INTERNATIONAL REAL ESTATE REVIEW

2014 Vol. 17 No. 3: pp. 395 – 413

Wealth, Labor Income and House Prices

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In this research, we compare the effect of aggregate U.S. financial wealth with the effect of aggregate U.S. labor income on house prices at the national and city levels. Financial wealth is measured by the net worth of U.S. households minus the equity of owners in home real estate or by the aggregate U.S. stock market index. After adjusting for the volatility of each explanatory variable, we find the economic impact of growth in financial wealth on the aggregate U.S. house price appreciation to be statistically significant and similar to that of labor income growth. We also find a significant wealth effect on some of the city-level house price appreciations. For the cities where both wealth and income effects are significant, the economic impacts of the two effects are found to be similar. While labor income growth has a contemporaneous effect on the house price appreciation, change in financial wealth, and in particular, the stock market, leads house price appreciation but not vice versa.

Keywords:

Wealth Effect, House Price Appreciation

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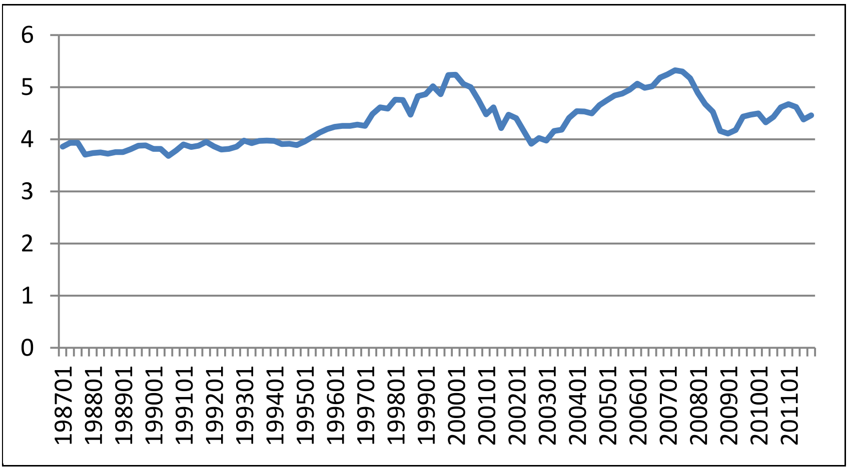
1. Introduction

What determines real house prices? It is well known that household consumption on housing constitutes one of the largest shares of household budgets. As a result, the demand for houses should be related to the total wealth available in household budgets. It is well recognized in economics and the finance literature that the two components of total wealth, namely asset wealth (holdings) and human wealth such as labor income, are important for explaining the behaviors of asset prices (e.g., Campbell, 1993, 1996; Lettau and Ludvigson, 2001a, 2001b, 2004). There is extensive literature in real estate and housing economics that generally agrees income is one of the most important factors that drive movements in equilibrium house prices (e.g., Case and Shiller, 1989,1990; Malpezzi, 1999; Capozza, Hendershott and Mack, 2004; Meen, 2002, Gallin, 2006; Gao, Lin and Na, 2009). However, there are limited studies on the importance of asset wealth, financial wealth in particular, as a determinant of house prices. As indicated in Figure 1, U.S. aggregate financial wealth equals approximately four to five times the aggregate income.

Figure 1 Ratio of Financial Wealth to Disposable Personal Income



Note: Income data are from Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce. Financial wealth is total net worth minus equity of owners in home real estate. Data for net worth and equity of owners in home real estate are from the Board of Governors of the Federal Reserve System.

In this article, we provide an empirical investigation on the effect of financial wealth on house prices. We use both the aggregate U.S. national-level and city-level house price indices. Financial wealth is measured by the net worth of U.S. households minus the equity of owners in home real estate or by the aggregate U.S. stock market index. We compare the effect of growth in financial wealth with that in aggregate U.S. labor income. After adjusting for the volatility of each explanatory variable, we find the economic impact of financial wealth growth on the aggregate U.S. house price appreciation to be statistically significant and similar to that of labor income growth. We also find a significant wealth effect on some of the city-level house price appreciations. For the cities where both wealth and income effects are significant, the economic impacts of the two effects are found to be similar.

The analysis in this article is based on the assumption that the appreciation rates of house prices and the growth rates of income and wealth are stationary. As a result, this analysis does not rely on the controversial assumption that the levels of prices, income and wealth are cointegrated. Malpezzi (1999) reports that the ratio of price to income is stationary and proposes an error-correction model for house prices. Meen (2002) uses U.S. and U.K. national data of house prices, income and wealth, but employs an error correction model in which house price appreciation rates are related to levels of income and wealth. Capozza, Hendershott and Mack (2004) and Gao, Lin, Na (2009) estimate error-correction models by assuming linear and cointegrating equilibrium relations between house prices, income and other determinants of house prices. By using both national and city-level data, Gallin (2006) finds that the hypothesis of no cointegration in the data is not rejected and concludes that the error-correction specification for house prices and income commonly utilized in the literature may be inappropriate.

