The Effects of Monetary Policy on Real Estate Price Dynamics: An “Asset Substitutability” Perspective

Hai-Feng Hu

Associate Professor
Department of Business Administration, Wenzao Ursuline College of Languages, Taiwan, R.O.C.
Email: harris@mail.wtuc.edu.tw

Abstract

Real estate prices are discussed frequently in the literature of urban economics, and the effectiveness of monetary policy on real estate prices has been well documented by many papers. But relatively little attention has been paid to the properties of the dynamic adjustment of real estate prices when the real estate market faces a monetary shock. Our approach here attempts to provide a perspective of asset substitutability for studying the real estate price dynamics. We utilize the modeling technique usually used in the analysis of the exchange rate dynamics in the field of international finance, and try to address the proposition that the degree of substitutability between real estate and bonds will influence the type of adjustment of real estate prices when the real estate market experiences a change in monetary policy.

We use the time series data regarding real estate prices and money supply in Taiwan, along with the econometric techniques, such as VAR, to check the explanatory power of our theoretical model. The empirical results show that the quarterly change rate of money stock has positive effect on the change rate of real estate prices. But we could not find enough evidence to support our inference from the perspective of asset substitutability.

Key words: asset substitutability; real estate prices; monetary policy.
1. Introduction

Real estate prices are discussed frequently in the literature of urban economics. They often show a type of cyclical fluctuations, presumably due to the property of durable goods and the special way of financing. To explore this phenomenon, many papers dig into the relationship between macro fundamentals and real estate prices. Most of them focus on the macroeconomic impacts, such as the change in money supply, interest rates, national income, saving rates, and the price level of general goods etc. In particular, they focus on the problem of leading or lagging between real estate prices and these variables (Roulac, 1996; Chen and Patel, 1998; Dehesh and Pugh, 1999; Hudson-Wilson and Pappadopoulos, 1999; Case, 2000). Relatively few papers had studied the pattern of dynamic adjustment of real estate prices.

Along this line of research, the positive relationship between the stock of money supply and real estate prices has been well documented by many papers. But relatively little attention has been paid to the dynamic adjustment of real estate prices when the real estate market faces a monetary shock. Therefore, this research will fill in this gap by studying the details of the effect of the government’s monetary policy on real estate price dynamics.

Regarding the studies of regarding the dynamic adjustment of commodity prices, most papers appear in the field of macroeconomics, especially in international financing such as Dornbusch (1976); Chen et al. (1989). And a major approach in these papers is to introduce the expectations of individuals to the analytic framework (Brock, 1975; Burmeister, 1980; Buiter, 1984; Gordon, 1987; Setterfield, 2000). Different assumptions lead to a variety of theoretical models from which various explanations and policy implications are drawn.

In general, the dynamic adjustment of economic variables could be categorized into three kinds of pattern: (1) overshooting, (2) undershooting, and (3) misadjustment. They are illustrated in Figure1. In the real society, which one will occur? It may depend on some critical condition in the society, such as the degree of asset substitutability between different assets (Lai et al., 1996), or the price elasticity of
Therefore there are many papers dealing with finding the critical conditions for each kinds of adjustments, for example, Dornbusch (1976); Aoki (1985); and Frankel (1986) etc. These papers are famous for studying the issues regarding the dynamic adjustments of economic variables. Up to now, there have been many approaches to investigating critical conditions that influence the dynamic adjustment of variables. Between these papers, the approach of taking the asset substitutability perspective, such as Kouri (1976); Branson (1979); Turnousky (1981); and Lai et al (2005) etc. gives us some inspirations for investigating the dynamic adjustment of real estate price under the influence of government’s monetary policy.

2. The asset substitutability perspective

In these papers of taking the asset substitutability perspective, the economic variable can show different types of adjustment via specifying different degree of substitutability between assets. For example Lai et al. (2005) sets up a general equilibrium model to investigate the dynamic adjustment of agricultural commodity.
prices. There are three markets in their theoretical model, namely, agricultural market, industrial market, and money market. They find that the degree of asset substitutability between agricultural product and bonds plays a very important role in explaining the adjustment type of agricultural commodity prices. If the degree is high, then the adjustment of agricultural commodity prices will show an overshooting type. In other words, when the economic system faces a change of money supply, the adjustment amplitudes of agricultural commodity prices will be larger than the gap between old and new equilibrium.

