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Abstract

This paper aims to achieve two objectives. First, we demonstrate that with respect to business cycle frequency (Burns and Mitchell, 1946), there was a general decrease in the association between macroeconomic variables (MV) and housing market variables (HMV) following the global financial crisis (GFC). However, there are macro-finance variables that exhibited a strong association with the HMV following the GFC. For the medium-term business cycle frequency (Comin and Gertler, 2006), we find that while some correlations exhibit the same change as the business cycle counterparts, others do not. These "new stylized facts" suggest that a reconsideration and refinement of existing "macro-housing" theories would be appropriate. We also provide a review of the recent literature, which may enhance our understanding of the evolving macro-housing-finance linkage.

Keywords: Stylized facts, macro-housing-finance linkage, global financial crisis, business cycle frequency, housing market variables
JEL classifications: E30, G10, R30

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1. Introduction

As suggested by the title, this chapter attempts to provide an incomplete overview of the research that highlights the macroeconomic aspects of the housing market.[1] It is incomplete because the literature has been constantly growing, especially following the global financial crisis (GFC), and hence is almost impossible to review completely. Therefore, we would like to apologize in advance as some insightful papers may not have been discussed in this chapter, not because they are unimportant, but simply because they have been discussed in detail elsewhere. For instance, there have been several similar attempts to discuss the literature in special issues of academic journals, survey papers, and monographs.[2]

According to Leung (2004), housing was not included in traditional macroeconomics. However, on account of a few path-breaking papers, much has changed.[3] While prior literature focuses on residential investment and how it interacts with other macroeconomic variables such as business investment, gross domestic product (GDP), and so on, extant literature quickly expands to cover house price, transaction volume, vacancy, and so on.[4] As one of the objectives of this paper is to provide a general overview of the related research, we re-examine

[1]This paper focuses on housing. Related literature covers studies on land markets, which is beyond the scope of this paper. See Davis and Palumbo (2008), Krainer et al. (2010), Leung and Chen (2006), Liu et al. (2013), Ogawa et al. (1996), among others, and the references therein.

[2]The list is growing constantly, and it is difficult to provide a "complete list" here. See Bostic and Ellen (2014), Davis and Van Nieuwerburgh (2014), Hendershott et al. (2010), Ihlanfeldt and Mayock (2015), Jordà et al. (2016), Malpezzi (2017a, b, c), McMillen (2011), Piazzesi and Schneider (2016), Sanders and Van Order (2011), among others, and the references therein.

[3]See Baxter (1996), Greenwood and Hercowitz (1991), Kiyotaki and Moore (1997), among others.

[4]See Aoki et al. (2004), Chang (2000), Davis and Heathcote (2005), Iacoviello (2005), Iacoviello and Minetti (2008), Jin and Zeng (2004), Kan et al. (2004), Kwong and Leung (2000), Leung (1999, 2003, 2014), Leung and Feng (2005), Leung et al. (2002a, b), Lin et al. (2004), Ortalo-Magné and Rady (2006), Tse and Leung (2002), among others, and the references therein.

some "stylized facts" of how the macroeconomic variables (MV) on the one hand, and housing market variables (HMV), on the other hand, are correlated. Hopefully, this will inspire new research on macro-housing. Again, for the sake of inspiring new research, we then selectively review some of the recent literature. In the final section, we conclude this paper.

2. Stylized Facts

2.1. Business Cycle Frequency

We first focus on the business cycle frequency. To establish some "stylized facts" on the "macro aspects of housing," we follow the approach of Cooley and Prescott (1995), which provides some (unconditional) correlations between MV and HMV in the United States, where most macroeconomic research is done.[5] Clearly, studies on the macroeconomic aspects of housing have used data from different countries.[6] Here, we use data from the United States because (1) they are the most accessible, and (2) most "macroeconomic research" uses U.S. data and hence our use of the same data will facilitate comparison. Our list of HMV includes not only the price index (which is the focus of most research), but also the number of new houses sold, the vacancy rate, and the residential investment. Owing to the well-known debate on the potential bias with respect to appraisals, we use the transaction-based house price index.[7] Hence, we trade off the length

[5]For an introduction to the U.S. housing market, see Green and Malpezzi (2003), among others. For a comparison of the U.S. mortgage system with that in other countries, see Green (2014), Green and Wachter (2005), Cho (2007, 2009), among others.

[6]The literature is too vast to be reviewed here. See Bardhan et al. (2004, 2008, 2012), Ben-Shafar et al. (2008), Cesa-Bianchi et al. (2015), Chang and Chen (2012), Chao and Yu (2015), Cheung et al. (2017), Edelstein and Kim (2004), Ho et al. (2008), Kawaguchi (2009), Kim (2012), Leung (2017), Leung and Chen (2017), Leung and Quigley (2007), Leung and Tang (2012), Lum (2012), Malpezzi and Sa-Aadu (1996), Mera and Renaud (2000), Seek et al. (2014), Seko et al. (2012), Tirtiroglu (2012), Tiwari (2001), among others, and the references therein.

[7]The literature is too vast to be reviewed here. See Gau and Wang (1991), Geltner (1991), Geltner et al. (2003), among others.

of the time series data for a less controversial interpretation of the results. Except for a few variables such as the consumer price index (CPI) and federal funds rate (FFR), all of the other variables are represented in *real terms*.

Following Burns and Mitchell (1946) and most subsequent research on business cycles, this section focuses on the "cyclical components," i.e., components with periodicity between 6 and 32 quarters. As many of the variables are non-stationary, moments (including correlations) are not well defined. The variables need to be detrended, and we therefore use the following procedures. First, we use the band-pass filter developed by Christiano and Fitzgerald (2003) to extract the "cyclical components."[8] Second, we not only report those correlations, but also test whether they are statistically significant or not. Third, we compare two sampling periods: (1) from 1991 to 2006, which will be referred to as the pre-crisis sub-sample (PCSS), and (2) from 1991 to 2017Q3, which will be referred to as the full sample (FS). Some authors argue that there has been a "structural change" following the GFC. We therefore compute the correlations in both sampling periods and examine whether there are indeed some important differences. There is one technical issue here. Forbes and Rigobon (2002) demonstrate that if the volatility of a variable increases over time, the measured correlation could be biased. We mitigate this concern by following Stock and Watson (2002) to first standardize the volatility of all variables, and then compute the correlations among different variables. We explain the details in the appendix.

[8]See Baxter (1991, 1994), Canova (1998), among others, who show that "stylized facts" are not robust to different filtering methods and the first-difference filter exaggerates the high-frequency components. Burnside (1998) shows that "stylized facts" are indeed robust if one turns to the frequency domain. Cogley and Nason (1995), King and Rebelo (1993) show that the Hodrick-Prescott (HP) filter creates spurious serial correlations and distorts "stylized facts." Baxter and King (1999) and Christiano and Fitzgerald (2003) show that the band-pass filter, which builds on some results in the frequency domain, is statistically "superior" to the commonly used HP filter. In the present context, the "full sample" includes the GFC, which could be a high-frequency event for some data series, and at the same time a lasting event for other series. As we do not know *a priori* in which series the GFC is short-lived, and in which it is a long-lasting event, it is natural to use the band-pass filter to ensure that the corresponding periodicities of the components that we extract are precise.

Table 1 Panel A shows the correlations (contemporaneous, one-period-lead, and one-period-lag) among the housing market variables and the more conventional macroeconomic variables. Table 1 Panel B shows the counterparts among the housing market variables and the macro-finance variables. The idea is to investigate whether some macroeconomic variables may be "leading" the housing market variables, or vice versa.[9]

(Table 1 about here)

Several observations are in order. First, most correlations are significant, suggesting that the (aggregate) housing market variables and the macroeconomic variables are indeed closely related. In other words, the "macro-housing" literature is justified. Second, while most correlations in the two sampling periods are similar, there are cases with some noticeable differences. For instance, in the PCSS, the real GDP, and vacancy rate of the for-sale housing were significantly and negatively correlated. The unemployment rate and house prices were also significantly and negatively correlated. The idea is simple. When the economy receives a positive shock, firms hire more labor and people are more willing to purchase housing units, resulting in an increase in the aggregate output and a decrease in the unemployment rate. At the same time, the house prices increase and the vacancy rate of the for-sale housing market decreases. However, for the full-sample, such intuitive correlations disappear. Clearly, these are simple correlations and they provide no proof of causality. Nevertheless, they suggest perhaps that there is a change in the dynamics between the macroeconomy and

[9]Clearly, the treatment here is heuristic. For further treatment of the subject see Berge (2015), Camacho and Perez-Quiros (2002), among others, and the references therein.

the housing market, which may be related to the "jobless recovery" following the GFC in the sense that the aggregate GDP rebounds much faster than the labor market. Moreover, the slow recovery of the labor market also affects the recovery of the housing market.[10] This is discussed in depth later.

Another set of important correlations is related to the level of the CPI. This is clearly important because many undergraduate students were taught that the CPI and inflation are at the core of macroeconomics.[11] Moreover, the mandate of several central banks is tied to some sort of "price stability." Therefore, we believe that it is important to examine the correlations between the CPI on the one hand, and the housing variables on the other hand. Table 1 Panel A shows that before the GFC, the CPI was positively correlated to house prices. However, the statistical significance disappears when we consider the full sample, suggesting that the relationship between the CPI and house prices has also "weakened" after the GFC. Moreover, the correlations between the CPI on the one hand and other housing variables on the other hand also tend to be insignificant, which is consistent with the recent literature that suggests that the relationship between the inflation rate and other macroeconomic variables may have changed after the GFC.[12]

The fourth row of Table 1 Panel A also shows that the real private non-residential fixed investment had a strong positive correlation with real house price, and a negative correlation with the for-sale housing vacancy rate in the PCSS. This intuition is simple to explain. When the economy is booming, more

[10]For a general discussion on recovery and labor markets, see Christiano et al. (2015, 2016), among others. For a discussion on the slow recovery and the housing markets, see Garriga and Hedlund (2017), Hedlund (2016 a, b), Luo (2017), among others, and the references therein.
[11]For instance, see Hubbard and O'Brien (2014). See also Doepke and Schneider (2006), among others.
[12]The literature is too vast to be reviewed here. See Del Negro et al. (2015), Gilchrist et al. (2017), Hall (2011), King and Watson (2012), among others.

investment is made for non-residential fixed assets. At the same time, the demand for housing increases and hence house prices increase and the vacancy rate decreases, which explains the observed correlations. Conversely, once we include the post-crisis years, the correlation between non-residential fixed investment and house prices weaken, and the correlation between the non-residential fixed investment and the for-sale housing vacancy rate becomes insignificant. Similarly, while non-residential fixed investment and residential investment are evidently correlated,[13] the correlations seem to weaken after the GFC. In fact, the correlation between the prior period of non-residential investment and the current period of residential investment was around 0.4 before the GFC. The same correlation drops to about 0.15 and becomes statistically insignificant in the full sample. Again, we observe a "weakening" of the link between the macroeconomy and the housing market.