To our knowledge, this is the first article that studies the effects of U.S. aggregate financial wealth and U.S. aggregate income on house price appreciations at both the national and city levels. Gallin (2006) has studied the U.S. national-level data of house prices, income and the stock market index. However, at the city-level, his study is restricted to the relation between house prices and income and he does not investigate the relation between house prices and wealth. He finds a surprisingly negative relation between the aggregate U.S. house price and the stock price. Other researchers have focused on the wealth effect, but not the income effects. For example, Tsai, Lee and Chiang (2012) employ a threshold cointegration model and find an asymmetric wealth effect in the U.S. national-level house and stock markets. Similarly, Fan, Zsuzsa and Zhang (2012) adopt an indifference pricing approach and find that real estate price increases with expected financial asset return only in weak (normal) market comovement when investors enjoy diversification benefit.

The rest of the article is organized as follows. In the next section, we will describe a model in which the demand and supply of houses are determined by fundamental factors and the house price is solved by a market equilibrium condition. We then describe the data and present the empirical results. The last section concludes.

2. The Model

In the existing literature, house prices are commonly assumed to be the present value of future rents and values of rents are in turn assumed to be related to fundamental factors, such as income (e.g., Capozza and Li, 1994, 2001, 2002). Since the focus of this paper is the prices of single-family houses which are presumably owner-occupied, we describe a model under the assumption that the demand and supply of houses are related to some underlying factors. The aggregate housing prices are then determined by the market equilibrium. This approach is commonly used in models of owner-occupied housing (e.g., DiPasquale and Wheaton (1994)).

To study the demand for houses, we consider two sources of wealth in the budget constraints of housing market participants: income and financial wealth measured by total net worth minus equity of owners in home real estate. Although total net worth and the equity of owners in home real estate depend on aggregate house prices, the financial wealth should be mainly related to net worth only in financial assets like stocks and bonds. Let p_t denote the log of the aggregate house price for period *t*. Let y_t and w_t denote the logs of income and financial wealth for period *t*. In addition to wealth, there may be other factors such as the user cost of ownership (e.g., mortgage payment) that affect the demand for houses. Let m_t denote the mortgage payment for period *t*. The aggregate demand for houses at time *t* is given by the following equation:

$$d_t = a_d + \sum_{i=0}^{k} (a_{iw} w_{t-i} + a_{iy} y_{t-i} + a_{im} m_{t-i}) + e_d p_t \qquad (0)$$

In Equation (0), coefficient a_d is an intercept, a_{iw} represents the sensitivity of demand to the current $(i = 0)$ or lagged $(i > 0)$ financial wealth, a_{iy} represents the sensitivity of demand to current or lagged income, a_{im} represents the sensitivity of demand to current or lagged mortgage payment,and finally, the coefficient $e_d < 0$ in the last term is the elasticity of demand with respect to the contemporaneous house price. Here income, asset wealth and mortgage payment are exogenous variables, so demand can be related to contemporaneous as well as lagged values of these variables ($i = 0, 1, \cdots, k$).

Wealth and mortgage payment in Equation (0) are the fundamental factors that drive the demand for houses. An increase in financial wealth or income indicates an improvement of housing affordability, which should result in increased demand by first-time home buyers, trade-up homeowners and real estate investors alike. Here lagged information is included to account for the time to search and close transactions. The house market is informationally more efficient if the number of lags is smaller.

Next, we describe the aggregate supply of houses. In the long run, the supply of houses may vary with contemporaneous and lagged values of economic factors, such as construction costs. Let c_t denote the log of the construction cost for period *t*. The aggregate supply of houses is given by the following:

$$s_t = a_s + \sum_{i=0}^{k} a_{ic} c_{t-i} + e_s p_t \qquad (0)$$

In Equation (0), a_s is an intercept, a_{ic} represents the sensitivity of supply to the current $(i = 0)$ or lagged $(i > 0)$ construction cost and the coefficient $e_s \geq 0$ is the elasticity of supply with respect to the contemporaneous housing price change.

Under market equilibrium, aggregate demand is equalized to aggregate supply: $d_t = s_t$. Equalizing the right hand side of Equation (0) with that of Equation (0) yields the following equilibrium log house price:

$$p_t = \frac{1}{e_s - e_d} \left[(a_d - a_s) + \sum_{i=0}^{k} (a_{iw} w_{t-i} + a_{il} y_{t-i} + a_{im} m_{t-i} - a_{ic} c_{t-i}) \right] \qquad (0)$$

Since $e_s - e_d > 0$, the aggregate house price should respond to the fundamental demand factors in the same direction as the aggregate demand. An increase in asset wealth (or income) should be associated with an increase in the house price for period *t* if such an increase in wealth or income has a positive impact on the aggregate demand. Similarly, if the demand is inversely related to the mortgage payment, a rise in the cost of ownership should be associated with a decline in the house price. However, the house price and the aggregate supply should react to supply factors such as the construction cost in the opposite direction. If a higher construction cost is expected to dampen supply $(a_{ic} < 0)$, it should drive up the house price.

