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Affordability, Speculation and House Price in Taipei*
購買能力、投機與大台北地區之房屋價格*

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ABSTRACT

The paper tries to explain the price behavior of the housing market in Taipei metropolitan area for the last two decades with modified concept of affordability that takes mortgage financing factors as well as household's budget appropriation for housing expenditure into account. The purpose of the modification is to construct a variable that, to a large extent, can represent the changes of the economic fundamentals in a coherent way so that the influence of this variable on the price of houses can be more readily estimated and/or analyzed.

The results of empirical studies show that the author's hypothesis that the movements of the market price of houses in the period studied can be explained by the changes in people's affordabilities and their speculative behavior is by and large confirmed.

Key words: affordability, mortgage financing factors, speculative behavior, market price

摘　要

本文嚐試以修正的支付能力(affordability)概念詮釋近二十年來大台北地區住屋市場的價格行爲。所謂修正的支付能力概念，係在傳統的房價與家户所得變數之外，再將抵押貸款利率、貸款成數以及家户的抵押貸款支出占預算的比率等因素納入考慮。

所進行的統計分析，顯示大台北地區房價在研究期間的上漲，主要還是因爲市民的支付能力，尤其是抵押融資與預算二因子的改善。

關鍵詞：支付能力、抵押貸款比率、抵押貸款成數、家戶抵押貨款支出成數、投機行為

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1. Introduction

The appreciation of house prices in Taipei had been a remarkable phenomenon in the recent past. The average annual rate of appreciation was about 14% from 1976 to 1996. This is equivalent to about two and half times that of general price inflation rate in the same period. Theoretically, such an unusual phenomenon must be resulted from housing shortages, since prices are bid up whenever the supply is insufficient to meet the demand. Yet the phenomenon observed here in Taipei is quite complicated than this simple explanation. In the last census report released by the government it is shown that the number of housing units for Taiwan Areas as a whole was greater than that of households at the end of 1990 when the census was taken. This indicates that the supply of housing, at least on aggregate basis, is not in shortage so far as the need for accommodating the populace is concerned. Given this circumstances, then, what are the reasons that make house prices appreciated so much ?

The basic reason, in the authors' opinion, is high income growth rate coupled with a favorable environment for home owning. As the economy has been growing rapidly, the per capita income has been increasing at an annual rate of 8% since early 1970's. In the mean time, due to the fact that there was no formal social security system for the ordinary people to rely on, a good portion of the " extra " income has been saved in stead of consumed during the growth process. Although the saving rate has been declining gradually in the recent decade, the amount of money wealth that people accumulated through time still remain considerable. This amount of money wealth enabled people to engage in investment or speculation in various kind of assets. Among them, housing commodity is probably the most prominent one and thus deserves our special attention. Statistics from the construction Bureau of the Government reveal that in recent years our home ownership ratio has reached a level as high as 83%, probably the highest in the world. This indicates that people in Taiwan have very strong intentions in owning houses, no matter for investment or speculation, whenever they can afford them. And this is occurred without reasons. For one thing, owning to a peculiar way of taxation, the effective rate of real estate tax has been so low that the average amount of real estate tax that people pay for their houses is usually no more than that they pay for their motor vehicles (cars). We believe this extraordinary low real estate rate render itself as a haven to the speculative-minded house purchasers since the holding costs are so low that houses can never become burdens to their owners ever when they become idle. In asymmetry, when the market turns bright, the speculative investor may make a good fortune without paying too much capital gain tax due, again, to a peculiar way of capital gain assessment which is based on the so -called Announced Present Value published once every year by the authorities concerned rather than on the actual market values. In addition to this favorable tax treatment for the home owners, there is another institutional factor that may have aggravated the situation. In Taiwan, there is a peculiar way of transaction (exclusively for new houses) called selling-in-advance scheme that has been prevailing in the housing market since some forty years ago. Under this scheme, a builder needs not to have his/her houses ready for delivery when he/she makes deals with his/her patron-customers and the latter need only to pay a small fraction (usually 5%) of the agreed transaction price as a security for the deal and then pay the rest amount in installations in accordance with the construction schedule. In this manner, the object in transaction is essentially a kind of forward contracts to both parties. Obviously, this scheme enables the builders to greatly reduce their capital costs since they can collect security deposits from

their patrons and use them as their working capitals to carry out the constructions. The buyers, on the other hand, can also benefit greatly from the arrangement because they need not to prepare a large sum of money and pay the whole purchase price right the way when making deals with builders but rather pay them in installations until the closing date. The liquidity constraints faced by potential buyers, to a great extent, are thus attenuated and the housing market becomes much more accessible to them than what would be otherwise. Given this kind of environment, it is nature that both builders and buyers would like to take advantage of this scheme whenever they see it appropriate to engage in such trade. This implies that huge demand may flood into the market in a very short period of time when people believe in the market's prosperity. Inevitably, price volatility ensues. As a matter of fact, very large volume of transactions in new houses have been observed in the past, especially when the housing market is in booming, and stories of extraordinary profitability of real estate investment or speculation abounded in the same time. Thus, to many economists, the market has been characterized by speculation, especially in booming periods.