The same "weakening" may also be exhibited in consumption. The "wealth effect of consumption" is being discussed even in undergraduate macroeconomic textbooks. There is extensive literature on whether (and how) fluctuations in housing wealth and stock market wealth affects consumption.[14] Table 1 Panel A displays many correlations between the aggregate private consumption on the one hand, and the housing market variables on the other hand. The correlations between consumption and house price ranged from 0.66 to 0.73 before the GFC. However, when we consider the full sample, those correlations drop to between 0.41 and 0.58. The intuitive correlations between consumption and the vacancy

[13]It has been studied extensively. See Greenwood and Hercowitz (1991), Chang (2000), Chen and Liao (2017), among others, and the references therein.

[14]The literature is too vast to be reviewed here. See Bostic et al. (2009), Calomiris et al. (2009), Carroll et al. (2011), Case et al. (2005), Gerardi et al. (2018), Kaplan et al. (2016), Zhou and Carroll (2012), among others, and the references therein.

rate are negative and statistically significant. When the economy booms, people consume more and are simultaneously more willing to buy a house, and hence the vacancy rate drops. However, those correlations become insignificant when we consider the full sample. Again, it only adds to the evidence that the correlations between housing market variables and macroeconomic variables weakened after the GFC.

Similarly, before the GFC, the correlations between the trade surplus and house prices were high, and were around -0.77.[15] At the same time, the trade surplus (in real terms) is positively related to the vacancy rate of for-sale housing. The intuition here is also simple to explain. When the trade account has a surplus, the capital account is in deficit, suggesting that there is an outflow of capital. With an outflow of capital, it is natural to expect that house prices fall and the vacancy rate of housing increases.[16] However, when the years following the GFC are included, the correlations between trade surplus and house prices drop to between -0.30 and -0.48. The correlations between the trade surplus and the vacancy rate of for-sale housing are also significantly reduced, and some even become statistically insignificant.

Table 1 Panel B shows the correlations between some "macro-finance" variables on the one hand, and the housing market variables on the other hand. We begin with the Federal Fund Rate (FFR), which is often considered as the "policy rate," an indicator of the "tightness" of the monetary policy. The first row presents the results for the nominal FFR and the second row presents the counterpart for the real FFR, which is defined as the difference between the

[15]There are studies relating the housing market to international trade, both theoretically and empirically. See Bardhan et al. (2004), Corrigan (2017), Leung (2001), Leung et al. (2013), among others.
[16]See Aizenman and Jinjarak (2009), Tomura (2010), among others, and the references therein for related analysis.

nominal FFR and the inflation rate (based on the CPI). Note that after the GFC, the Federal Reserve cuts the nominal interest rate to almost zero and many authors argue that the "zero lower bound" (ZLB) introduces distortions in both parameter estimation as well as welfare cost. To formally study the ZLB, however, is a very involved process.[17] Therefore, we introduce the real FFR instead, which does not have a ZLB for comparison. Comparing the first and second rows of Table 1 Panel B, it is evident that the results related to the nominal and real FFR are usually similar, which is perhaps because the CPI inflation rate is dominated by high-frequency components. As the Christiano and Fitzgerald band-pass filter accurately extracts only the business cycle components (i.e., components with periodicity between 6 and 32 quarters), the impact of inflation on the FFR is minimal. Clearly, the FFR is positively correlated to the real house price, and only weakly correlated with other housing market variables. This may sound counter-intuitive because a higher interest rate should discourage people from investing. However, if we take the *endogeneity* of the FFR into consideration, the correlation between the FFR and house prices can be understood better. Nakamura and Steinsson (2017) explain this well:[18]

"…The Federal Reserve lowered interest rates aggressively in 2008 as evidence mounted that the economy was heading for a severe downturn. Suppose one sought to use this variation in monetary policy to estimate the effect of monetary policy on the economy by estimating an OLS regression of the change in output on the change in interest rates. Doing this might lead one to conclude that reductions in interest rates lead to decreases in output. Would this constitute convincing evidence on the effects of monetary policy? Of course not. The reason

[17]The literature is too vast to be reviewed here. See Gust et al. (2017), Hirose and Inoue (2016), Wu and Xia (2016), among others.
[18]See Sims (2010, 2012), among others.

the Fed was lowering interest rates was that other factors—such as rapidly falling home prices and their effects on the balance sheets of households, firms, and banks—were negatively affecting the economy. In a simple OLS regression, these other factors would confound the effects of the change in monetary policy. This approach would, therefore, uncover not the pure effect of the interest rate reduction, but rather, the combined effect of the interest rate reduction and the adverse macroeconomic factors that led the Fed to undertake it."

In the literature, therefore, researchers have used other interest rates, as proxies of the credit market conditions, and examine the co-movements of those interest rates and the housing market variables.[19] Table 1 Panel B also shows how these interest rates are related to housing market variables. For instance, clearly the term spread, which is the difference between the long-term and short-term interest rate, is negatively correlated with house prices and residential investment. Interestingly, while the correlations between the macroeconomic variables on the one hand and the housing market variables, on the other hand, weakened after the GFC, the correlation between the term spread and the residential investment became stronger. Furthermore, the correlations between the term spread and the number of new houses sold are either enforced or turning from statistically insignificant to negatively significant.

The Treasury-EuroDollar rate (TED) spread is the difference between a measure of the interbank interest rate and the risk-free rate. An increase in TED is often interpreted as an increase in the cost of external funds for financial

[19]The literature is too vast to be reviewed here. See Chang et al. (2010, 2011, 2012, 2013, 2016), Chen and Wang (2007, 2008), Jin et al. (2012), Malpezzi (2017a, c), Yavuz (2014), among others, and the references therein.

intermediaries. Not surprisingly, it is not significantly related to either the house price or the residential investment before the GFC. However, when we examine the same correlation for the full sample, the TED spread is negatively correlated with both house prices and the residential investment. In fact, it seems to be "leading" both house prices and the residential investment. The correlations between the TED spread and the number of new houses sold are also strengthened after the GFC. Such changes may be related to two factors: (1) the manner in which the Federal Reserve Bank implements the monetary policy,[20] and (2) the adoption of the unconventional monetary policy (UMP) since the GFC. Recent research confirms that the UMP impacts the financial institutions and the economy through different channels.[21] Table 1 Panel B simply confirms that research in the context of the housing market.

The case for the external finance premium (EFP) is interesting. The EFP is the difference between the prime bank lending rate and the 3-month Treasury-bill (T-bill) rate. An increase in EFP is often interpreted as an increase in the cost of external funds for non-financial firms, and it has been used in many types of research.[22] Table 1 Panel B shows that its correlation with the house price is negative. On the other hand, it had a positive and significant correlation with the vacancy rate before the GFC. The idea is that when the credit market is tight, it is difficult for both firms and households to obtain credit. And when households cannot obtain credit, many of them cannot purchase homes. Hence, both the EFP and the vacancy rate of the for-sale housing increase, and the house prices

[20]See Frost et al. (2015), Ihrig et al. (2015), among others.
[21]The literature is too vast to be reviewed here. See Bhattarai and Neely (2016), Chodorow-Reich (2014), Gertler and Karadi (2011), Gertler and Kiyotaki (2011), among others, and the references therein.
[22]See Bernanke and Gertler (1995), Bernanke et al. (1999), among others. Jin et al. (2012) modify the framework of Bernanke et al. (1999) and study how the EFP and housing price can interact.

decrease. When we consider the full sample, i.e., when the GFC and the subsequent years are taken into consideration, the correlations between the EFP and the vacancy rate of for-sale housing weaken, and some even become statistically insignificant. At the same time, the negative correlation between the EFP and house prices is "strengthened" in the sense that it becomes more negative.

There is extensive literature on the co-movement between the housing market and the stock market.[23] Table 1 Panel B shows that the correlations between the house price and stock price (measured by the S&P 500 index) are indeed positive and statistically significant, both before and after the GFC. There is a subtle difference here. In the PCSS, the correlation between the lagged stock price of one period and the house prices of the current period is larger than the contemporaneous correlation, which in turn is larger than the correlation between the stock price of one period ahead and the house prices of the current period, suggesting that the stock price is somewhat leading the house price. As we consider the full sample, i.e., including the years after the GFC, we find the reverse pattern, suggesting that the stock price is somewhat lagging the house price. Clearly, a formal testing for leading versus a lagging relationship would need more sophisticated tests and perhaps a longer time series. Nevertheless, this suggests a possible change in the relationship between the stock and housing markets. At the same time, as we compare the correlations between the stock price on the one hand, and the other HMV on the other hand (including the number of new houses sold, the vacancy rate of for-sale housing, and the private residential fixed investment), we see a "general weakening" of the relationship. For instance,

[23]The literature is too vast to be reviewed here. See Chang et al. (2012, 2013, 2016), Chu (2010), Davis and Martin (2009), Kwan et al. (2015), Leung (2007), Piazzesi et al. (2007), Quan and Titman (1999), among others, and the references therein.

the relationship between the stock price and the number of new houses sold remain positive, but the numerical values drop in the full sample. Some correlations between the stock price and the housing vacancy rate turn from negative and significant to insignificant. The correlations between the stock price and the residential investment remain positive but are numerically much smaller. Clearly, it is pre-mature to conclude a "de-coupling" between the stock market and housing market. At the same time, it seems important to examine whether and how the relationship between the stock and housing market has changed after the GFC.