In order to study house price appreciation, we take the first-order differences of both sides of Equation (0) and obtain the following:

$$\Delta p_t = \sum_{i=0}^{k} (\beta_{iw} \Delta w_{t-i} + \beta_{il} \Delta y_{t-i} + \beta_{im} \Delta m_{t-i} + \beta_{ic} \Delta c_{t-i}), \qquad (0)$$

where $\beta_{iw} = a_{iw} / (e_s - e_d)$, $\beta_{iy} = a_{iy} / (e_s - e_d)$, $\beta_{im} = a_{im} / (e_s - e_d)$, and $\beta_{ic} = -a_{ic} / (e_s - e_d)$.

In Equation (0), the house price appreciation is related to current and lagged growth rates of financial wealth and labor income, as well as rates of changes of the mortgage payment and the construction cost. Unlike Equation (0), the intercept in Equation (0) vanishes, thus implying that the house price appreciation does not occur without any change in one or more of the fundamental factors.

3. Data Description

The data series for aggregate house price is the S&P/Case-Shiller (CS) Composite-10 Home Price Index available monthly starting from January 1987. The index is designed to measure changes in the market values of pre-existing single-family residential real estate in the United States. The index construction relies on a repeat sales pricing methodology. The Composite-10 index is created by combining the home price indices of 10 metropolitan statistical areas (MSAs). The 10 MSAs are: Boston-Cambridge-Quincy, MA-NH; Chicago-Naperville-Joliet, IL; Denver-Aurora, CO; Las Vegas-Paradise, NV; Los Angeles-Long Beach-Santa Ana, CA; Miami-Fort Lauderdale-Pompano Beach, FL; New York City Area, CT-NJ-NY-PA; San Diego-Carlsbad-San Marcos, CA; San Francisco-Oakland-Fremont, CA; Washington-Arlington-Alexandria, DC-VA-MD-WV.

There are two principal home price indices in the United States: the CS index published by Standard & Poor's and Fiserv Inc. and the Home Price Index (HPI) published by the Federal Housing Finance Agency (FHFA). Although both indices employ the same repeat sales valuation approach by forming sales pairs of the same residential property from arms-length transactions, they differ in the sources of data and weighting schemes. More specifically, the valuation data of the FHFA are derived from only conforming conventional mortgages provided by Fannie Mae and Freddie Mac, whereas the CS index uses information on all residential property transactions that are obtained from county assessor and recorder offices. As a result, the CS index has broader market coverage that includes not only properties financed by conforming conventional mortgages, but also other properties financed by cash, FHA loans, and adjustable rate and subprime mortgages. Moreover, as opposed to the FHFA index, the CS index is value-weighted and hence a better measure of changes in the aggregate market value of U.S. residential markets.

Unlike house price data, data on aggregate U.S. labor income, asset holdings and equity of owners in home real estate are available on a quarterly basis. The aggregate labor income is defined as wages and salaries plus transfer payments plus other labor income less personal contributions for social insurance and less taxes. Labor income is converted into real labor income by deflating the nominal series with the chain-type personal consumption expenditure (PCE) deflator. An alternative measure of income is the aggregate disposable personal income. Components of labor income, personal income and PCE deflator are obtained from the Bureau of Economic Analysis (BEA) of the U.S. Department of Commerce. Real personal income is also calculated with a PCE chain-type deflator. Unlike disposable income, labor income does not include proprietor, rental and personal income receipts on assets such as dividends and interest income. We follow Lattau and Ludvigson (2001a, 2001b, 2004) in calculating labor income data.

Other data including total net worth, equity of owners in home real estate and the 30-year conventional mortgage rate are provided by the Board of Governors of the Federal Reserve System. To be consistent with real income data, CS HPI, financial wealth and home equity are converted into real values with the PCE chain-type deflator. The mortgage rate is used to calculate monthly mortgage payment which is then converted into real values with the PCE deflator. Furthermore, total net worth, home equity and income data are converted into per capita real data by deflating the real data series with the U.S. population data provided by the Census Bureau of the U.S. Department of Commerce. Financial wealth is calculated as the total net worth minus equity of owners in home real estate. Although total net worth and equity of owners in home real estate depend on aggregate house prices, financial wealth should be mainly related to net worth only in financial assets, like stocks and bonds. As an alternative measure of financial wealth, we use the value-weighted market index of all stocks traded in the New York Stock Exchange, American Stock Exchange and NASDAQ. The stock index data are provided by the Center for Research in Security Prices at the University of Chicago. Lastly, the quarterly data series for the unit labor cost of construction is obtained from the Organization for Economic Cooperation and Development. Both the stock market index and the labor cost are also converted into real values with the PCE deflator.