According to the theoretical framework of Lai et al. (2005), we know that the degree of asset substitutability plays an important role in the dynamic adjustment of commodity prices. We can apply the interesting inference to the dynamic adjustment of real estate price. Similar to Lai et al. (2005), we can set up a general equilibrium model that there are only two types of goods in the economic system, namely, real estate and a composite consumption good. In accordance with Frankel (1986), we treat real estate as an “auction product”, while the composite consumption good is a “customer product”; therefore the price of the composite consumption good adjusts with a time lag, not instantly. In addition, we assume that here are three markets in this economic system, namely, the market of real estate, the market of composite consumption good, and the market of money. And the domestic resident in the system could face three types of assets: nominal money, bonds, and real estate. Therefore we could set up a general equilibrium model in which could be used to explain the adjustment of real estate price (Hu and Chang, 2005).

After a proper calculation, we could conclude that the degree of asset substitutability between real estate and bonds is the key factor in deciding the adjustment type of real estate price (Hu and Chang, 2005). If the proposition is true, we could try to use some empirical data regarding real estate prices and money supply in Taiwan to test the degree of asset substitutability between real estates and bonds.

Comparing real estate and bonds, there are some common properties in these two
assets. Firstly, they both are assets that need a specific amount of money to buy. Usually, their prices vary in different time periods; if prices go up, the individuals can get capital gains from holding these assets. Secondly, individuals can get some income for holding them after a specific time period. For real estate, the income is rent; and for bonds, the income is interest.

Contrarily, the main difference between real estate and bonds is the amount of money needed to invest. Relative to bonds, due to the indivisibility of real estate, we need much more money to buy real estate; it has a big problem of fluidity. Another important difference between real estate and bonds is the type of assets. For real estate, its type belongs to real asset; it has depreciation problems, but it could maintain its value effectively in a period of inflation. For bonds, it is a kind of financial asset; it does not have the problem of maintenance. These differences reduce the asset substitutability between these two assets.

But in modern society, there are some new financial instruments of real estate that lessen the indivisibility of real estate, such as the real estate investment trusts (REITs). According the definition made by Clauretie and Sirmans (2003:542), REIT is an organized association whereby individual investors pool their funds for the purpose of investing in real estate. A REIT is created in the form of a business trust. If the tax requirements are met, it provides for a pass-through of income without double taxation. For decades REITs played a limited role in real estate investment in the U.S. However, in 1992, the REIT marketplace increased dramatically (Clauretie and Sirmans, 2003:421). In Taiwan, REITs have also attracted many investors’ attention in recent years.

The main nature of REITs is that it cuts the asset of real estate into many species: it reduces the amount of money that is needed to invest in real estate, it improves the fluidity of real estate, and it transforms real estate to financial asset from real asset. In other words, REITs decrease the barrier of investing in real estate. Therefore, modern financial instruments for real estate, such as REITs, have increased the asset substitutability between real estate and bonds. In accordance with the inference of this model, it then increases the probability of occurrence of overshooting of real estate prices in the real world; in other words, if the modern financial instrument REITs has increased dramatically the asset substitutability between real estate and bonds, then the
policy of expansionary money supply will cause the short-run adjustment of real estate prices showing the type of overshooting. Although we can infer that the probability of overshooting is proportional the size of REITs marketplace, it is still a hypothesis here, and needs more empirical evidence to support.

In the aspect of empirical study, this paper tries to use the instruments of analyzing time series data, such as the vector auto-regression (VAR) model or the co-integration model, to investigate the impacts monetary policy on the real estate prices. We try to test the proposition that the degree of asset substitutability between real estate and bonds will induce a different adjustment type when a new monetary policy is implanted. For example, in Figure 2, $t_0$ and $t_1$ represent different periods of time respectively. Because of the emerging development of financial instruments regarding real estate, it is reasonable that we suppose the degree of asset substitutability between real estate and bonds increases as time goes by. This means that if the degree of asset substitutability in period $t_1$ is larger than that one in period $t_0$, and if the degree is large enough in period $t_1$, according to the perspective of asset substitutability, the real estate price will overshoot its new equilibrium when the economic system faces a money supply shock in period $t_1$.

![Figure 2](image-url)
3. Empirical analysis

In order to study the dynamic relationship between money supply and real estate prices, this paper uses the data regarding money stock and some real estate price indexes in Taiwan, and then utilizes the empirical techniques of the VAR model or co-integration model to set up the regression equations. We seek some connection between them.