Besides the income effect, the monetary conditions are also suspected by the authors to have played an important role in causing house price inflation in the past. During the rapid growing period mentioned above, the country's foreign reserves as well as money stocks were growing in great speed. As a result, the financial sector of the country had been fed from time to time with amounts of loanable fund that were so huge that they couldn't be fully utilized by ordinary business activities and thus resulted in an extraordinary amount of excess reserves for the sector as a whole. The existence of the excess reserves, in turn, resulted in an excessively easy financing environment for the home buyers as the financial institutions were competing severely for mortgage lending. The easy financing environment, to view from microeconomics perspective, obviously had made the populace more likely to become home buyers and enabled the potential home buyers to afford more expensive homes or, to put in another words, enhanced the home buyers' price affordabilities toward the houses of their interest. Here, the concept of affordability is rather different from the conventional one. In this study, its definition is modified to take the mortgage financing factors as were as people's housing budget into account and thus can be regarded as the prices that the ordinary people can afford to pay for the houses they wish to buy.

In short, the author wishes to address the housing price fluctuation problem of the past through an exploration of the relationship between the price affordabilities of the people and the price movements of the houses on the market. Beside this, the influence of the speculative motives of the people on house purchasing is also to be investigated. In section II, the concept of the affordability and its specification in this study is further expounded and the conceptual framework of the study based on this concept is laid. In section III, the hypothesis that house price appreciation in Taipei has to do with the changes in people's price affordabilities is tested and results of related empirical studies are displayed, examined, and discussed. The final section, section IV, contains the summary and conclusion of this study.

2. The Conceptual Framework and Analytical Model

2.1 The price-setting framework

Since house are different from ordinary goods or services in the sense that each housing unit has its

own uniqueness in terms of location, structure type, or interior set-up ...etc., their prices are determined in a way rather different from that of ordinary goods or services. For ordinary goods or services, as everybody knows, the prices are determined by the interaction of both demand and supply functions. Although this is generally true for the case of housing also, one needs to note, however, that the supply of housing, particularly in a well settled metropolitan area, has the same property that characterizes the supply of land. That is, the supply is quite inelastic, especially in short run. As such, the price of housing is basically determined by the demand function. Moreover, since housing is immobile, it is impossible for its suppliers to transport it to a certain point in space for sale. Rather, it is exposed to a number of potential buyers right on its own location. And, if the number of potential buyers is rather large, which is usually true, the buyers have to bid for the interested houses and only those who offer the highest prices can secure the purchases. Hence, the prices are determined basically from the demand side, and the process of price setting is usually referred as a bidding process.

Based on this understanding, one can easily see that under competitive circumstances, the price that strikes a deal is determined ultimately by the affordability of the highest bidder. Now, an important question to ask is: What determines the affordable price of that bidder?

From microeconomics point of view, the answer to this question obviously has to do with the economic strength of the buyer. The wealth he (she) accumulated, the income bracket he (she) is in, the financial conditions he (she) faces,... all are relevant factors. Specifically, the affordable price is an increasing function of the amount of resources that the buyer can appropriate for housing purpose. The amount of resource, in turn, is also an increasing function of the buyer's income level. So, as the income level of the buyer changes, other things being equal, the affordable price will change in the same direction concomitantly, although the changes may not be proportionate to each other since the buyer's demand elasticity needs not be exactly unity. Besides this, the other things may not be equal over time. For the most important one, the monetary condition of the country in question may change from time to time. This inevitably affects the availability of fund for home-purchase loans and/or the terms for these loans. The changes in fund availability and/or terms of loans would, of course, have profound influence on the household's affordable price for the house of interest. Specifically, the affordable price is expected to change in the same direction as the change in money supply since more money supply, other things being equal, will usually bring the interest rate down and make the terms of credit more favorable to the potential debtors. To mean the same thing, more amount and/or longer lending periods of loans can be secured for the same house as collateral. Generally speaking, the relationship between the affordable price, denoted as AP, and its determinants can be expressed loosely as the following:

$$AP = f(\alpha, Y, i, n, L/P) \text{ with } f_{\alpha}>0,\ f_{Y}>0,\ f_{n}>0,\ f_{i}<0,\ f_{L/P}>0 \quad \text{..... (1)}$$

where Y, i, n are denoting household disposable income, mortgage interest rate, lending period respectively while L/P and α denote respectively the ratio of loan to house purchasing price or the so-called loan-to-value ratio and the share of household income that can be appropriated for housing purpose.