4. Results

4.1 Summary Statistics

The sample period for this study covers the first quarter of 1987 through to the fourth quarter of 2011 due to the first available date of the CS HPI and the quarterly frequency at which the income and wealth data are available. The summary statistics for all variables in percent are provided in Table 1. On average, the aggregate 10-MSA real house price appreciates at a rate of 0.25 percent per quarter, which is slower than the average growth rates of financial wealth (FIN) of 0.54 percent, the CRSP stock return (RET) of 1.43 percent, disposable personal income (DPI) of 0.39 percent, and labor cost of construction (LCC) of 0.48 percent. Average labor income (LBR) grows at a rate of 0.14 percent, much slower than that of personal income, which also includes incomes from invested wealth. The real mortgage payment experiences a decline of 1.15 percent, as a result of falling interest rates in the sample period. Note that the average growth rates of all variables are in excess of the average inflation rate of 0.61 percent, as measured by the PCE deflator.

Next, we discuss the volatility of house prices and other variables. The standard deviation of house price appreciation is 2.65 percent, which is higher than those of the growth rates of labor income (0.84), personal income (0.84), or labor cost of construction (0.90). However, the standard deviation of house price appreciation is lower than those of the growth rate of financial wealth (3.13), the rate of change in mortgage payment (4.12), and in particular, the standard deviation of stock return (8.94). On the basis of the coefficient of variation (CV), which is the standard deviation divided by the mean, however, house price appreciation has the highest CV of 10.54, while stock return has a CV of 6.25, labor income growth has a CV of 6.03 and financial wealth has a CV of 5.83. Thus, after adjusting the mean (the scale) of each variable, the volatility of house price appreciation is most remarkable. Compared with the CVs of stock market return, labor income and financial wealth, the CVs of other variables are much smaller. For example, the CVs of DPI, PMT and LCC are 2.16, -3.60 and 1.88, respectively. Later, we find that the explanatory variables with higher CVs tend to be more significant in explaining house price appreciation.

Table 1 Summary Statistics

All series are the quarterly first differences in percent and in logs (rate of change) for the period of the first quarter of 1987 through the fourth quarter of 2011. All variables are converted into real variables by using the personal consumption expenditure (PCE) deflator. Income and financial wealth are per capita values. CV is the coefficient of variation. Financial wealth is total net worth minus equity of owners in home real estate.

	Variables	Mean	Std. Dev.	CV
HPI	Appreciation rate of Case-Shiller home price index	0.251	2.645	10.540
FIN	Growth rate of financial wealth	0.537	3.130	5.825
RET	Return on the CRSP stock market index	1.431	8.944	6.250
LBR	Growth rate of labor income	0.140	0.842	6.032
DPI	Growth rate of disposable personal income	0.390	0.844	2.162
PMT	Rate of change in mortgage payment	-1.145	4.117	-3.596
LCC	Rate of change in labor cost of construction	0.477	0.895	1.876
PCE	Rate of change in PCE deflator	0.609	0.384	0.631

Correlation Coefficients

	FIN	RET	LBR	DPI	PMT	LCC	PCE
HPI	0.159	0.089	0.124	0.195	0.103	0.136	0.087
FIN		0.934	0.075	0.161	0.129	0.101	0.146
RET			0.016	0.078	0.097	0.021	0.164
LBR				0.826	0.114	0.203	0.005
DPI					0.057	0.284	0.326
PMT						-0.246	-0.159
LCC							0.220

Last, we examine correlations between pairs of variables displayed in the second half of Table 1. A few high correlations are expected. The highest correlation of 0.93 is between growth in financial wealth and stock returns, probably because the largest and most volatile component of asset holdings is common stocks. The second highest correlation of 0.83 is between labor income growth and disposable income growth, because labor income is the main ingredient of disposable income. The correlations between the other pairs of variables are generally much lower. For example, the correlation of labor income growth, LBR, with financial wealth, FIN, is 0.08 and its correlation with stock return, RET, is 0.02.