We chose the VAR model proposed by Sim (1980) because it can surmount the difficulties encountered in using the traditional empirical model, that is, the difficulties of setting up the regression equations. In the traditional empirical model, we need to build up the structural form of the empirical model in advance, according to a prior theory, but we cannot always be sure of the causality between variables in the prior theory. A VAR model has solved the difficulties of identifying variables as exogenous or endogenous, constituting a very important technical instrument for analyzing the time series data.

Similarly, in the co-integration model, the purpose is to study the long-term relation between different time series. The basic idea of the co-integration model is: If the trends of two time series are consistent, there will be some linear combination of these two time series exhibiting a stationary situation. It means that the trend of the specific liner combination dose not have obvious upward or downward phenomenon.

Which model is the proper one for studying the issue will depend on the order of the time series data we adopt. If these time series dates are I (0), we should use the VAR model; if they are I (1), co-integration will be the proper model. According to the results of the Phillips-Perron unit-root test, the times series data regarding the quarterly change rate of real estate price and money supply we adopt in this paper, are all I (0); therefore, we use the VAR model in order to study the relationship between the change rate of real estate price and the change rate of money supply in Taiwan.

Taking it one step further, we seek to estimate the asset substitutability of real estate and bonds by observing the relationship of these two change rates of real estate price and money supply.

(1) Model specification

In this paper, we utilize the VAR model proposed by Sim (1980) to clarify the
relationship and causality between the change rates of real estate price and money stock. In the VAR model, we need not assume the causality in advance. And the VAR model can assist us in observing the hidden information in these two time series data. Simultaneously, we can find the causality between them by the Granger causality test in the VAR model. We set up the regression equations as follows:

\[ REP_t = a_{10} + \sum_{s=1}^{L} a_{1s} REP_{t-s} + \sum_{s=1}^{L} b_{1s} MS_{t-s} + e_{1t} \]
\[ MS_t = a_{20} + \sum_{s=1}^{L} a_{2s} REP_{t-s} + \sum_{s=1}^{L} b_{2s} MS_{t-s} + e_{2t} \]

Where \( REP \) is the quarterly change rate of real estate price

\( MS \) is the quarterly change rate of money supply

\( t \) represents the current period; \( t-s \) implied lagged \( s \) periods;

\( L \) is the number of lag ;

\( a_{10}, a_{1s}, a_{20}, a_{2s}, b_{1s}, b_{2s} \) are constants and coefficients of variables in the right-hand side of above equation , and \( e \) is the error term.

(2) Data description

The data regarding money stock of Taiwan is released regularly by the Central Bank of Taiwan (R.O.C). This data is recorded every day, and it is precise and complete. We can calculate the simple average to fit the need of time frequency in the specified empirical model. And according to the definition of money supply, there are two major indexes to measure money stock, namely, M1 and M2. Because of the special financial property of real estate mortgage, we will use the quarterly data of M1 for empirical tests.

Regarding the data of real estate prices, in general, due to the demand of privacy for agents, it is not easy to obtain this data. However, in Taiwan, the Ministry of Domestic Affairs investigates the exchange price of land in each region of Taiwan regularly, and the Ministry of Domestic Affairs compiles the land price index every half year according to the data of land exchanges from 1993. But for the management
of assets portfolio, individuals always buy a house, not pure land; therefore, the land price index is not suitable for this research. Luckily, in the private sector, Sinyi Realty Inc. has made the “Sinyi Taiwan Housing Market Indexes” quarterly according their enormous housing exchange data form 1991 Q3. There are five indexes of regions in the Sinyi Taiwan Housing Market Indexes: Taipei City, Taipei County, Taichung City, Kaohsiung City, and the entire Taiwan.

Compared to the data of money stock, the length of periods of Sinyi Taiwan Housing Market Indexes is shorter than the data of money stock announced by the Central Bank of Taiwan, therefore we have to truncate some data of money stock for the empirical studies. Consequently the data regarding real estate prices and money stocks we use in this research comes from 1991 Q3 to 2006 Q4.

(3) Empirical results

The steps of the empirical task include: Firstly, the premise of the VAR model, that all time series data in the model have zero order stability. The stability premise can be confirmed by a unit-root test. Secondly, the determination of a time lag in the VAR model can be solved by a likelihood ratio test. Lastly, we can use the Granger causality test to identify the causality between the change rates of money supply and real estate prices.