2.2. Medium Cycle Frequency

Thus far, we have focused on business cycle frequency, which many macroeconomic studies have also focused on. However, some authors propose that we should focus on the "longer run."[24] Here, we follow Comin and Gertler (2006) to study components with periodicity between 32 and 80 quarters, which we label as "medium-run components." We are aware that our sampling period is relatively short and hence the estimate of the medium cycles may not be as accurate as it should be. Constrained by the unavailability of data, we can only recognize the limitations and proceed nevertheless. To facilitate the comparison, we repeat the exercise in the previous section with the "medium-run components." The results are reported in Table 2, which are identical to those in Table 1, except that the correlations are now correlations among medium-run components rather than cyclical components. As in the case of cyclical components, most

[24]See Drehmann et al. (2012), among others. Borio (2014, p.183) claims "the financial cycle has a much lower frequency than the traditional business cycle…"

correlations are statistically significant, suggesting that the macroeconomy and the housing market are closely related in the medium run as well. At the same time, we do observe some difference between the PCSS and the full sample, and focus our discussion on those differences.

Given the structure, we begin with the first row in Table 2 Panel A, the correlations between the GDP on the one hand, and housing market variables on the other hand. Interestingly, while the correlations between GDP and housing market variables are weakened in the business cycle frequency, they are *strengthened in the medium-cycle frequency*. For instance, the correlations between the cyclical components of GDP and the vacancy rate of a for-sale housing turn from negative and significant to insignificant, while the medium-cycle counterparts turn from mostly insignificant to mostly negative and significant. Undoubtedly, this is a challenge for future research to construct a theoretical model to explain these changes.[25]

Such a challenge is not limited to the relationship between GDP and housing market variables. As we study the second row of Table 2 Panel A, we find that the correlations between the medium-run components of the unemployment rate and house price are strengthened, while the counterparts in cyclical components are weakened. Moreover, while the correlations between the cyclical component of the unemployment rate and the number of new houses sold are mostly insignificant, they are negative and significant in the medium-run component. Furthermore, the correlations are strengthened after the GFC. While the

[25]Research efforts have been devoted to explaining the heterogeneous "stylized facts" across different frequencies. See Pancrazi (2015), who show how a change in the persistence of the exogenous shocks can generate "heterogeneous great moderation," among others.

correlations between the cyclical components of the unemployment rate and the vacancy rate of for-sale housing are mostly negative in the full sample, the counterparts in the medium-run components are *mostly positive* in the full sample, which seems to be more intuitive. When the economy is hit by a bad shock, the unemployment rate increases and hence the demand for housing drops, which in turn leads to an increase in the vacancy rate of housing.

Note that there are also situations in which patterns in cyclical components and medium-run components are consistent. For instance, the third row of Table 2 Panel A shows that the correlations between the medium-run components of CPI and (real) house price are negative and significant, but the correlations are obviously weakened in the full sample. This is in line with the finding in the cyclical component that the positive correlation between the two variables turn from positive and significant to mostly insignificant. In fact, the correlations between the medium-run components of CPI and other housing market variables (the number of new houses sold, a vacancy rate of for-sale housing, and private residential fixed investment) are dramatically weakened in the full sample. Thus, it is in line with the idea that changes in nominal variables have limited long-run impact on real variables.[26]

The case for private non-residential fixed investment also poses a challenge. It is well known that the non-residential fixed investment and the residential counterparts are positively correlated with business cycle frequency.[27] Table 2 Panel A reveals that in fact, the counterpart in medium-cycle frequency is *negatively* correlated before the GFC. It, however, turns to be positive and

[26] Clearly, the treatment here is heuristic. The literature on "money neutrality" is too large to be discussed here. See King and Watson (1997), Vaona, A. (2015), among others, and the references therein.
[27] See Baxter (1996), Chang (2000), Greenwood and Hercowitz (1991), among others, and the references therein.

significant in the full sample. Similarly, the correlations between the medium-run components of the non-residential investment and house price are negative before the GFC and become positive and significant in the full sample. This is in contrast to the case of cyclical components, which remain positive and significant in the PCSS and the full sample.

The correlations between the medium-run components of trade surplus and housing prices somewhat differ from the cyclical component counterpart. In the case of cyclical components, the correlations between the trade surplus are reduced from the -0.76 to -0.78 range to the -0.30 to -0.48 range as we extend from the PCSS to the full sample. In the case of medium-run components, however, the correlations are always in between -0.90 and -0.99, suggesting that in real terms, the international capital flow and house prices are *more correlated in the medium run* than in the business cycle frequency. In fact, the correlations between the trade surplus on the one hand, and the number of new houses sold and the private residential fixed investment, on the other hand, display a similar degree of co-movements. Thus, even for a large country like the United States, where net exports constitute around 10% of the GDP, international capital flows are important for the housing market. Future research may further explore this dimension.

Table 2 Panel B exhibits the correlations between the medium-run components of the macro-finance variables on the one hand, and housing market variables on the other hand. Its format closely follows that of Table 1 Panel A, where the counterpart of the business cycle components is displayed. The first row shows the correlation between the nominal FFR and the housing market

variables. Its "pattern" dramatically differs from the counterparts of the cyclical components. For instance, the correlations between the medium-run component of the nominal FFR and the house price are statistically significant, yet numerically small (in the range of 0.17 to 0.33 in the full sample). In contrast, in the case of cyclical components, the correlations are in the range of 0.55 to 0.69, and they are statistically significant. The correlations between the medium-run components of the nominal FFR and the vacancy rate of for-sale housing are in the range of 0.84 to 0.93 in the PCSS, and in the range of 0.57 to 0.70 in the full sample. Although the correlations are "weakened," they remain statistically significant. On the other hand, the cyclical counterpart is mostly insignificant. At the same time, the correlations between the medium-run components of the nominal FFR and private residential fixed investment become marginally significant or even insignificant in the full sample. The cyclical component counterparts are also statistically significant at the 1% level and in the range of 0.33 to 0.60. In other words, the co-movements between the nominal FFR and the housing market are very different in the business cycle frequency and in the medium cycles.

In the previous section, we have also shown in the business cycle frequency, the correlations between nominal FFR and housing market variables, and those between the real FFR and housing market variables are similar. In the medium run, however, this is not always the case. For instance, the second row of the Table 2 Panel B shows that the correlations between the real FFR and real house price are negative and significant before the GFC. When we consider the full sample, those correlations become numerically small and statistically insignificant. The counterpart in the business cycle frequency is always positive and significant,

whether in the PCSS or in the full sample. In other cases, the behavior of the medium-run components of nominal and real FFR seem to be similar. Both the nominal and real FFR are positively correlated with the vacancy rate of the for-sale housing in the medium run, while almost un-correlated with the vacancy rate in the business cycle frequency. Both the nominal and real FFR are statistically correlated with the number of new houses sold before the GFC in the medium run and then become almost uncorrelated in the full sample, while they are typically uncorrelated with the number of new houses sold in the business cycle frequency. As monetary research constitutes a significant part of the macroeconomic research, accounting for these differences may be important for future modeling development.

The third row of the Table 2 Panel B shows how the term spread correlates with the housing market variables. It is interesting to note that before the GFC, the medium-run term spread is only weakly correlated with the house price in the PCSS. It becomes statistically correlated with the house price in the full sample. Yet the numerical values are somewhat small, in the range of -0.18 to -0.25, which is in sharp contrast to the case of business cycle frequency. The correlations between the cyclical components of term spread and house price are always between -0.61 and -0.70, and they are statistically significant. The cyclical component of the term spread is also negatively correlated with the number of new houses sold in the full sample, with correlations between -0.20 and -0.40. In the medium run, however, the two variables are more or less uncorrelated.

Similarly, a dramatic difference is observed in the TED spread. The fourth row of Table 2 Panel B clearly shows that the correlations between the medium-

run components of the TED spread and house price are negative and significant before the GFC and become almost insignificant in the full sample. In the cyclical component counterpart, while the two variables are not correlated before the GFC, they become negatively and significantly correlated in the full sample. Moreover, the medium-run components of the TED spread and the vacancy rate of the for-sale housing are significantly correlated. The correlations range between 0.75 and 0.80, whether in the PCSS, or during the full sample. The cyclical components of the same pair of variables are almost uncorrelated.

While the relationships between the EFP and housing market variables are similar in the business cycle frequency and in the medium-cycle frequency, the relationships between the stock price (measured by the S&P 500 index, in real terms) and housing market variables are very different in the two frequencies. Recall from Table 1 Panel B that the cyclical components of the stock price and house price are positively (and significantly) correlated, both before the GFC and in the full sample. Table 2 Panel B, however, shows that the medium-cycle components of the same pair of variables are *negatively* and significantly correlated before the GFC, with correlations between -0.36 and -0.42. In the full sample, the two asset prices become *uncorrelated*. Similarly, the cyclical components of the stock price and the number of new houses sold are positively and significantly correlated, both before the GFC and in the full sample. However, the medium-cycle components of the same pair of variables are negatively and significantly correlated before the GFC, with correlations between -0.23 and -0.27. In the full sample, the stock price and number of new houses sold become positively correlated. The correlations are statistically significant, but economically weak, in the range of 0.25 to 0.26. The cyclical components of the

stock price and private residential investment is positively and significantly correlated, both before the GFC and in the full sample. The correlations are 0.55 or above. However, the medium-cycle components of the same pair of variables are negatively and significantly correlated before the GFC, with correlations between -0.31 and -0.33. In the full sample, the stock price and residential investment become positively correlated. The correlations are statistically significant, but economically weak, in the range of 0.22 to 0.23.