4.2 Regression Results

At market equilibrium, the house price appreciation should be determined by the demand and supply factors according to Equation (4). To investigate the relative importance of wealth, income and other determinants of house prices, we first regress the house price appreciation on one of the demand or supply factors. Here, only the first lag (K = 1) is included as higher-order lags are found to be insignificant. Other independent variables that serve as auxiliary variables include a constant, three seasonal dummy variables and a lagged dependent variable. The dummy variables are intended to capture the well-known seasonality in house price appreciations and the lagged dependent variable is to capture the autocorrelations of the house price appreciation induced by the repeat sales methodology. The results of the regressions are summarized in Table 2. The adjusted coefficient (coefficient on a variable times the standard deviation of the variable), adjusted R^2 and Durbin-Watson (DW) statistics are reported in the last three columns of the table. While the adjusted R^2 is a measure of the explanatory power of all explanatory variables included in each regression, the adjusted coefficient is an indicator of the impact on the house price appreciation from a one standard deviation change of each explanatory variable. By adjusting the coefficients to account for the variability of the explanatory variables, the adjusted coefficients become comparable in terms of the size of economic impact. The DW statistic measures the level of the residual autocorrelation. Value 2 of the DW indicates no autocorrelation. If the DW is substantially less (greater) than 2, there is evidence of positive (negative) serial correlation. Residual autocorrelations are generally found to be low as the DW lies between 1.89 and 1.99. Nonetheless, standard errors that are robust to heteroscedasticity and residual autocorrelations are calculated with Newey-West/Bartlett window and 4 lags of residuals. The estimated coefficients and other statistics associated with the auxiliary variables are qualitatively unaffected by the choice of the demand or supply factors. So estimation results for the auxiliary variables are reported for the regression with these variables only at the bottom of Table 2.

Table 2 Regressions of House Price Appreciation on One Demand or Supply Factor

See Table 1 for definitions of variables. The parenthesis refers to the first lag. The dependent variable is the appreciation rate of the Case-Shiller home price index. The explanatory variables in each regression include one of demand or supply factors and (or) its first lag plus auxiliary variables including a constant, three seasonal dummy variables and the lagged dependent variable. Robust standard errors are calculated with Newey-West/Bartlett window and 4 lags of residuals. The adjusted coefficient is the coefficient multiplied by the standard deviation of the explanatory variable. DW refers to Durbin-Watson statistic. Coefficients that are significant at the 5 percent level are highlighted in bold.

Regression	Explanatory Variable	Coefficient	Std. Err.	Adj. Coeff.	Adj. R^2	DW
1	FIN	-0.006	0.049	-0.018	0.785	1.894
	FIN(1)	**0.082**	**0.028**	**0.256**		
2	RET	-0.002	0.017	-0.013	0.787	1.917
	RET(1)	**0.030**	**0.009**	**0.270**		
3	LBR	**0.301**	**0.142**	**0.253**	0.787	1.975
	LBR(1)	0.233	0.124	0.197		
4	DPI	0.105	0.136	0.089	0.777	1.944
	DPI(1)	0.018	0.127	0.015		
5	PMT	0.036	0.028	0.147	0.780	1.937
	PMT(1)	0.022	0.021	0.090		
6	LCC	0.024	0.174	0.021	0.778	1.982
	LCC(1)	-0.152	0.175	-0.136		
Auxiliary variables only	Constant	-0.000	0.002		0.781	1.991
	2nd quarter dummy	**0.023**	**0.005**			
	3rd quarter dummy	-0.007	0.003			
	4th quarter dummy	**-0.014**	**0.003**			
	HPI(1)	**0.866**	**0.068**			

Now, we discuss the regression results with financial wealth or stock return as the explanatory variable. We find that the contemporaneous growth in financial wealth is insignificant in explaining the house price appreciation. However, the lagged financial wealth growth enters the regression with a coefficient of 0.08 and standard error of 0.028, thus implying that the house price appreciation is significantly and positively related to the lagged growth in financial wealth at the 1 percent level. The evidence is consistent with the prediction by the model in that increasing wealth raises the demand for houses and results in a positive house price appreciation. Not surprisingly, given the high correlation of the financial wealth growth and the stock return, similar results are found for the stock return as the alternative demand factor. The lagged stock return enters the regression with a coefficient of 0.03 that is also significant at the 1 percent level. The coefficient is much smaller compared with that on financial wealth. However, the adjusted coefficients on the financial wealth and the stock return are quite similar, which are 0.26 and 0.27 respectively. Since financial wealth and the stock return are highly volatile, most of the change in wealth or returns is likely to be unexpected. As a result, the demand for houses and the house price appreciation react slowly to the change in wealth and the stock return. Given the standard deviations reported in Table 1, approximately 3.1 percent growth in financial wealth or an 8.9 percent increase in the stock return will cause a 0.26-0.27 percent house price appreciation in the next quarter, or equivalently, more than 1 percent house price appreciation on an annualized basis. This suggests that after adjusting for volatility, the financial wealth and the stock return have very similar effects on the house price appreciation. Also note that the resulting increases exceed the mean house price appreciation rate. The adjusted R^2s of the two regressions are 0.785 and 0.787 respectively, which suggest only a slightly higher explanatory power of the stock return than financial wealth. Note that both adjusted R^2s here are higher than the adjusted R^2 of 0.781 from the regression with auxiliary variables only, as reported at the bottom of Table 2.

