1) $P_{m,t} = \alpha_m + X_{m,t}\beta + \varepsilon_{m,t}$ to obtain $P^*_{m,t}$			
MSA fixed effects	√	√	√
t		√	√
t^2			√
Panel B: Key parameters in equation (2) $\Delta P_{m,t+1} = \theta_1 \Delta P_{m,t} + \theta_2 (P_{m,t} - P^*_{m,t}) + \theta_3 \Delta P^*_{m,t+1} + \eta_{m,t+1}$			
$P_{m,t} - P^*_{m,t}$	-0.0170***	-0.0162***	-0.0170***
	(0.0022)	(0.0023)	(0.0024)
$\Delta P_{m,t}$	0.4967***	0.5025***	0.4999***
	(0.0275)	(0.0278)	(0.0272)
Panel C: Key parameters in equation (3) for one-year expectations $E_t \Delta P_{m,t+1} = \lambda_1 \Delta P_{m,t} + \lambda_2 (P_{m,t} - P^*_{m,t}) + \lambda_3 E_t \Delta X_{m,t+1} + \xi_{m,t+1}$			
$P_{m,t} - P^*_{m,t}$	0.0178***	0.0167***	0.0223***
	(0.0059)	(0.0052)	(0.0062)
$\Delta P_{m,t}$	0.3878***	0.3820***	0.3839***
	(0.0404)	(0.0361)	(0.0390)
Panel D: Key parameters in equation (3) for expectations on annual appreciation over the next five years $E_t \Delta P_{m,t+1} = \lambda_1 \Delta P_{m,t} + \lambda_2 (P_{m,t} - P^*_{m,t}) + \lambda_3 E_t \Delta X_{m,t+1} + \xi_{m,t+1}$			
$P_{m,t} - P^*_{m,t}$	0.0416***	0.0384***	0.0420***
	(0.0063)	(0.0064)	(0.0068)
$\Delta P_{m,t}$	0.1148***	0.1001***	0.0911***
	(0.0338)	(0.0337)	(0.0329)

The standard errors are in the parentheses. *Denotes significance at a 10% level. **Denotes significance at a 5% level. ***Denotes significance at a 1% level.

Table 8 Subjective house-price expectations in the Case-Shiller survey

$$E_t \Delta P_{m,t+h} = \lambda_1 \Delta P_{m,t} + \lambda_2 (P_{m,t} - P^*_{m,t}) + \lambda_3 E_t \Delta X_{m,t+h} + \xi_{m,t+h}, \qquad h = 1, 10$$

	Model I		Model II	
	Est.	S.E.	Est.	S.E.
Panel A: dependent variable is 1-year expectation				
Intercept	0.0312***	0.0019	0.0256***	0.0047
$P_{m,t} - P^*_{m,t}$	0.0637***	0.0107	0.0598***	0.0123
$\Delta P_{m,t}$	0.8656***	0.0645	0.7232***	0.0686
$E_t \Delta X_{m,t+1}$:				
Expectation: % change of CPI			-0.0872	0.1054
Expectation: % change of income			0.0303	0.0320
Expectation: Economy better			0.0101	0.0075
Expectation: Interest up			0.0203***	0.0063
Expectation: Unemployment up			-0.0063	0.0067
R-square	0.7011		0.7432	
Panel B: dependent variable is expectation on average annual appreciation rate over next 10 years				
Intercept	0.0707***	0.0021	0.0671***	0.0043
$P_{m,t} - P^*_{m,t}$	0.1303***	0.0114	0.1306***	0.0124
$\Delta P_{m,t}$	0.2936***	0.0769	0.2516***	0.0736
$E_t \Delta X_{m,t+1}$:				
Expectation: % change of CPI			-0.0244	0.1027
Expectation: % change of income			0.0757**	0.0334
Expectation: Economy better			0.0171**	0.0075
Expectation: Interest up			-0.0027	0.0063
Expectation: Unemployment up			0.0036	0.0068
R-square	0.5766		0.6083	

The dependent variable is the annual average subjective expectation for house-price appreciation by the Case-Shiller survey respondents within a central county in an MSA during the 2003-2012 period. There are four counties in the Case-Shiller survey: Alameda County, CA (Oakland and much of the East Bay in the San Francisco-Oakland-Fremont MSA); Milwaukee County, WI (the core of the Milwaukee-Waukesha-West Allis MSA); Middlesex County, MA (Cambridge and the areas north and west in the Boston-Cambridge-Quincy MSA), and Orange County, CA (which includes Anaheim and Irvine in the southern part of the Los Angeles-Long Beach-Santa Ana MSA). The standard errors of the coefficients are estimated using White's heteroscedasticity-consistent estimator. *Denotes significance at a 10% level. **Denotes significance at a 5% level. ***Denotes significance at a 1% level.