1 Results of unit-root test

In general, if we want to use a unit-root test for detecting the stability of the time series data, we would adapt the method proposed by Dickey and Fuller (1979, 1981). But in the Dickey and Fuller test, we need to assume that the error term distribution is independently normal in advance, which makes the premise relatively restrictive. Therefore we use the method proposed by Phillips and Perron (1988). The non-parameter testing method in Phillips and Perron (1988) allows the error terms to be highly serially related. The results of the unit-root test are shown in Table 1. The results of the Phillips and Perron test reveal that the times series data regarding the
quarterly change rate of real estate prices and money supply in Taiwan are stable.

Table 1: Results of Phillips-Perron unit-root test

<table>
<thead>
<tr>
<th>Region</th>
<th>Real estate prices (quarterly change rate)</th>
<th>Money supply, $M_1A$ (quarterly change rate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taipei City</td>
<td>-6.72863 ***</td>
<td>-10.54419 ***</td>
</tr>
<tr>
<td>Taipei County</td>
<td>-6.71585 ***</td>
<td>-10.54419 ***</td>
</tr>
<tr>
<td>Taichung City</td>
<td>-7.59950***</td>
<td>-10.54419 ***</td>
</tr>
<tr>
<td>Kaohsiung City</td>
<td>-9.95165 ***</td>
<td>-10.54419 ***</td>
</tr>
<tr>
<td>Taiwan</td>
<td>-7.15994***</td>
<td>-10.54419 ***</td>
</tr>
</tbody>
</table>

Note: *** denotes significance at 1% level

2 Time lag determinations

We estimated the above equation with a typical VAR model. It is crucial in the VAR model that we have a proper time lag. For doing this work, we chose a maximum time lag in an unrestricted mode in advance. The next step was to do a likelihood test in order to find the proper time lag in the VAR model. In the issue we wanted to study, if we assume that the impact of monetary policy on real estate price will not exceed 6 quarters, and then we can choose 6 as a maximum time lag in doing the likelihood test. After proper calculations, the proper time lags in each county and city are illustrated in Table 2.

The second column of Table 2 shows the proper time lag we set up in the VAR model. The third and four columns are the results of these tests. From Table 2, we know that the proper time lags are 3 quarters in each housing price indexes of different regions.
Table 2: Determination of proper time lag

<table>
<thead>
<tr>
<th>Region</th>
<th>Proper Time Lag</th>
<th>Chi-Squared Value of Maximum Likelihood Ratio Test</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taipei City</td>
<td>3</td>
<td>16.884630</td>
<td>0.15398894</td>
</tr>
<tr>
<td>Taipei County</td>
<td>3</td>
<td>16.890338</td>
<td>0.15376921</td>
</tr>
<tr>
<td>Taichung City</td>
<td>3</td>
<td>16.888829</td>
<td>0.15382728</td>
</tr>
<tr>
<td>Kaohsiung City</td>
<td>3</td>
<td>16.894118</td>
<td>0.15362382</td>
</tr>
<tr>
<td>Taiwan</td>
<td>3</td>
<td>16.897442</td>
<td>0.15349609</td>
</tr>
</tbody>
</table>

Notes: We chose 6 quarters as a time lag in the unrestricted model.

3. The results of the Granger causality test

The main idea of the Granger causality test is that, if variable X is one of the factors affecting variable Y, then we can improve the estimation of Y by adding a historic data of X into the regression equation. By using this idea, we utilize the time series data regarding the quarterly change rates of money stock $MS$ and the Sinyi Taiwan Housing Market Indexes $REP$ to do the Granger causality test in order to determine their relationship and causality. The results are illustrated in Table 3.

According to results of Granger causality test, we see the change rates of monetary expansion have positive effects on the change rates of real estate prices in the five regions. But only on the Taipei City, Kaohsiung City, and Taiwan overall, the effects are significant at 1% levels.

We took it one step further, since we care about the relative amplitudes of adjustments. We drew the curves of these time series data regarding the quarterly change rates of money stock and real estate prices in Taipei City, Kaohsiung City, and Taiwan overall. They are shown in Figure 3, Figure 4 and Figure 5 respectively.

In the simplest inference of monetary theory, if the “neutrality of money” sustains, the amplitude of adjustment of asset price is the same as the change of the money supply. Our inference coming from the asset substitutability perspective is that, because of the development of modern real estate financial instruments, such as REITs, the degree of asset substitutability between real estate and bond will increase as time goes by. This means that adjustment amplitude of house price will increase according to the asset
substitutability perspective. Therefore we can compare the adjustment amplitudes of real estate price and money supply.

Table 3: The F-statistics of Granger Causality test between real estate price and money supply in Taiwan.