2.3. A Summary

Here we provide a quick summary. For the business cycle frequency (or "cyclical components," i.e., components with periodicity between 6 and 32 quarters), while macroeconomic variables and housing market variables are correlated in many dimensions, we find that some "stylized facts" indeed change after the GFC. More specifically, many intuitive correlations between MV on the one hand and HMV, on the other hand, are *weakened*. At the same time, several measures of interest rates have their correlations with HMV *strengthened*. These changes may be important because we may have built theoretical models to explain the "old stylized facts," and this is how our "intuitions" are formed. The revision of those stylized facts may be a call for refining some existing models of macro-housing. Hopefully, we can see more refined models that are consistent with both the "stylized facts" for the period before the GFC, as well as the period after.[28] For the medium-cycle frequency, some correlations follow changes similar to their counterparts in business cycle frequency, while others are very

[28]See Benes et al. (2014), Del Negro et al. (2013, 2015), Funke et al. (2017), Guerrieri et al. (2015), among others, for related efforts.

different. Apparently, existing models are relatively silent on these differences, which reinforces the call for more serious theoretical modeling efforts.

Now we qualify our results in the following ways. First, all of these correlations are unconditional and bilateral. Although they are statistically significant, they do not indicate the direction of causality. It is possible that the correlations are driven by some "third factor." While some of the unconditional correlations are insignificant, it is possible that the conditional counterpart of these correlations are significant, i.e., when some third variable is being held constant. In addition, if some variables exhibit non-linear dynamics such as regime-switching or contain a "bubble" component, the unconditional correlations may not provide us with the full picture.[29] Moreover, all of these correlations are based on aggregate data. Recent research, on the other hand, tends to use micro-data. In the next section, we will, therefore, review some of those works.

3. A Review of Selected Literatures

Although recent years have witnessed a rapid growth in the macro-housing literature, this section only provides a review of a subset of this literature. The order and topics selected are somehow arbitrary. Our only objective is to provide an (incomplete) review that will facilitate the exchange of ideas and perhaps encourage even more research in this area.

[29]The literature is too vast to be reviewed here. See Chang et al. (2011, 2012, 2013, 2016), Chen et al. (2006, 2010, 2015), Chen and Leung (2008), Deng et al. (2017), Phillips et al. (2015a, b), Yiu et al. (2013), among others, and the reference therein.

3.1. Bankruptcy and Mortgage Contract

In their Mayekawa Lecture presented at the Bank of Japan, Goodhart and Tsomocos (2011) argue the following: "What is the main limitation of much macroeconomic theory, among the failings pointed out by William R. White at the 2010 Mayekawa Lectures? We argue that the main deficiency is a failure to incorporate the possibility of default, including that of banks, into the core of the analysis…." Recent research efforts have indeed addressed such a concern. In particular, authors have introduced heterogeneity in banks, firms, households, and their potential defaults in macroeconomics.[30] In the context of macro-housing, it is natural to consider mortgage default. It follows that one should first introduce mortgage debt in macro models. Chambers et al. (2009a, b, c), among others, propose overlapping generation models (OGM) with stochastic labor income and endogenous tenure choice (to rent or to own).[31] They also compare different types of mortgage contracts and study their implications in equilibrium. Their models can match some stylized facts of the U.S. aggregate economy and the housing market, including the homeownership rates across different age groups. Iacoviello and Pavan (2013) study an OGM with aggregate shock and match some stylized facts of housing and mortgage debt over the business cycles.

Carlos Hatchondo et al. (2015), among others, go one step further by building a model in which the house prices are characterized by a stochastic

[30]The literature is too vast to be reviewed here. See Athreya et al. (2012, 2015, 2017), Chatterjee et al. (2007), Corbae and D'Erasmo (2017), Gertler and Kiyotaki (2011), Gertler et al. (2015), Khan et al. (2014), Krueger et al. (2016), among others, and the references therein.

[31]There are many related studies on mortgage contract and/or homeownership. See Amior and Halket (2014), Anagnostopoulos et al. (2013), Fisher and Gervais (2011), Ghent (2012), Kydland et al. (2016), Luo (2017), Ortalo-Magne and Prat (2014), Ríos-Rull and Sánchez-Marcos (2008), Sun and Tsang (2016), Yao (2018), among others, and the references therein.

process and allow agents to default the mortgage loan. This step significantly complicates the analysis. For instance, in the case of recourse mortgage, if a borrower fails to make the scheduled mortgage payment, the lender has the right to seize the other liquid assets of the borrower. Hence, the saving decision is related to the default decision and hence the dynamic optimization problem involves interacting continuous and discrete choices, and some conventional methods of modeling mortgage contract may not be suitable in this context.[32] Based on their structural model, they conduct counter-factual experiments and find that combining recourse mortgage and a loan-to-value (LTV) ratio limit may mitigate the sharp increase in the default rate after a sharp decline in house prices. Corbae and Quintin (2015) study a model in which agents stochastically age over time. The house price is also exogenous. The agents can choose a high or low level of down payment on the mortgage contract. Based on their structural model, they conclude that high-leverage loans originating before the financial crisis are responsible for the high foreclosure rate following the crisis. Apparently, both Carlos Hatchondo et al. (2015) and Corbae and Quintin (2015) point to the policy recommendation that some minimum level of down payment may mitigate the severity of the crisis. Mitman (2016) also builds a dynamic model with an exogenous house price process, an endogenous tenure choice, different ways of "filing bankruptcy" (Chapter 7 or Chapter 13), and foreclosure that may or may not happen.[33] He also exploits the cross-state difference in the default laws in his modeling and calibration, and subsequently examines two policies, namely, the Bankruptcy Abuse Prevention and Consumer Protection Act (BAPCPA), which

[32]Some previous studies model a mortgage contract as a staggered contract, following Taylor (1980) and others model a mortgage contract as a down payment constraint, following Kiyotaki and Moore (1997). There is related literature on optimal mortgage contract design, which is typically partial equilibrium and theoretical in nature. See Pikorski and Seru (2018), among others, for a review of that literature.
[33]See Karsten et al. (2013), Lambertini et al. (2017), among others, for a related analysis.

was imposed in 2005, and the Home Affordable Refinance Program (HARP), which was imposed in 2009. He finds that the BAPCPA reform significantly reduces the number of bankruptcy cases, and simultaneously leads to a significant increase in foreclosures during the Great Recession. He also finds that the HARP program enables households with high LTV to refinance their mortgages, thereby leading to significant welfare gains to those households.[34]

Justiniano et al. (2013, 2015a, b, 2016), among others, argue that it may be important to distinguish borrowing constraint from lending constraint. In their models, borrowing constraint is the same as the collateral constraint imposed by Kiyotaki and Moore (1997), as the value of debt cannot exceed the product of an exogenously imposed parameter θ and the total value of the collateral. In this case, a "loosening" of a borrowing standard refers to an increase in the value of θ, capturing the idea that the same value of collateral can now "support" a larger amount of borrowing at the individual level. The lending constraint, on the other hand, refers to an upper bound on the total amount of mortgage lending that households can obtain. Justiniano et al. (2015a) show in their appendix B that the lending constraint is equivalent to a leverage constraint faced by financial intermediaries. They find that it is indeed the lending constraint, rather than the widely used borrowing constraint, that is more consistent with the four stylized facts related to the Great Recession: (1) house prices rise dramatically between 2000 and 2006, (2) household mortgage debt also increases dramatically during the same period, (3) mortgage debt and house price increase in parallel, and (4) real mortgage interest rates decline during that period. They illustrate their mechanism with two types of agents and an endogenous house price.[35] However,

[34]See also Kaplan and Violante (2014), among others, for a related analysis.
[35]See Chatterjee and Eyigungor (2015), among others, for a related analysis.

that series of models does not consider mortgage default and household bankruptcy.

If both the default and endogenous house price dynamics are important for our understanding of the housing market, it is natural to conjecture that combining both features will produce a very robust analysis.[36] It should be noted that even with the exogenous house price process, models with default and bankruptcy are typically difficult to solve. Thus, introducing endogenous house prices makes the task even more difficult. There are a few papers that have taken up this challenge. For instance, Favilukis et al. (2017) consider an overlapping generation model in which agents are subject to both idiosyncratic and aggregate risks on the one hand and have limited access of instruments that can diversify those risks on the other hand. Thus, a distribution of (ex-post) heterogeneous households will be generated even if the agents were identical *ex-ante*. However, the agents are also heterogeneous *ex-ante*. In Favilukis et al.'s (2017) model, a small fraction of agents receives a bequest from their parents and makes a bequest to their offspring. At the same time, most agents start with little wealth when they start to work, which creates a non-trivial wealth distribution in the model. In addition, there are participation costs for the equity market, transaction costs for the housing market, and borrowing costs, which have important implications for asset markets. For instance, when the economy is hit by an adverse aggregate shock, some agents who have (relatively) lower levels of income and wealth may choose not to participate in asset markets, leaving the relatively rich to actively participate in these markets.[37] If the aggregate shock turns favorable, then those who held

[36]See Foote and Willen (2017), among others, for a related discussion.
[37]This result is well known. See Dixit and Pindyck (1994), Stokey (2009), among others.

assets during the downturn capture a bigger share of the capital gains. In other words, with positive asset market participation costs, the distributional dynamics of income and wealth and the dynamics of asset prices can interact in a non-trivial manner. In fact, the model can then simultaneously match some macro-stylized facts, life-cycle age-income profiles, and asset returns reasonably well.

While credit market conditions and beliefs are often cited as the driving forces behind the Great Recession, their relative importance is still not known. Kaplan et al. (2017) address this question by building a dynamic general equilibrium model with three different types of aggregate shocks. The first type of shock is the traditional shock on aggregate labor productivity. The second type of shock, which is significant, impacts a group of parameters that capture credit market conditions, including the maximum LTV ratio at mortgage origination, the maximum payment-to-income (PTI) level, mortgage origination cost, and so on. The third type of shock is related to a clever formulation of the aggregate preference for housing ϕ. In their model, ϕ evolves stochastically and follows a three-state Markov process, $\phi \in \{\phi_L^*, \phi_L, \phi_H\}$, where $\phi_L^* = \phi_L < \phi_H$. Thus, the preference for housing in the periods are the same when the economy is in the state of ϕ_L^*, ϕ_L. On the other hand, the two states differ in terms of the (conditional) probability of transferring to the state of ϕ_H, where a higher preference weight is put on housing. Kaplan et al. (2017) therefore distinguish the *news shock or belief shock* (which is a transition between ϕ_L^* and ϕ_L) from an actual *preference shock* (which is a transition between ϕ_L^* or ϕ_L and ϕ_H).