2.2 The analytical model

As mentioned in previous section, beside the relationship between the house prices and people's price affordabilities, this study will also investigate the speculation phenomenon that had occurred con-

comitantly with booms in the local housing market before 1990.

In this study, we make use of the people's affordability to represent the fundamental part of house price on the market while the deviation to this fundamental value is explained by the bubble-like component of the capital gain from house purchases. In terms of algebra, the house price on the market, ph_t, can be formulated as

$$ph_t = ap_t + g_t,\ t = 1,2\ldots,\ldots,T \quad \text{..... (2)}$$

Here, for analytical convenience, all the variables are specified in logarithmic form. That is, ph_t, ap_t, g_t, are standing for in HP_t, in AP_t, in G_t respectively and AP_t denotes people's affordability which, in fact, stands for the so-called "affordable price" that is derived from the house purchasers' financial cash flows to be explained latter, and G_t represents the component that might drift away from the affordable price. It can also be regarded as a comprehensive reaction of the housing market under various impetuses. Due to its unobservable character, this component is quite hard to specify in the model. In fact, different people have different opinions on this regard. Nevertheless, we believe that it might be appropriate to reformulate eq.(2) in stochastic form, as followed:

$$ph_t = \delta_1 + ap_t + \delta_2 g_t + \eta_t \quad \text{..... (3)}$$

where $\{\eta_t\}$ represents the white noise error process with constant variance σ_η^2, and δ_1, δ_2 are the parameters to be estimated. Theoretically, δ_1 is positive while δ_2 may take any value.

From house purchaser's financial cash flow perspective, it is straightforward to see the amount of debt service (cash flow) from a mortgage holder to its debtor is equal to the amount of loan acquired times the mortgage repayment factor as follow: AM=KP (MPF), where the LHS represents the amount of mortgage payment, or debt service, that a household has to pay to its debtor while the RHS represents how this amount is calculated. As indicated, it is calculated by multiplying the amount of loan, represented by KP here, with the mortgage repayment factor, MPF. (The mortgage repayment factor is usually called capital recovery factor.)[1]

Notice that the amount of loan here is taken as a product of two factors: the house price, p, and the so-called loan-to-price ratio, K. It is so specified to reflect the local financial institutes' common lending practices in deciding the amount of loan to be extended by an appropriate ratio (usually less than 1) of the market value of the collateral (house).

To view from another perspectives, the above equation implies that the price of house that a household is able to afford, is determined by those factors such as K, MPF, and AM[2] with AM representing the debt service that the household is able to pay to its debtor. In other words, by rearranging and substituting the variables in the above equation, one gets

$$AP = \frac{1}{K}(AM / MPF). \quad \text{..... (4)}$$

where AP denotes the affordable price as mentioned above while K, AM, MPF retain their meanings as before. In logarithmic form, the linear formulation of affordability becomes:

$$ap_t = -k_t + am_t - mpf_t \quad \text{..... (5)}$$

In dealing with gt, there have been many methods adopted by many researches. For example, Yang

and Chang(2000) and Abraham and Hendershott(1996) have treated it basically as the bubble component of the house price and estimate it with some weighted average of the recent market prices and their deviations from the fundamental values while N. K. Chen(1998) treated it as a self-evolved bubble process with each period of it assigned a probability that the bubble will become burst.

In the literature, the speculation factor has been dealt with a conceptual framework in which the price of house is decomposed into two components --- one reflects the economic fundamentals while the other represents the bubble, with the latter being observed in prosperous periods. This can be seen from works of Abraham and Hendershott (1996), Kim and Suh (1993), Yang and Chang (2000), N.K.Chen (1998), Lai and Hwa (2000), and Lin and Lin (1995), among others.

Although different from each other, the ways of treatment in each of these researches can be classified into two categories. According to the order of the above mentioned references, the former three have considered simultaneously the interactive reactions of demand and supply in price determination and then add a leeway component that is allowed to deviate away from the fundamental value (component). The latter three, on the other hand , have taken a non-linear function of the real estate's(or any other asset's) expected return as the fundamental value and regard the repeated expectation on future price as a mechanism that generates the bubble.