Next, we find that house price appreciation is related to labor income growth as the demand factor. Unlike financial wealth or stock return, contemporaneous labor income growth is statistically significant rather than lagged growth. The coefficient on the LBR is 0.30 with a standard error of 0.14, so the contemporaneous labor income growth is significant at the 5 percent level. As labor income growth is less volatile than the financial wealth and the stock return, most of labor income growth is likely to be expected and affects the house price appreciation immediately. In contrast, personal income growth and the lagged growth are not significant at conventional levels, which suggest that labor income component of personal income is a more crucial demand factor for house prices. On the basis of the adjusted coefficient of 0.25 for labor income growth, the effect of the financial wealth or the stock return is similar to that of labor income growth. The adjusted R^2 of the regression with labor income growth as the demand factor is 0.787, identical to the one with the stock return as the demand factor. Hence, the explanatory powers of asset wealth and labor income are quite similar. None of the remaining factors, including current and lagged changes in the mortgage payment and the labor cost of construction, are found to be significant even at the 10 percent level.

The results at the bottom of Table 2 indicate significant seasonal variations in the average quarterly house price appreciations. Compared with the 1st (winter) quarter, the average appreciation rate is 2.3 percent higher in the 2nd (spring) quarter and 1.4 percent lower in the 4th (fall) quarter. The standard errors associated with the two quarter dummy variables are less than 0.01, thus implying that the seasonal changes are significant at the 1 percent or even lower level. The lagged dependent variable has a coefficient of 0.87 and a standard error of 0.068, which indicate high and significant autocorrelations of the house price appreciation. As a result, we find that excluding seasonal dummy variables or the lagged dependent variable in the regressions can lead to substantial declines in the adjusted R^2s and DWs, and more importantly, such exclusions can sometimes distort the statistical inferences associated with the demand and supply factors. For example, without the seasonal dummy variables, the coefficients and their statistical significance associated with LBR and LBR(1) become overestimated, thus implying that both are significant at the 1 percent level. However, the results that concern the DPI and the wealth variables are largely unchanged.

Now we turn to Table 3, where the results are presented for regressions with both wealth and income growth as explanatory variables. The seasonal dummy variables or the lagged dependent variable in the regressions are also included. Other factors, such as the rates of change in the mortgage payment and the construction cost, are omitted as neither of them is statistically significant in the regressions. The regression coefficients and associated standard errors for the explanatory and auxiliary variables here are similar to those in Table 2, where only one of the demand or supply factors is included among the explanatory variables. For example, from Regression 1, lagged financial wealth growth, FIN(1), and contemporaneous labor income growth, LBR, are both significant in explaining the house price appreciation at the 5 percent level. Similarly, from Regression 2, both the lagged stock return, RET(1), and the contemporaneous labor income growth, LBR, are also significant. The adjusted coefficients on FIN(1), LBR and RET(1) in the two regressions are similar again in the range of 0.24-0.28, which imply that the effect of asset wealth is as important as that of income growth. The adjusted R^2s here are 0.790 and 0.793 for the two regressions, higher than 0.785-0.787 from Regressions 1-3 in Table 2, where only one of three factors is included as explanatory variables.

We also run regressions in which DPI instead of LBR is used. In the presence of the financial wealth or stock return as part of the explanatory variables, DPI and its lag are still not significant at conventional levels. So the lack of the significance of DPI or its lag is not due to the missing-variable problem related to the exclusion of the asset wealth variables in the regressions. Overall, this result confirms that labor income growth is more important than personal income growth for explaining the house price appreciation.

Table 3 Regressions of House Price Appreciation on Wealth and Income Growth

See Table 1 for definitions of variables. The parenthesis refers to the first lag. The dependent variable is the appreciation rate of the Case-Shiller home price index. Robust standard errors are calculated with Newey-West/Bartlett window and 4 lags of residuals. DW refers to Durbin-Watson statistic. The adjusted coefficient is the coefficient multiplied by the standard deviation of the explanatory variable. Coefficients that are significant at the 5 percent level are highlighted in bold.

Regression	Variable	Coefficient	Std. Err.	Adj. Coeff.	Adj. R^2	DW
1	Constant	-0.003	0.003		0.790	1.896
	2nd quarter	**0.024**	**0.004**			
	3rd quarter	-0.004	0.004			
	4th quarter	**-0.011**	**0.003**			
	FIN	-0.009	0.045	-0.029		
	FIN(1)	**0.078**	**0.030**	**0.244**		
	LBR	**0.280**	**0.141**	**0.236**		
	LBR(1)	0.236	0.128	0.199		
	HPI(1)	**0.826**	**0.077**			
2	Constant	-0.003	0.003		0.793	1.915
	2nd quarter	**0.023**	**0.004**			
	3rd quarter	-0.005	0.004			
	4th quarter	**-0.012**	**0.003**			
	RET	-0.002	0.016	-0.017		
	RET(1)	**0.031**	**0.009**	**0.276**		
	LBR	**0.297**	**0.147**	**0.250**		
	LBR(1)	0.254	0.130	0.213		
	HPI(1)	**0.834**	**0.077**			

Having studied the 10-MSA aggregate house price index, we then examine the price index for each of the MSAs. The dependent variable is the appreciation rate of the CS MSA home price index. The explanatory variables in each regression include the lagged stock return or contemporaneous labor income growth plus the same set of seasonal dummy variables used earlier and a lagged dependent variable. Note that both the stock return and labor income are based on the aggregate U.S. data and all house prices are deflated by the nationwide PCE deflator used earlier. The goal here is to identify the MSAs where the house price appreciations are sensitive to the aggregate U.S. stock return or the aggregate labor income growth, or both. The results of the regressions are reported in Table 4.