There are other important assumptions in Kaplan et al. (2017). For instance, they assume that renters cannot borrow as they do not have collateral. However,

homeowners can use their houses as collateral and borrow through a home equity line of credit (HELOC). HELOC is refinanced on a period-by-period basis and hence the amount of borrowing is affected by the time-varying house value. It is clearly very different from a mortgage loan, where the amount of borrowing is affected by the house value during the origination period only. They carefully calibrate their model to match both cross-sectional and time-series facts related to the housing market.[38] In addition, they perform a series of counterfactual experiments to disentangle different effects including (1) households belief in housing demand remain fixed over time, (2) households believe that they themselves will increase the demand for housing in the future, and at the same time believe that others will not, (3) mortgage lenders believe that households will increase their demand for housing in the future, while rental firms and households do not, (4) mortgage lenders are pessimistic about the chance of households increasing their housing demands, while the rental firms and households are in fact subject to the belief shock, and so on. They find that it is indeed important to include the rental sector, and it is the belief shock rather than taste shock (the actual change in preference parameters) that accounts for the observed boom-bust dynamics. Contrary to some earlier studies, Kaplan et al. (2017) find that the relaxation and subsequent tightening of the credit market conditions are relatively minor in explaining the observed boom and bust in consumption and house prices. In Kaplan et al. (2017), the belief change is exogenous. The authors study endogenous belief dynamics in an environment

[38]As a matter of fact, the "stylized facts" related to the Great Recession are evolving over time, as more data become available and more research efforts are being devoted. See Agarwal et al. (2017), Foote et al. (2008, 2016), Foote and Willen (2017), Gerardi et al. (2008, 2015a, b), Mian and Sufi (2015, 2016), Palmer (2015), among others, and the references therein.

with informational frictions. We will discuss some of their contributions in the next section.

3.2. Search and Belief.

The application of the search-and-bargaining theory in housing market research has been widely recognized. For instance, according to the Nobel Committee (2010), "…This year's three Laureates have formulated a theoretical framework for search markets. Peter Diamond has analyzed the foundations of search markets. Dale Mortensen and Christopher Pissarides have expanded the theory and have applied it to the labor market.… Search theory has been applied to many other areas in addition to the labor market. This includes, in particular, the housing market. The number of homes for sale varies over time, as does the time it takes for a house to find a buyer and the parties to agree on the price." Clearly, it is impossible to even provide an exhaustive list of that literature.[39] Instead, we focus on a few papers and highlight their insights on the macroeconomic aspects of the housing market.[40]

One of the results of Kaplan et al. (2017) is that belief shocks matter considerably. In fact, the importance of beliefs has been discussed in the real estate literature, perhaps with different names.[41] The more recent literature

[39]Wheaton (1990) may be the first paper that adopts a search-and-matching approach (SMA) in an equilibrium model to study the house price and vacancy. SMA is then adopted by many authors, including Albrecht et al. (2007), Bayer et al. (2011), Díaz and Jerez (2013), Halket and Pignatti Morano di Custoza (2015), Halket and Vasudev (2014), Hort (2000), Huang et al. (2017), Krainer (2001), Head and Lloyd-Ellis (2012), Head et al. (2014, 2018), Ngai and Tenrevro (2014), among others. The mathematical foundation of the search-and-matching models has been studied by Duffie and Sun (2012), among others.

[40]The related literature uses partial equilibrium search models to analyze the housing market. Again, the literature is too vast to be reviewed here. See Anglin and Gao (2011), Arnott (1989), Deng et al. (2012), Leung et al. (2006), Leung and Zhang (2011), Lin and Vendall (2007), Yavas (1992), among others, and the references therein.

[41]The literature is too vast to be reviewed here. See Case and Shiller (1988, 2003), among others, and the references therein.

embeds "beliefs" in a general equilibrium search model so that we can quantitatively study its impact. For instance, Piazzesi and Schneider (2009) show that in a simple house search model, a small number of "optimistic" buyers in the economy can drive up housing prices because in a search environment, prices are determined in a bilateral trade. Optimistic buyers, although a small fraction in the economy, can arise endogenously as a large fraction of "active traders," and hence are able to exert a large impact on the market price. The result is clearly in sharp contrast with the results reported in Kaplan et al. (2017), where "belief shock" needs to impact virtually all agents to generate a significant increase in housing prices. While the setup of the two models are very different and hence not trivial to compare, it is crucial to note that in Piazzesi and Schneider (2009), the housing market is decentralized and subject to search frictions while in Kaplan et al. (2017), the housing market is centralized and cleared in every period.

Burnside et al. (2016) also explore the possibility of a small number of "optimists" that would affect the whole market through "social dynamics," meaning that the "beliefs" of some economic agents could change when they meet others with different beliefs in a stochastic manner. Thus, a model with heterogeneous expectation is needed. Guided by the psychology literature, Burnside et al. (2016) assume that when two agents meet randomly, the agent who has less uncertainty about the fundamental of the housing market, measured by the entropy, would not be convinced by the agent who has more. However, the probability that an agent with high uncertainty is a decreasing function of the difference of the ratio of the uncertainty of the two agents that, other things being equal, agents are *more likely to be changed by people with relatively similar beliefs* than by people with very different beliefs.

Given these assumptions, the authors show that although initially there is only a small fraction of "skeptical" and "optimistic" agents, and most of the population is, therefore, "vulnerable," i.e., they are the ones who are most likely to change their beliefs, it is possible that the number of optimistic agents will rise and then fall as long as this uncertainty is not resolved. In one of the cases they consider, "skeptical" agents are the least likely to change, followed by the "optimistic" and "vulnerable" agents, who are most likely to change. Here, when an optimistic agent meets a skeptical agent, it is possible for the optimistic agent to be "converted" into a skeptical agent. However, when an optimistic agent meets a vulnerable agent, the former will remain optimistic and the latter may be converted into an optimistic agent. In a world of random matching, and the initial amount of skeptical and optimistic agents being equally small, the chance of an optimistic agent of "converting" a vulnerable agent is much higher than the chance of him/her being "converted" by a skeptical agent. Hence, the population of optimistic agents is expected to grow. The population of skeptical agents will grow as well because whether they meet an optimistic agent or a vulnerable agent, they could "convert" them into skeptical agents. However, as the beliefs of skeptical agents are so different from those of the vulnerable majority, the growth rate of skeptical agents is slower than that of optimistic agents within certain parameter values. At some point, however, the relative population of optimistic agents becomes so large that the chance for them of meeting skeptical agents is higher than that of meeting vulnerable agents. The net growth of optimistic agents then becomes negative.

The rise and subsequent fall of the proportion of optimistic agents also leads to a boom-bust cycle of housing prices, as they, unlike the other types of agents, believe that housing will deliver a higher value of utility in the future. Burnside et al. (2016) demonstrate the basic mechanism with a simple model and then show that the intuition carries to a model with 12 different types of agents, who may differ in terms of their beliefs or their housing market participation. They calibrate their models and match some facts of the housing market.

While the previously mentioned papers are based on a random search, Hedlund (2016a, b) explores a model using a directed search.[42] In particular, Hedlund assumes that all transactions are intermediated by brokers. Hence, buyers buy from brokers and sellers sell to brokers. Modifying the "search activities" enables the model to consider a more complicated form of mortgage contracts than many search-theoretic models of housing.[43] In Hedlund's model, the pace of amortization is flexible and hence borrowers can slow down the speed of repayment when needed. However, homeowners can extract home equity only by paying off the original mortgage contract first and then originating a new mortgage contract.[44] There are two issues to consider here. First, the homeowners who need to extract home equity may not have enough liquid assets to pay off the original mortgage contract. Second, even if they are willing to borrow, banks may not be willing to lend. In the model, banks need to pay for both the mortgage origination cost (which functions like a "fixed cost") as well as serving cost to maintain a mortgage cost (which functions like a "variable

[42]It is beyond the scope of this paper to discuss the expanding literature on directed searching. See Wright et al. (2017), among others, for a review of the literature.
[43]See also Eerola and Maattanen (2018) and Head et al. (2018).
[44]See Laufer (2018), among others, and the references therein for the effect of equity extraction on the subsequent default probability.

cost"). Thus, banks may not want to originate a new mortgage contract in certain situations.

Equipped with this setup and through careful calibration, Hedlund mimics the stylized fact that leverage, selling price, and time-on-the-market (TOM) are correlated.[45] The intuition is straightforward. When a homeowner needs to smooth out his/her consumption, he/she can either sell his/her liquid assets, extract home equity, or simply sell his/her house. When the number of liquid assets decreases, he/she may be tempted to extract the home equity. However, the bank may not want to originate a new mortgage contract for such needy homeowners. In this case, the homeowner will be forced to sell his/her house. Thus, homeowners with little liquid assets, so-called distressed owners, may be forced to launch a "fire sale." However, those who are highly leveraged may not even be able to do that because they do not have enough liquid assets to make up the difference between the selling price and the outstanding mortgage loan. Therefore, those distressed owners who are also highly leveraged will be forced to post high selling prices. Undoubtedly, other things being equal, high selling prices will lead to a longer TOM, which further increases the opportunity for foreclosure. Hedlund (2016a, b) articulates this intuition with a cleverly designed directed search model of the housing market.

Thus far, we have seen two extreme forms of house searching, namely, either completely random (such as the case of Piazzesi and Schneider, 2009; Burnside et al. 2016) or completely directed (such as the case of Hedlund), in which no

[45]Prior research explains the correlation by using behavioral economics such as the preference of loss aversion (for instance, see Genesove and Mayer, 1997, 2001). Some recent research, however, has cast doubts on the importance of loss aversion (for instance, see Easley and Yang, 2015 and Li et al. 2017).

seller sells to an end-user directly. While these models succeed with respect to many dimensions, the fluctuations in terms of trading volume seem to have been overlooked. For instance, in Figure 5 and 6 of Burnside et al. (2016), we notice that the transaction volume (which is also the turnover rate, as the total supply of housing stock is fixed in their model) can deviate up to 20% from the steady-state value. Some studies are relatively silent on the turnover rate. Figure 1 represents the real house price and the turnover rate in the United States.[46] To facilitate comparison, we normalize both series to 100 at the beginning of the period. It is clear that turnover rate fluctuates significantly *more* than the house price. Even at the aggregate level, the turnover rate at its peak can be double of its own trough.