As discussed by Blanchard and Watson(1982) (Sargent(1987) also), the bubble process may be represented by a suitably designed martingale process. Along this line of treatment, beside Chen's specification as mentioned above, there are two kinds of specifications that might be worth of consideration°G

$c_t = c \quad \forall t = 1,2...,....,T$

and $\{c_t\}, \quad c_t = \rho^{-t} x_t$

where $|\rho| < 1$ and x_t represents the exogenous variables in the model.

In this study, g_t is specified to represent the price information of the recent past and the information pertaining to their deviations from the fundamental values in hoping that the specification may have better connection with other variables in the model and better mimic of the real world:

$$g_t = \sum_{j=1}^{m} \left[\beta_j ph_{t-j} + r_j (ph^*_{t-j} - ph_{t-j}) \right] + v_t \quad \text{..... (6)}$$

where $\{v_t\}$ is also a white-noise error process with parameter σ_v^2 and ph_t^* represents the houses' fundamental price in period t. Although the specification of eq.(6) comes from the idea of generalizing G_t, similar to the reason why we specified the number of lag periods as m, our primary concern here is to measure the bubble. In another words, it is specified primarily for price information purpose. And, in order to enlarge our domain of thinking, we put the variable ph^* into the model. Generally, this fundamental price is unobservable and, hence, has to be estimated.

One thing to mention is that, in specifying eq.(6), it is stressed that people have a speculative motive in purchasing their houses, that is, to make profit from their price changes and we use price level data directly which is rather different from the ways did by Abraham and Hendershott and others as mentioned earlier. Putting eq.(6) into eq.(3) and then making it fully stochastic, we have

$$ph_t = \theta_0 ap_t + \sum_{j=1}^{m} \theta_j ph_{t-j} + \sum_{i=1}^{m} \theta_{m+i} \left(ph^*_{t-i} - ph_{t-i} \right) + \varepsilon_t \quad \text{..... (7)}$$

where $\{\varepsilon_t\}$ is a white noise stochastic process with constant variance σ_ε^2, and θ_j, j=1, 2,..., 2k contain β_j, r_j in theory.

If eq. (5) is put into eq. (7), then

$$ph_t = \theta_{B1}k_t + \theta_{B2}am_t + \theta_{B3}mpf_t + \sum_{j=1}^{m}\theta_j ph_{t-j} + \sum_{i=1}^{m}\theta_{m+i}\left(ph_{t-i}^* - ph_{t-i}\right) + w_t \quad \text{..... (8)}$$

where $\{w_t\}$ is also a white noise stochastic process with constant variance, σ_w^2 (= $\sigma_\varepsilon^2 + \sigma_u^2$; assuming $\{\varepsilon_t\}$ and $\{v_t\}$) are independent of each other).

Notice that in eq.(7) and eq.(8), we use $\sum_{j=1}^{m}\theta_j ph_{t-j} + \sum_{i=1}^{m}\theta_{k+i}\left(ph_{t-i}^* - ph_{t-i}\right)$ to represent the influence of the house purchasers' speculation on the market price of houses.

Besides, as to the deduction of eq.(7) and eq.(8), the speculation component of house price expressed in those equations can not be estimated due to the unobservability of ph_{t-i}^*. To circumvent this impasse, we adopt a partial adjustment specification similar to that of Dipasquale and Wheaton (1994), as followed:

$$ph_t = \tau\ ph_t^* + (1-\tau)\ ph_{t-i} \quad \text{..... (9)}$$

in which τ stands for the adjustment coefficient[3]. Solving it, we get

$$ph_t^* = ph_{t-i} + \xi\Delta ph_t \quad \text{..... (10)}$$

where ξ=1/τ, $\Delta ph_t = ph_t - ph_{t-1}$. Putting it into eq.(6), we have

$$g_t = \sum_{j=1}^{m}\left[\beta_j ph_{t-j} - r_j(1-\xi)\Delta ph_{t-j}\right] + v_t' \quad \text{..... (11)}$$

This specification means, if we follow the above-mentioned way of thinking, then we can estimate the extent of deviation of the actual (house) prices from the affordable prices by using the information of the house prices and their changes in the past only. Then, eq.(7) and eq.(8) can be rewritten as

$$ph_t = \theta_0 ap_t + \sum_{j=1}^{m}\theta_j ph_{t-j} + \sum_{i=1}^{m}\theta_{m+i}'\Delta ph_{t-i} + \varepsilon_t' \quad \text{..... (12)}$$

$$ph_t = \theta_{B1}k_t + \theta_{B2}am_t + \theta_{B3}mpf_t + \sum_{j=1}^{m}\theta_j ph_{t-j} + \sum_{i=1}^{m}\theta_{m+i}'\Delta ph_{t-i} + w_t',$$

$$t=1,2,\cdots,T \quad \text{..... (13)}$$

In these equations, $\{v_t'\}$, $\{\varepsilon_t'\}$ and $\{w_t'\}$ are all white noise process. As such, eq.(12) and (13) can be used for estimation. Yet, δ_2, ξ and the r_i s can not be estimated separately from that estimation since $\theta_{m+i}' = \delta_2 r_i(1-\xi)$, i=1, 2,..., m.unless we have additional information on this regard.