Table 4 Regressions of City-Level House Price Appreciations on Stock Returns and Income Growth

The dependent variable is the appreciation rate of the Case-Shiller MSA home price index. The explanatory variables in each regression include the lagged stock return or contemporaneous labor income growth plus auxiliary variables including a constant, three seasonal dummy variables and the lagged dependent variable. Robust standard errors are calculated with Newey-West/Bartlett window and 4 lags of residuals. DW refers to Durbin-Watson statistic. The adjusted coefficient is the coefficient multiplied by the standard deviation of the explanatory variable. Coefficients that are significant at the 5 percent level are highlighted in bold.

Panel A. Lagged stock return RET(1) as the main explanatory variable

	Coeff	Std. Err.	Adj. Coeff,	Adj. R^2	DW
Boston	**0.040**	**0.016**	**0.360**	0.679	2.434
Chicago	0.006	0.043	0.058	0.308	1.960
Denver	0.054	0.039	0.479	0.448	2.029
Las Vegas	0.037	0.027	0.331	0.674	2.148
Los Angeles	**0.031**	**0.013**	**0.280**	0.809	1.697
Miami	0.021	0.018	0.190	0.717	2.285
New York	**0.026**	**0.012**	**0.230**	0.701	1.968
San Diego	0.024	0.013	0.214	0.755	2.049
San Francisco	**0.082**	**0.023**	**0.730**	0.629	1.841
Washington, DC	0.006	0.015	0.053	0.682	2.138

Panel B. Labor income growth LBR as the main explanatory variable

	Coeff	Std. Err.	Adj. Coeff,	Adj. R^2	DW
Boston	**0.420**	**0.182**	**0.353**	0.678	2.507
Chicago	0.211	0.182	0.177	0.312	1.982
Denver	0.101	0.231	0.085	0.429	2.052
Las Vegas	0.322	0.236	0.271	0.672	2.098
Los Angeles	0.136	0.178	0.114	0.804	1.759
Miami	0.087	0.285	0.073	0.714	2.314
New York	0.110	0.150	0.093	0.692	1.954
San Diego	0.265	0.147	0.223	0.755	2.083
San Francisco	**0.706**	**0.258**	**0.594**	0.618	1.976
Washington, DC	**0.391**	**0.184**	**0.330**	0.695	2.176

From Panel A of Table 4, we find that for the four MSAs, including Boston, Los Angeles, New York and San Francisco, house price appreciations are related to the lagged stock return at the 5 percent or lower significant level. The regression and adjusted coefficients for San Francisco are at least twice as large as those for the other three MSAs and the 10-MSA aggregate index. For example, the adjusted coefficients here are 0.73 for San Francisco, 0.36 for Boston, 0.28 for Los Angeles, and 0.23 for New York, while the coefficient is 0.27 in Table 2 for the 10-MSA index. The results here are consistent with the finding of Green (2002), who reports a strong wealth effect under circumscribed conditions like the San Francisco Bay area. The adjusted $R^2$for Los Angeles is highest at 0.81, but the DW statistic is lowest at 1.70, indicative of possible positive serial correlations of residuals. The adjusted R^2s for Boston, New York and San Francisco lie in the range of 0.63-0.70 and DWs fall within 1.84-2.43, thus implying low residual autocorrelations and a goodness of fit of the model.

Now we turn to Panel B of Table 4. House price appreciations for three MSAs (Boston, San Francisco and Washington, DC) are significantly related to the same-period U.S. labor income growth at the 5 percent level. The adjusted coefficients are 0.59 for San Francisco, 0.35 for Boston, and 0.33 for Washington, DC. It is of interest to note that house price appreciations of two MSAs (Boston and San Francisco) are sensitive to both the lagged stock return and the contemporaneous labor income growth. On the basis of the adjusted coefficients and adjusted R^2s, the effects of the stock return on the house price appreciation for the two MSAs are similar or slightly greater than those of labor income growth. For example, for San Francisco, the adjusted coefficient on RET(1) is 0.73 with an adjusted R^2 of 0.63, while the adjusted coefficient on LBR is 0.59 with an adjusted R^2 of 0.62. Overall, the results from the individual MSA price indices reinforce the earlier evidence from the 10-MSA aggregate price index that the aggregate wealth effect is at least as important as the aggregate income effect on house price appreciations.