(Figure 1 about here)

Some attribute the volatile turnover to "speculative activities." Leung and Tse (2017) consider an intermediate case by introducing the (endogenous) participation of "flippers" (or "speculators," or "investors," which are used interchangeably in their work). In their model, a homeowner may receive a "separation shock" (as the "job separation shock" in the Mortensen-Pissarides model), after which he/she can choose to sell the house to a flipper, which is immediate, and move to a rental housing unit or become a buyer and search for another for-sale housing unit. Alternatively, he/she can wait for a buyer to visit. Hence, the model *endogenizes* the extent of intermediated trade in the housing

[46]Our real housing price is defined as the nominal house price, which is the transaction-based house price index from OFHEO (http://www.fhfa.gov) divided by the CPI from the Federal Reserve Bank at St. Louis. Transaction is measured by the quarterly sales in single-family homes, apartment condos, and co-ops, normed by the stock of such units. The sales data are from the Real Estate Outlook by the National Association of Realtors, complied by Moody's Analytics. The housing stock is defined as the sum of owner-occupied units and vacant for-sale-only units. The data are from the Bureau of Census's CPS/HVS Series H-111 available at http://www.census.gov/housing/hvs/data/histtabs.html.

market and embeds two extreme cases: (1) buyers and sellers meet randomly and no trade is intermediated, and (2) all trade is intermediated (as in the case of Hedlund). In the model, flippers have the advantage of bargaining (i.e., may get a bigger share of the gains from trade than the households) and of inventory (i.e., face a lower discount rate while waiting for buyers to come than the households). Recall that selling a house to a flipper involves receiving a lower selling price but a shorter waiting time (or, a shorter TOM). Thus, it is possible to observe price dispersion in equilibrium if some mismatched households sell their houses to flippers while others sell to buyers directly. From the household perspective, whether to use the flipper to facilitate trade depends on (1) the *price differential* between selling to a flipper versus selling to an end-user and (2) the *time differential* between selling to a flipper (which is assumed to be zero in their model) versus selling to an end-user.[47] From the perspective of the flipper, however, whether a flipper is willing to "facilitate" a trade depends on whether his/her share of gains from trade is large enough, and whether his/her discount rate is sufficiently different from the household. Leung and Tse (2017) show both analytically and quantitatively that multiple equilibria are possible, meaning that for given preferences and technologies, it is possible to have different prices in equilibrium, and each price is associated with a different share of flipper participation. In their calibration, even without a change in "economic fundamentals," average house price can differ by up to 20%. Moreover, by fixing the discount rate of households, the effect of a change in a flipper's discount rate can have a very non-linear effect on the equilibrium price. The intuition is very simple to explain. Note that the *participation of flippers is endogenous*. With a slight increase in their discount rate, the participation rate of the flippers may

[47]See Guren (2016), among others, for more discussion on this point.

change slightly as well. However, after reaching some critical values, the participation rate of flippers may dramatically drop, and the probability of buying and selling will change as well. The resulting equilibrium will look very different.

There are unanswered questions in Leung and Tse (2017). If we can have multiple equilibria in the housing market, we would want to know how equilibrium is being selected. A natural way to do so is to introduce the formation and evolution of beliefs. Thus, a natural extension is to combine a search model with beliefs (such as Piazzesi and Schneider, 2009; Burnside et al. 2016) with an explicit modeling of flippers (such as Leung and Tse, 2017) and examine both the theoretical and empirical implications. There are many opportunities for future research in this regard.

3.3. Urban Development and Housing Market

According to United Nations (2016) "Most people can agree that cities are places where large numbers of people live and work; they are hubs of government, commerce and transportation. But how best to define the geographical limits of a city is a matter of some debate. So far, no standardized international criteria exist for determining the boundaries of a city and often multiple different boundary definitions are available for any given city." In the economics literature, much has been discussed on city formation, the interaction of spatial agglomeration and economic development, and related topics.[48] Here, we only highlight a few papers, which may encourage more research in this area.

[48]It is beyond the scope of this paper to review the literature. See Berliant (2010), Berliant et al. (2002), Berliant

Most macro-housing papers assume that there is only one housing market, and abstract away the spatial and urban considerations.[49] Wang and Xie (2014) develop a two-sector growth model with explicit spatial considerations. More specifically, Wang and Xie assume that the city is a line segment and agents can choose their preferred locations. Hence, housing prices can vary across locations (i.e., different "points" on the same line segment) in equilibrium. In their model, housing depends on the amount of land as well as the physical structure. While land does not depreciate, the physical structure does depreciate over time. Hence, agents need to invest in structure continuously and consequently to trade off the investment in structure (for "housing consumption") versus investment in physical capital (for goods production). They further deviate from the commonly used specification in the macro-housing literature in that (1) they assume that there is a positive amount of minimum structure, and (2) housing is a luxury good in the sense that its income inelasticity differs from that of consumption goods. As agents can reallocate themselves freely across locations, the prices must adjust in a way that the utility at each location is equalized. Their model can mimic some cross-sectional and time series stylized facts. In addition, they show that if instead (1) they assume homothetic preference (i.e., housing has the same income elasticity as consumption goods), or (2) there is no minimum physical structure, then the model would generate counter-factual predictions. In other words, we need to assume that (1) housing is a luxurious good and (2) there is a minimum physical structure.

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and Mori (2017), Berliant and Wang (2008), Berliant and Watanabe (2015), Bond et al. (2016), Duranton (2007), Duranton and Puga (2004), Glaeser (2011), Kopecky and Suen (2010), Li (2017), Liao et al. (2017), Lucas and Rossi-Hansberg (2002), Schiff (2015), Wang et al. (2017), among others, and the references therein.

[49]There are a few exceptions. See Lin et al. (2004), Leung and Teo (2011), among others, and the references therein.

Clearly, both of these assumptions deviate from the standard macro-housing models. Wang and Xie (2014) need these assumptions to be consistent with the stylized facts while standard models do not because they impose two realistic conditions on the model: (1) the amount of land supply increases with the distance from the Central Business District (CBD) and (2) other things being equal, agents prefer to live closer to the CBD (Wang and Xie call this a "locational discount"). Essentially, Wang and Xie seem to suggest that, if we were to account for both cross-sectional and time series facts of housing, we need to reconsider the standard macro-housing models.

Recently, Herkenhoff et al. (2017), among others, take the "spatial macro-housing models" (SMHM) to another level. It is well-known that land-use regulations limit housing supply and affect house prices.[50] Leung and Teo (2011) built one of the first multi-regional, dynamic, general equilibrium models and show that their model is qualitatively consistent with several stylized facts. However, they do not provide a careful calibration of the regional level data. Herkenhoff et al. (2017) aggregate the 48 states of the United States into 8 regions and separately model them, thereby allowing parameters to differ across regions. They find that if they could de-regulate California and New York back to their 1980 level of regulation, the "gain" in consumption would be up to 5%, which is a very significant number.

[50]The literature is too vast to be reviewed here. See Glaeser et al. (2005), Green et al. (2005), Saiz (2010), among others, and the references therein.

While most macro-housing models focus on the U.S. case, there are important exceptions. For instance, there is much debate on whether (1) the housing market in China is expanding too fast, (2) it could collapse soon, and (3) if it indeed collapses, it could exert negative externality on other markets and countries.[51] Garriga et al. (2017) contribute to the debate by building a dynamic model with "rural" and "urban/city" areas. In their model, continuous productivity growth in the manufacturing sector plays an important role because it widens the productivity gap between the manufacturing and agricultural sectors. It enables city workers to afford more expensive housing over time, and also attracts rural workers, who can only work in the agricultural sector, into urban areas. Both effects lead to a continuous increase in the relative price of housing. The authors calibrate their model carefully and find that they can explain most changes in the housing market. Clearly, China is not the only developing country. Therefore, there is much room for the application and extension of the studies in other developing housing markets.

3.4. Urban Policy and Human Capital

Recent research confirms that human capital is important to economic growth, and educational reform has the potential to significantly improve the economic growth rate (e.g., Hanushek et al., 2017 a, b; Hanushek and Woessmann, 2015). Research has also confirmed that early stage human capital formation (for instance, before the age of 10, or even earlier) is crucial to later stage human

[51]The literature is too vast to be reviewed here. See Wu et al. (2012, 2016), Deng et al. (2017), Hsu et al. (2017), Huang et al. (2015), Leung et al. (2011), Song and Xiong (2018), Yang and Chen (2014), Zhang et al. (2016), Zheng and Saiz (2016), among others, and the references therein.

capital formation (e.g., Cunha and Heckman, 2007, 2008; Cunha et al. 2010; Heckman, 2008). In the United States, the approach to providing local public financing of primary and secondary schools naturally binds the local housing market and the financing of pre-college education. Hanushek and Yilmaz (2011, p.583) summarize it this way, "…In simplest terms, poverty, race and schooling are very highly correlated with location…. The reliance on the local tax for a large portion of school funding implies that the government grant system has an important effect on both locational decisions and educational outcomes… Education in the United States is provided by local school districts that operate with considerable autonomy. Funding is provided by a combination of local, state, and federal revenues with the level of spending and the performance of schools varying significantly across school districts…." Thus, it is possible that some families who can only afford less desirable neighborhoods raise their offspring in those neighborhoods. In turn, the future development of these offspring may be constrained and adversely affected, and hence result in cross-sectional segregation and intergenerational immobility. Benabou (1993, 1996a, b), Durlauf (1996), among others, explore such related theoretical possibilities. Empirically, however, this seems to be controversial and many authors have contributed to this literature.[52] Here, we only highlight a few contributions and hopefully encourage even more research on this literature. For instance, Hanushek and Yilmaz (2007, 2013) build a static general equilibrium model, which allows for endogenous community choice (according to Tiebout) and spatial locational choice (according to Alonso).[53] They calibrate the model to match some stylized facts of the United

[52]The literature is too vast to be reviewed here. See Bayer et al. (2007), Brasington and Haurin (2009), Epple and Nechyba (2004), Nechyba (2006), Nguyen-Hoang and Yinger (2011), among others, and the references therein. More recently, Chetty and Hendren (2017a, b) confirm with their large administrative dataset that the neighborhood that children grow up in does have an impact on subsequent economic outcomes.