Table 9 Subjective house-price expectations: individual level analyses

$$E_t \Delta P_{i,t+h} = \gamma_1 \Delta P_{m,t} + \gamma_2 Z_{i,t}(P_{m,t} - P^*_{m,t}) + \gamma_3 E_t \Delta X_{m,t+h} + \gamma_4 Z_{i,t} + \xi_{m,t+h}, \qquad h = 1$$

	Model I		Model II		Model III		Model IV	
	Est.	S.E.	Est.	S.E.	Est.	S.E.	Est.	S.E.
$\Delta P_{m,t}$	0.3878***	0.0390	0.3685***	0.0451	0.3672***	0.0448	0.3671***	0.0451
$P_{m,t} - P^*_{m,t}$	0.0164**	0.0076	0.1048**	0.0425	0.0779*	0.0405	0.1203**	0.0454
$(P_{m,t} - P^*_{m,t})$ ×Female			0.0051	0.0073	0.0023	0.0079	0.0028	0.0078
$(P_{m,t} - P^*_{m,t})$ ×American African			0.0360*	0.0184	0.0364*	0.0185	0.0358*	0.0185
$(P_{m,t} - P^*_{m,t})$ ×Hispanic			-0.0131	0.0146	-0.0112	0.0134	-0.0158	0.0138
$(P_{m,t} - P^*_{m,t})$ ×American Indian			0.0281	0.0355	0.0282	0.0358	0.0250	0.0353
$(P_{m,t} - P^*_{m,t})$ ×Asian			-0.0228	0.0142	-0.0286*	0.0142	-0.0265*	0.0144
$(P_{m,t} - P^*_{m,t})$ ×Married			-0.0126**	0.0059	-0.0047	0.0067	-0.0054	0.0069
$(P_{m,t} - P^*_{m,t})$ ×With kids			-0.0004	0.0163	-0.0011	0.0166	-0.0010	0.0164
$(P_{m,t} - P^*_{m,t})$ ×Education			-0.0050*	0.0026			-0.0036	0.0028
$(P_{m,t} - P^*_{m,t})$ ×Age			-0.0001	0.0003	-0.0004	0.0004	-0.0004	0.0004
$(P_{m,t} - P^*_{m,t})$ ×Income quantile					-0.0127**	0.0059	-0.0108*	0.0065
$(P_{m,t} - P^*_{m,t})$ ×Home value quantile			-0.0032	0.0031	-0.0003	0.0036	0.0005	0.0036
Female			-0.0033**	0.0013	-0.0034**	0.0014	-0.0034**	0.0014
American African			0.0055**	0.0025	0.0056**	0.0025	0.0056**	0.0025
Hispanic			0.0054*	0.0030	0.0053*	0.0030	0.0053*	0.0030
American Indian			-0.0249***	0.0075	-0.0248***	0.0077	-0.0252***	0.0076
Asian			0.0000	0.0047	0.0000	0.0048	0.0000	0.0047
Married			-0.0006	0.0018	-0.0004	0.0018	-0.0005	0.0018
With kids			-0.0019	0.0017	-0.0019	0.0017	-0.0019	0.0017
Education			0.0000	0.0004	0.0001	0.0004	0.0000	0.0004
Age			0.0001*	0.0000	0.0001	0.0001	0.0001	0.0001
Income quantile			0.0001	0.0007	-0.0002	0.0007	-0.0002	0.0007
Home value quantile			0.0033***	0.0007	0.0033***	0.0007	0.0034***	0.0007
Expectation: % change of CPI	0.0217	0.0195	0.0206	0.0194	0.0195	0.0194	0.0199	0.0194
Expectation: % change of income	0.0135***	0.0037	0.0184***	0.0041	0.0185***	0.0041	0.0185***	0.0041
Expectation: Economy better	0.0096***	0.0013	0.0096***	0.0011	0.0096***	0.0011	0.0096***	0.0011
Expectation: Interest up	0.0044***	0.0010	0.0054***	0.0008	0.0054***	0.0008	0.0054***	0.0008
Expectation: Unemployment up	-0.0110***	0.0012	-0.0105***	0.0010	-0.0105***	0.0009	-0.0104***	0.0009
MSA fixed effects	Yes		Yes		Yes		Yes	
R-square	0.0870		0.1030		0.1034		0.1037	
N	8434		8434		8434		8434	

The dependent variable is the individual households' subjective expectations for house-price appreciation rates over the next year by the Michigan Survey respondents. $P_{m,t} - P^*_{m,t}$ are the residuals generated from the estimation in Table 3 using the data from the top 30 MSAs. *Denotes significance at a 10% level. **Denotes significance at a 5% level. ***Denotes significance at a 1% level.