Since we have documented that house price appreciation depends on the growth of financial wealth or stock return, a natural question to ask is whether financial wealth growth or stock return also depends on house price appreciation. To answer this question, we regress the growth of financial wealth (Panel A of Table 5) or the stock return (Panel B of Table 5) on current and lagged house price appreciations plus auxiliary variables including a constant, three seasonal dummy variables and the lagged dependent variable. We include the seasonal dummy variables to control the effect of seasonality in the dependent variable. The results are reported in Table 5. We find that current and lagged house price appreciations are insignificant at any conventional levels in explaining the growth of financial wealth or the stock return. Significant seasonality is detected in the growth rate of financial wealth, but not in the stock return. The adjusted R^2 is 0.07 as a result of the seasonality in the growth rate of financial wealth. With the stock return as a dependent variable, the adjusted R^2 is negative. Overall, the results here along with those in earlier tables suggest that change in financial wealth, and in particular, the stock market, leads house price appreciation but not vice versa. This is understandable since the stock market is much more liquid than the housing market.

Table 5 Regression of Wealth Growth or Stock Return on House Price Appreciation

See Table 1 for definitions of variables. The parenthesis refers to the first lag. Robust standard errors are calculated with Newey-West/Bartlett window and 4 lags of residuals. DW refers to Durbin-Watson statistic. Coefficients that are significant at the 5 percent level are highlighted in bold.

Panel A. Growth rate of financial wealth, FIN, is the dependent variable

Variable	Coefficient	Std. Err.	Adj. R^2	DW
Constant	0.008	0.006	0.074	1.981
2nd quarter	-0.001	0.009		
3rd quarter	**-0.019**	**0.008**		
4th quarter	0.005	0.007		
HPI	-0.037	0.316		
HPI(1)	0.332	0.241		
FIN(1)	0.105	0.107		

Panel B. Return on CRSP stock market index, RET is the dependent variable

Variable	Coefficient	Std. Err.	Adj. R^2	DW
Constant	0.013	0.014	-0.027	1.956
2nd quarter	0.015	0.023		
3rd quarter	-0.030	0.023		
4th quarter	0.009	0.026		
HPI	-0.086	0.997		
HPI(1)	0.444	0.818		
RET(1)	0.052	0.094		

5. Conclusions

In this research, we have compared the effect of aggregate U.S. financial wealth with the effect of aggregate U.S. labor income on house prices at the national and city levels. Financial wealth is measured by the net worth of U.S. households minus equity of owners in home real estate or by the aggregate U.S. stock market index. After adjusting for the volatility of each explanatory variable, we find that the economic impact of financial wealth growth on aggregate U.S. house price appreciation to be statistically significant and similar to that of labor income growth. We also find a significant wealth effect on some of the city-level house price appreciations. For the cities where both wealth and income effects are significant, the economic impacts of the two effects are found to be similar.

More specifically, we find that lagged but not contemporaneous growth in financial wealth is significant in explaining national house price appreciation. Not surprisingly, given the high correlation between financial wealth growth and stock return, similar results are found for stock return as the alternative demand factor. For every one standard deviation of change in financial wealth growth orthe stock return, which is approximately 3.1 percent increase in financial wealth or 8.9 percent increase in the stock return, the aggregate national house price appreciates by more than 1 percent on an annualized basis. The adjusted R^2s suggest a slightly higher explanatory power of the stock return than financial wealth. Unlike the stock market return, contemporaneous labor income growth but not lagged growth is statistically significant in explaining house price appreciation. In contrast, current and lagged personal income growths are not significant at conventional levels, thus suggesting that the labor income component of personal income is the more crucial demand factor for house prices. On the basis of the regression coefficients adjusted for the standard deviations of the explanatory variables and the adjusted R^2s of the regressions, the effect of financial wealth or stock return is similar to that of labor income growth. None of the other factors, including current and lagged changes in the mortgage payment and labor cost of construction, are found to be significant in explaining house price appreciation. While labor income growth has a contemporaneous effect on house price appreciation, change in financial wealth, and in particular, the stock market, leads house price appreciation, but not vice versa.

We also find that for four cities, including Boston, Los Angeles, New York and San Francisco, house price appreciations are related to lagged stock return. The regression coefficient for San Francisco is at least twice as large as those for the other three cities and the 10-city aggregate index. The results here are consistent with the finding of Green (2002), who reports a strong wealth effect under circumscribed conditions like the San Francisco Bay area. House price appreciations for three cities, including Boston, San Francisco and Washington, DC, are significantly related to the same-period U.S. labor income growth. It is of interest to note that the house price appreciations of two cities (Boston and San Francisco) are sensitive to both lagged stock return and contemporaneous labor income growth. On the basis of the regression coefficients adjusted for standard deviations and adjusted R^2s, the effects of stock return on house price appreciation for the two cities are similar or slightly greater than those of labor income growth. Overall, the results from the city-level price indexes reinforce the evidence from the 10-city aggregate price index that the aggregate wealth effect is at least as important as the aggregate income effect on house price appreciations.

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