[53]In Hanushek and Yilmaz, neighborhoods are *identical ex-ante*. Other authors study the case when neighborhoods are *different ex-ante* (for instance, downtown versus suburban). See de Bartolome and Ross

States. Based on the calibrated parameters, they point out that the manner in which education is financed matters. Hanushek et al. (2011) introduce private schools in that framework and find that private schools can indeed improve the welfare of all types of agents. Leung et al. (2012) consider public housing versus housing vouchers in the Hanushek-Yilmaz model. They find that although there are different forms of market imperfections in the model, the conventional wisdom, namely, distributing cash is better than distributing public housing units, prevails. Hanushek and Yilmaz (2015) find that the zoning policy affects both education and the housing market. Bayer et al. (2016), however, estimate a dynamic, partial equilibrium model. They assume that the per-period utility function is somehow additively separable. Their dynamic estimates suggest that some prior estimates that are based on static demand functions of non-market amenities may be significantly biased. Given all of these calibrations and estimations, one may still wonder whether, or under what conditions, an urban policy (such as public housing or affordable housing policy) or an education finance reform (such as school finance consolidation) would necessarily improve the welfare and promote the accumulation of human capital and economic growth.[54] Clearly, much more work is needed in this area.

4. Concluding Remarks

To most households, housing is the most important form of asset holding that they can manage on their own (a retirement fund is clearly important as well but is typically subject to different constraints before retirement). Recently, the

(2003), among others, and the references therein.

[54]For more discussion, see Disney and Luo (2017), Favilukis et al. (2018), among others, and the references therein.

importance of housing has been increasingly recognized in economics and finance. This paper achieves two objectives. First, we re-examine the "stylized facts" of macro-housing. With respect to the business cycle frequency, we find that in many cases, the correlations between traditional MV and HMV have weakened following the GFC. However, the correlations between macro-finance variables and HMV have strengthened following the GFC. In the medium-cycle frequency, some correlations display the same change as in the business cycle frequency while others do not. Therefore, we urge researchers to pay more attention to the "stylized facts" in macro-housing research.

Our second objective is to review some of the literature. We highlight some contributions from important topics: mortgage and bankruptcies, search and beliefs, urban development and housing market, and urban policy and human capital. We find that substantial progress has been made, and at the same time, there remain open questions in these areas. Clearly, many important papers and research areas have been overlooked. We can only allow for such "recognition deficit" for the moment and hope for a more elaborate survey in the future.

Appendix

Forbes and Rigobon (2002) show that with a change in variance over time, the measured correlation may be biased. We therefore follow Stock and Watson (2002) to standardize the variance. Our procedure is given below.

Step one. We first use the Christiano-Fitzgerald filter to extract the business cycle components in the PCSS. By construction, the extracted time series is stationary and hence moments are well defined. Let $\{x_t\}$ be such a time series. The correspondence variance of $\{x_t\}$ is denoted by by σ_x^2. We then "standardize" the volatility of all variables. Now a new variable $z_t = \frac{x_t}{\sigma_x}$ is defined. Hence, $var(z_t) = var(x_t/\sigma_x) = var(x_t)/(\sigma_x^2) = 1$. We apply this data transformation to all variables and hence *all variables have the same volatility*. We can then compute all of the needed correlations.

Step two. We repeat the same procedure on the full sample. Note that even for the same variable x_t, for instance GDP, the sampling period is now different and hence the variance of the extracted series may also be different. A potentially different transformed variable $\{z'_t\}$ will be generated. We apply the procedure to all variables and then re-compute all of the needed correlations.

Step three. We repeat both step one and step two, only this time we extract the medium-cycle components instead of the business cycle components. We calculate and tabulate all of the needed correlations.

Table 1 Correlation between the cyclical component of housing and macro-variables (Panel A)

Housing variables at time t / Macro-variables		Real "purchase-only" house price index		New house sold		Vacancy rate of for-sale housing		Real private residential fixed investment	
		1991Q1-2006Q4	1991Q1-2017Q3	1991Q1-2006Q4	1991Q1-2017Q3	1991Q1-2006Q4	1991Q1-2017Q3	1991Q1-2006Q4	1991Q1-2017Q3
Real GDP	t-1	0.77***	0.57***	0.24*	0.14	-0.39***	-0.03	0.65***	0.54***
	t	0.78***	0.66***	0.42***	0.34***	-0.44***	-0.10	0.76***	0.68***
	t+1	0.74***	0.69***	0.58***	0.51***	-0.52***	-0.16	0.83***	0.76***
Unemployment rate	t-1	-0.67***	-0.27***	0.18	0.27***	-0.12	-0.28***	-0.29**	-0.12
	t	-0.76***	-0.43***	-0.01	0.09	0.08	-0.20**	-0.48***	-0.32***
	t+1	-0.81***	-0.59***	-0.21	-0.13	0.33***	-0.09	-0.64***	-0.51***
CPI	t-1	0.18	-0.12	-0.47***	-0.37***	0.39***	0.19**	-0.22*	-0.21**
	t	0.30**	0.00	-0.33***	-0.24**	0.14	0.13	-0.05	-0.06
	t+1	0.46***	0.19*	-0.18	-0.10	-0.07	0.06	0.13	0.11
Real private Nonresidential Fixed Investment	t-1	0.71***	0.31***	-0.04	-0.22**	-0.03	0.18*	0.39***	0.15
	t	0.78***	0.45***	0.14	-0.04	-0.18	0.12	0.55***	0.33***
	t+1	0.81***	0.58***	0.31**	0.16	-0.38***	0.03	0.69***	0.51***
Real personal consumption expenditures	t-1	0.66***	0.41***	0.02	0.06	-0.25**	0.02	0.45***	0.41***
	t	0.72***	0.52***	0.20	0.22***	-0.33***	-0.03	0.60***	0.55***
	t+1	0.73***	0.58***	0.37***	0.37***	-0.43***	-0.08	0.70***	0.65***
Real trade surplus	t-1	-0.77***	-0.30***	-0.17	-0.10	0.25**	0.00	-0.58***	-0.45***
	t	-0.78***	-0.39***	-0.34***	-0.27***	0.47***	0.11	-0.72***	-0.59***
	t+1	-0.77***	-0.48***	-0.50***	-0.44***	0.69***	0.23**	-0.82***	-0.69***

Table 1 Correlation between the cyclical component of housing and macro-variables (Panel B)

Macro-variables \ Housing variables at time t		Real "purchase-only" house price index		New house sold		Vacancy rate of for-sale housing		Real private residential fixed investment	
		1991Q1-2006Q4	1991Q1-2017Q3	1991Q1-2006Q4	1991Q1-2017Q3	1991Q1-2006Q4	1991Q1-2017Q3	1991Q1-2006Q4	1991Q1-2017Q3
Nominal federal funds rate	t-1	0.54***	0.56***	0.02	0.06	0.15	0.23**	0.27**	0.33***
	t	0.61***	0.64***	0.08	0.18*	0.01	0.08	0.38***	0.47***
	t+1	0.64***	0.69***	0.17	0.29***	-0.19	-0.07	0.50***	0.59***
Real federal funds rate	t-1	0.48***	0.63***	-0.28**	-0.06	0.35***	0.23**	0.06	0.13
	t	0.62***	0.65***	-0.16	0.01	0.22*	0.08	0.24*	0.22**
	t+1	0.66***	0.55***	-0.03	0.06	0.01	-0.03	0.39***	0.30***
Term spread	t-1	-0.64***	-0.62***	-0.10	-0.20**	-0.08	-0.07	-0.36***	-0.44***
	t	-0.69***	-0.64***	-0.19	-0.32***	0.15	0.11	-0.46***	-0.55***
	t+1	-0.68***	-0.61***	-0.27**	-0.40***	0.42***	0.28***	-0.55***	-0.65***
TED spread	t-1	-0.11	-0.43***	-0.39***	-0.45***	-0.08	-0.01	-0.22*	-0.37***
	t	-0.11	-0.36***	-0.33***	-0.43***	-0.15	0.11	-0.19	-0.28***
	t+1	-0.03	-0.21**	-0.28	-0.35***	-0.12	0.21**	-0.14	-0.17*
External finance premium	t-1	-0.38***	-0.42***	-0.33***	-0.29***	0.34***	-0.06	-0.48***	-0.45***
	t	-0.30**	-0.52***	-0.37***	-0.41***	0.47***	0.12	-0.49***	-0.49***
	t+1	-0.21	-0.57***	-0.44***	-0.50***	0.65***	0.31***	-0.49***	-0.49***
S&P 500 index (real terms)	t-1	0.74***	0.57***	0.43***	0.22**	-0.49***	-0.04	0.73***	0.55***
	t	0.70***	0.68***	0.55***	0.41***	-0.80***	-0.12	0.78***	0.66***
	t+1	0.62***	0.74***	0.64***	0.55***	-0.53***	-0.20**	0.78***	0.72***

Notes:

1. Sources of data: “purchase-only” house price index: Federal Housing Finance Agency; vacancy rate of for-sale housing, and new house sold: U.S. Bureau of the Census; private residential Fixed Investment, personal consumption expenditures, GDP and trade surplus: U.S. Bureau of Economic Analysis; CPI: U.S. Bureau of Labor Statistics; term spread: Federal Reserve Bank of St. Louis; effective federal funds rate: Board of Governors of the Federal Reserve System; External finance premium: corporate bond spread (Baa-Aaa): Moody's.
2. Term spread is the difference between 10-Year Treasury Constant Maturity and 3-Month Treasury Constant Maturity. TED spread is the difference between the Eurodollar deposit rate and the T-bill rate (both are 3-month). External finance premium is the corporate bond spread (Baa-Aaa).
3. All the variables are seasonal adjusted. Real variables are nominal variables are deflated by CPI.
4. Cyclical components are obtained by using Christiano and Fitzgerald (2003) band pass filter. Ng and Perron (2001) unit root test indicates that all the variables are I(1) except the nominal effective federal funds rate and the external finance premium: corporate bond spread (Baa-Aaa) which are I(0).