Table 10 Subjective house-price expectations: individual level analyses

$$E_t \Delta P_{i,t+h} = \gamma_1 \Delta P_{m,t} + \gamma_2 Z_{i,t}(P_{m,t} - P^*_{m,t}) + \gamma_3 E_t \Delta X_{m,t+h} + \gamma_4 Z_{i,t} + \xi_{m,t+h}, \qquad h = 5$$

	Model I		Model II		Model III		Model IV	
	Est.	S.E.	Est.	S.E.	Est.	S.E.	Est.	S.E.
$\Delta P_{m,t}$	0.0964**	0.0396	0.1028**	0.0425	0.1033**	0.0430	0.1030**	0.0424
$P_{m,t} - P^*_{m,t}$	0.0375***	0.0087	0.0415	0.0412	0.0082	0.0303	0.0372	0.0409
$(P_{m,t} - P^*_{m,t})$ ×Female			0.0033	0.0085	0.0040	0.0085	0.0041	0.0085
$(P_{m,t} - P^*_{m,t})$ ×American African			0.0221	0.0197	0.0226	0.0199	0.0221	0.0197
$(P_{m,t} - P^*_{m,t})$ ×Hispanic			0.0033	0.0303	0.0073	0.0311	0.0037	0.0306
$(P_{m,t} - P^*_{m,t})$ ×American Indian			0.0026	0.0178	0.0047	0.0179	0.0034	0.0176
$(P_{m,t} - P^*_{m,t})$ ×Asian			-0.0452*	0.0229	-0.0456*	0.0227	-0.0440*	0.0226
$(P_{m,t} - P^*_{m,t})$ ×Married			0.0069	0.0098	0.0053	0.0096	0.0042	0.0098
$(P_{m,t} - P^*_{m,t})$ ×With kids			-0.0097	0.0120	-0.0096	0.0119	-0.0096	0.0120
$(P_{m,t} - P^*_{m,t})$ ×Education			-0.0018	0.0026			-0.0022	0.0022
$(P_{m,t} - P^*_{m,t})$ ×Age			0.0002	0.0003	0.0003	0.0003	0.0003	0.0003
$(P_{m,t} - P^*_{m,t})$ ×Income quantile					0.0024	0.0041	0.0036	0.0044
$(P_{m,t} - P^*_{m,t})$ ×Home value quantile			0.0019	0.0038	0.0000	0.0043	0.0006	0.0042
Female			0.0020	0.0012	0.0020*	0.0012	0.0020	0.0012
American African			0.0062*	0.0031	0.0062*	0.0031	0.0062*	0.0031
Hispanic			0.0129***	0.0040	0.0130***	0.0040	0.0129***	0.0040
American Indian			-0.0099**	0.0036	-0.0097**	0.0037	-0.0097**	0.0036
Asian			-0.0004	0.0027	-0.0004	0.0027	-0.0004	0.0027
Married			0.0018	0.0013	0.0017	0.0013	0.0017	0.0013
With kids			-0.0033**	0.0013	-0.0033**	0.0013	-0.0033**	0.0013
Education			-0.0009**	0.0004	-0.0009*	0.0004	-0.0009**	0.0004
Age			0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Income quantile			0.0009	0.0009	0.0010	0.0009	0.0010	0.0009
Home value quantile			0.0037***	0.0006	0.0036***	0.0006	0.0036***	0.0006
Expectation: % change of CPI	0.1148	0.0315	0.1259***	0.0342	0.1256***	0.0344	0.1261***	0.0344
Expectation: % change of income	0.0079***	0.0038	0.0082**	0.0037	0.0082**	0.0037	0.0082**	0.0037
Expectation: Economy better	0.0079***	0.0038	0.0070***	0.0007	0.0070***	0.0007	0.0070***	0.0007
Expectation: Interest up	0.0002***	0.0007	0.0006	0.0008	0.0006	0.0008	0.0006	0.0008
Expectation: Unemployment up	-0.0052***	0.0010	-0.0053***	0.0011	-0.0053***	0.0011	-0.0053***	0.0011
MSA fixed effects	Yes		Yes		Yes		Yes	
R-square	0.0526		0.0677		0.0677		0.0678	
N	8819		7949		7949		7949	

The dependent variable is the individual households' subjective expectations for average annual house-price appreciation rates over the next five years by the Michigan Survey respondents. $P_{m,t} - P^*_{m,t}$ are the residuals generated from the estimation in Table 3 using the data from the top 30 MSAs. *Denotes significance at a 10% level. **Denotes significance at a 5% level. ***Denotes significance at a 1% level.

Table 11 An Alternative Identification Strategy

	Group A MSAs with stronger reversion in actual hp dynamics	**Group B** MSAs with weaker reversion in actual hp dynamics	Significance of difference
$(P_{m,t} - P^*_{m,t})$ on actual housing appreciation next year	-0.0219	-0.0114	2%
$(P_{m,t} - P^*_{m,t})$ on actual average annual housing appreciation next 5 years	-0.0620	-0.0363	0.01%
MSA-level analysis $(P_{m,t} - P^*_{m,t})$ on 1 year expectation	0.0166	0.0168	99%
$(P_{m,t} - P^*_{m,t})$ on annualized 5 year expectation	0.0551	0.0307	1%
MSA-level analysis $(P_{m,t} - P^*_{m,t})$ on 1 year expectation	0.0209	0.0120	56%
$(P_{m,t} - P^*_{m,t})$ on annualized 5 year expectation	0.0505	0.0167	4%

Figure 1 Deviation of Actual House Prices from the Fundamental Values

(Top 30 MSAs)