<table>
<thead>
<tr>
<th>Region</th>
<th>Independent Variable</th>
<th>Real estate prices, $REP$ (quarterly change rate)</th>
<th>Money supply, $MS$ (quarterly change rate)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taipei City</td>
<td>$REP$</td>
<td>0.9612</td>
<td>9.3365 ***</td>
</tr>
<tr>
<td></td>
<td>$MS$</td>
<td>10.4560***</td>
<td>13.0439 ***</td>
</tr>
<tr>
<td>Taipei County</td>
<td>$REP$</td>
<td>0.9562</td>
<td>5.4021 ***</td>
</tr>
<tr>
<td></td>
<td>$MS$</td>
<td>1.7497</td>
<td>9.1855 ***</td>
</tr>
<tr>
<td>Taichung City</td>
<td>$REP$</td>
<td>0.4046</td>
<td>0.4220</td>
</tr>
<tr>
<td></td>
<td>$MS$</td>
<td>0.5804</td>
<td>4.3515 ***</td>
</tr>
<tr>
<td>Kaohsiung City</td>
<td>$REP$</td>
<td>3.0303**</td>
<td>1.9419</td>
</tr>
<tr>
<td></td>
<td>$MS$</td>
<td>5.0255***</td>
<td>5.7938***</td>
</tr>
<tr>
<td>Taiwan</td>
<td>$REP$</td>
<td>0.6554</td>
<td>6.2916***</td>
</tr>
<tr>
<td></td>
<td>$MS$</td>
<td>6.2499 ***</td>
<td>9.9224 ***</td>
</tr>
</tbody>
</table>

Note: 1. These numbers in the Table 3 are the F-statistics of Granger Causality Test.
2. ***, **, and * denote significance at 1%, 5%, and 10% levels.

In Figure 3, Figure 4 and Figure 5, we find that the amplitudes of adjustments of real estate prices are not larger than the amplitudes of money stock change. In other words, we can not find evidence to support that the adjustment of real estate prices fits the type of overshooting from the preliminary observations.

In these three figures, we find that the amplitudes of adjustments of real estate prices are not larger than the amplitudes of money stock change. In other words, we can not find evidence to support that the adjustment of real estate prices fits the type of overshooting from the preliminary observations.
Figure 3: The quarterly change rate of Sinyi Housing Market Index of Taipei City and the quarterly change rates of money stock (M1A)

Figure 4: The quarterly change rate of Sinyi Housing Market Index of Kaohsiung City and the quarterly change rates of money stock (M1A)

Figure 5: The quarterly change rate of Sinyi Housing Market Index of Taiwan City and the quarterly change rates of money stock (M1A)
If our proposition here is true, one reasonable explanation for that is the scale of REITs is not very large indeed; therefore, the degree of asset substitutability between real estate and bonds is not high enough to support the overshooting of real estate prices. Of course, we can not neglect the possibility that our proposition in this research is incorrect; it simply needs more studies.

4. Conclusion

Real Estate prices often show a type of cyclical fluctuation due to the properties of durable goods and the particular way of financing. To explore this phenomenon, many papers dig into the relationship between macro fundamentals and real estate prices. Along this line of research, the positive relationship between the stock of money supply and real estate prices has been well proven by many researches. But relatively little attention has been paid to the type of adjustment of real estate prices when the real estate market faces a monetary shock. The perspective of asset substitutability, which appeared firstly in the field of international finance, can help us to study the dynamic adjustment of real estate prices. Therefore, this research will fill in this gap by providing the perspective of asset substitutability. In other words, this research tries to address the proposition that the degree of substitutability between real estate and bonds will influence the type of adjustment of real estate prices when the real estate market experiences a change in monetary policy.

The proposition coming from the perspective of asset substitutability is, if the asset substitutability of real estate and bonds is high, then the real estate price will overshoot its long-run equilibrium while the economic system faces an expansion of money stock. On the other hand, if the degree of asset substitutability is low, then the real estate price will undershoot its long-run equilibrium. In view of the emergence of modern financial instruments, such as REITs, if these financial instruments of real estate increase the degree of asset substitutability between real estate and bonds, then the probability of overshooting of real estate prices will increase as time goes by. This inference gives us a way to estimate the degree of asset substitutability between real estate and other assets.

We use the time series data regarding the quarterly change rates of real estate prices and money supply in Taiwan, along with the VAR model, to check the
explanatory power of the perspective of asset substitutability. The empirical results show that the quarterly change rate of money stock has a positive effect on the change rate of real estate prices. But we could not find enough evidence to support our inference in which coming from the perspective of asset substitutability.

References