Table 2 Correlation between the medium cycle component of housing and macro-variables (Panel A)

Macro-variables \ Housing variables at time t		Real "purchase-only" house price index		New house sold		Vacancy rate of for-sale housing		Real private residential fixed investment	
		1991Q1-2006Q4	1991Q1-2017Q3	1991Q1-2006Q4	1991Q1-2017Q3	1991Q1-2006Q4	1991Q1-2017Q3	1991Q1-2006Q4	1991Q1-2017Q3
Real GDP	t-1	0.57***	0.81***	0.61***	0.73***	-0.11	-0.14	0.62***	0.80***
	t	0.58***	0.79***	0.65***	0.79***	-0.16	-0.24***	0.65***	0.83***
	t+1	0.56***	0.75***	0.68***	0.83***	-0.26**	-0.34***	0.67***	0.85***
Unemployment rate	t-1	-0.34***	-0.69***	-0.35***	-0.67***	-0.12	0.14	-0.38***	-0.72***
	t	-0.36***	-0.67***	-0.41***	-0.72***	-0.07	0.24***	-0.43***	-0.76***
	t+1	-0.35***	-0.63***	-0.45***	-0.76***	0.01	0.33***	-0.46***	-0.77***
CPI	t-1	-0.57***	-0.29***	-0.53***	-0.24***	0.56***	0.25***	-0.49***	-0.20**
	t	-0.53***	-0.26***	-0.49***	-0.20**	0.55***	0.22**	-0.44***	-0.15
	t+1	-0.50***	-0.23**	-0.46***	-0.17*	0.58***	0.22**	-0.40***	-0.13
Real private Nonresidential Fixed Investment	t-1	-0.32***	0.21**	-0.25**	0.26***	0.26**	-0.05	-0.27**	0.28***
	t	-0.30**	0.20**	-0.23*	0.29***	0.28**	-0.09	-0.24*	0.31***
	t+1	-0.30**	0.18*	-0.21*	0.32***	0.30**	-0.13	-0.21*	0.33***
Real personal consumption expenditures	t-1	0.72***	0.86***	0.80***	0.78***	-0.38***	-0.19**	0.78***	0.83***
	t	0.70***	0.84***	0.81***	0.83***	-0.42***	-0.29***	0.78***	0.86***
	t+1	0.67***	0.80***	0.81***	0.86***	-0.51***	-0.38***	0.77***	0.88***
Real trade surplus	t-1	-0.99***	-0.98***	-0.94***	-0.84***	0.39***	0.17*	-0.96***	-0.90***
	t	-0.97***	-0.96***	-0.95***	-0.88***	0.46***	0.28***	-0.96***	-0.92***
	t+1	-0.95***	-0.93***	-0.96***	-0.92***	0.59***	0.38***	-0.95***	-0.93***

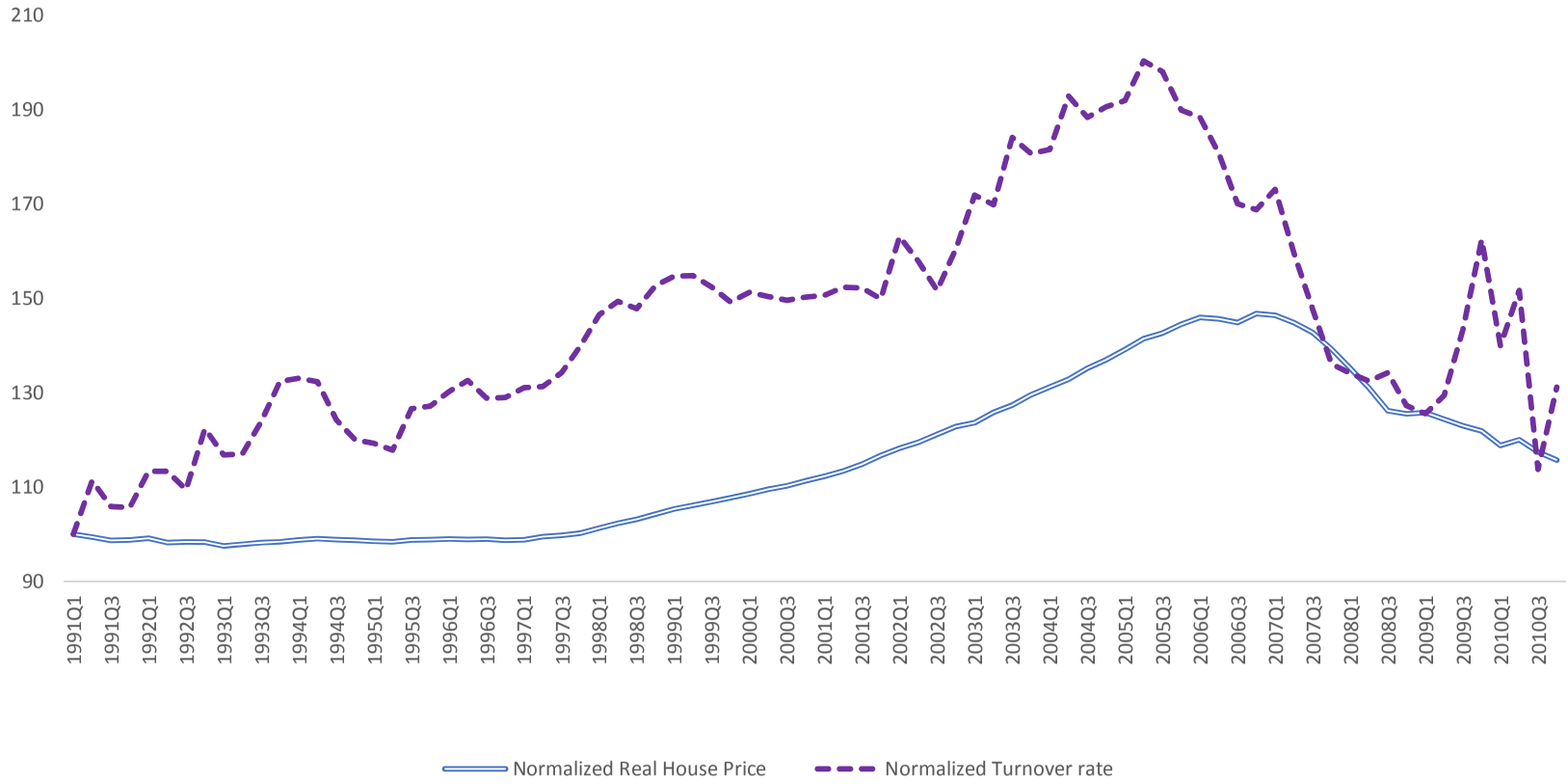
Notes: Our definition of "medium cycles" follow Comin and Gertler (2006), which captures the components with periodicity between 32 and 80 quarters.

Table 2 Correlation between the medium cycle component of housing and macro-variables (Panel B)

Housing variables at time t / Macro-variables		Real "purchase-only" house price index		New house sold		Vacancy rate of for-sale housing		Real private residential fixed investment	
		1991Q1-2006Q4	1991Q1-2017Q3	1991Q1-2006Q4	1991Q1-2017Q3	1991Q1-2006Q4	1991Q1-2017Q3	1991Q1-2006Q4	1991Q1-2017Q3
Nominal federal funds rate	t-1	-0.26**	0.17*	-0.49***	-0.19**	0.93***	0.70***	-0.34***	-0.03
	t	-0.14	0.25***	-0.37***	-0.08	0.89***	0.64***	-0.22*	0.08
	t+1	-0.05	0.33***	-0.28**	0.02	0.84***	0.57***	-0.12	0.18*
Real federal funds rate	t-1	-0.47***	0	-0.57***	-0.27***	0.78***	0.63***	-0.48***	-0.15
	t	-0.38***	0.07	-0.48***	-0.17*	0.78***	0.59***	-0.38***	-0.05
	t+1	-0.32***	0.14	-0.41***	-0.08	0.77***	0.54***	-0.31**	0.04
Term spread	t-1	0.27**	-0.18*	0.31***	0	-0.60***	-0.42***	0.25**	-0.10
	t	0.20	-0.22**	0.23*	-0.09	-0.58***	-0.35***	0.17	-0.18*
	t+1	0.17	-0.25***	0.17	-0.16*	-0.55***	-0.30***	0.10	-0.25***
TED spread	t-1	-0.45***	-0.02	-0.59***	-0.43***	0.75***	0.80***	-0.53***	-0.30***
	t	-0.35***	0.08	-0.51***	-0.32***	0.79***	0.78***	-0.42***	-0.19*
	t+1	-0.31**	0.16*	-0.43***	-0.22**	0.79***	0.75***	-0.34***	-0.08
External finance premium	t-1	-0.39***	-0.48***	-0.58***	-0.68***	0.30**	0.38***	-0.54***	-0.65***
	t	-0.35***	-0.43***	-0.58***	-0.68***	0.36***	0.45***	-0.53***	-0.63***
	t+1	-0.32***	-0.38***	-0.58***	-0.67***	0.44***	0.52***	-0.52***	-0.61***
S&P 500 index (real terms)	t-1	-0.36***	0.12	-0.23*	0.25***	-0.03	-0.25***	-0.31***	0.23**
	t	-0.39***	0.09	-0.25**	0.26***	0.03	-0.26***	-0.32***	0.23**
	t+1	-0.42***	0.05	-0.27**	0.25***	0.09	-0.27***	-0.33***	0.22**

Notes: Our definition of "medium cycles" follow Comin and Gertler (2006), which captures the components with periodicity between 32 and 80 quarters.

Figure 1: USA House Price and Turnover Rate



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