Apparently, the first term in the RHS of eq.(12) and the first three terms in that of eq.(13) are made to represent the fundamental component of the house price while the other terms are representing the bubble part.

The idea of using the price adjustment mechanism set in eq.(9) to compute ph_t^* is developed from

the concept of capital gaining from house purchasing as mentioned before. Needless to say, there are many ways of estimating ph_t^*, including those which use environmental variable, construction cost, ... etc (such as Shei 1990). They are not employed here lest that they would make the econometric models of (12) and (13) so complicated that the focus of the paper would be blurred.

3. Hypothesis Testing and the Results

Having formulated the relationships between the market house price and that of the affordable prices as well as the speculative factor, we are now in order to examine the statistical relationships between those variables with an aim to test the presumed hypothesis.

Now, before embarking on the empirical work, an account on what was the market situation during the observation period is in order.

From 1976 to 1998, CPI rose 107%, which is equivalent to an annual rate of increase about 4.9%. The general price increase was even more modest, at an annual rate of 3.6% if we exclude the extraordinary years of 1980 and 1981 during which the general price level rose 35.7% due to an unexpected oil price shock.

The growth of household disposable income, on the other hand, was quite spectacular. During the same period of time, it has increased 350% in real term, which is equivalent to 16% per year.

As to the financial aspect, there are a couple of indicators that are worthy of mentioning. The first is the level of interest rate. From 1976 up to 1982, it was never lower than 11% per year, averaged at 12.8% annually for the period. From then on, it fluctuated for a while, down from 9.1% to 5.5% in 1987 and 1988, as a result of the big surges in money supply at that time due to the so-called hot money influx from oversea capital market. Then, it bounced up to 8.4% in 1989 and further to 10.4% in 1990 owing to the government's contractionary monetary policy. After that, it declined gradually toward to its 1989 level in 1998, implying that the general financial environment had been improving for the home buyers to a modest extent.

The other indicator that is worthy of looking into is the ratio of loan to house price. Before 1982, the value of the ratio was 0.4 only . That implies that home buyers at that time had to save a great deal or to borrow heavily from some others outside the banking industry before marking themselves ready to enter into the house market. Since then, the credit condition improved gradually. Thus, the ratio of loan to house value rose from 0.4 to 0.5, 0.6 and finally to 0.7. In our observation, the ratio, in general, never surpassed 0.7 since mid 1980's because of the local banker's conservative attitude toward mortgage lending. To our knowledge, they used to take 0.7 as a bench mark in extending mortgage loans despite that the financial conditions had been improving. (Statistics on M_2 are available but are not reported here). All these factors, we believe, must have contributed to the people's affordability which, in this paper, is reflected by the measure of affordable price. And, as the financial conditions faced by home buyers kept improving, the affordability measure, represented by AP, had increased over time, as can be seen from the figure provided. There, an interesting point to observe is : before 1987, the year with a big surge in money supply, the levels of AP are quite close to the level of house prices on the market. After 1987, the two series have never been close to each other. The house price on the market had jumped for

more than 100% in the following two years while the affordable price registered a modest increase. After that, both series revealed an almost parallel upward trend.

Before the test, however, we need to make sure that the data used (data is given in the appendix) for testing have the required structural properties.

3.1 Investigating the structure of the time series

In order to extract more information from the data of variable used in the previous section, a statistical analysis is performed in this section. And, to assure that all the statistical inference will be valid, a preliminary test on the integrated property of the data and a review with regard to their stationarity are also given.

The analysis begins with the standard ADF unit root test for each data series in three ways:

(1) a regression with intercept only;

(2) a regression with a trend variable only;

(3) a regression with both intercept and trend variables.

On the condition that these regressions pass F-test (P-value be less then 0.05), the optimal lag for their independent variables were then determined with the AIC criterion.

The results show that we can't deny that there are unit root problems with the data since we found

1n $AM \sim I(0)$

1n $HP \sim I(4)$

1n $AP \sim I(0)$

1n $MPF \sim I(3)$

in 5% significant level. These are bewildering results, and that make our empirical work rather difficult.

Nevertheless, looking at the trend figures (Figures 1) for clues, we found that there might be a

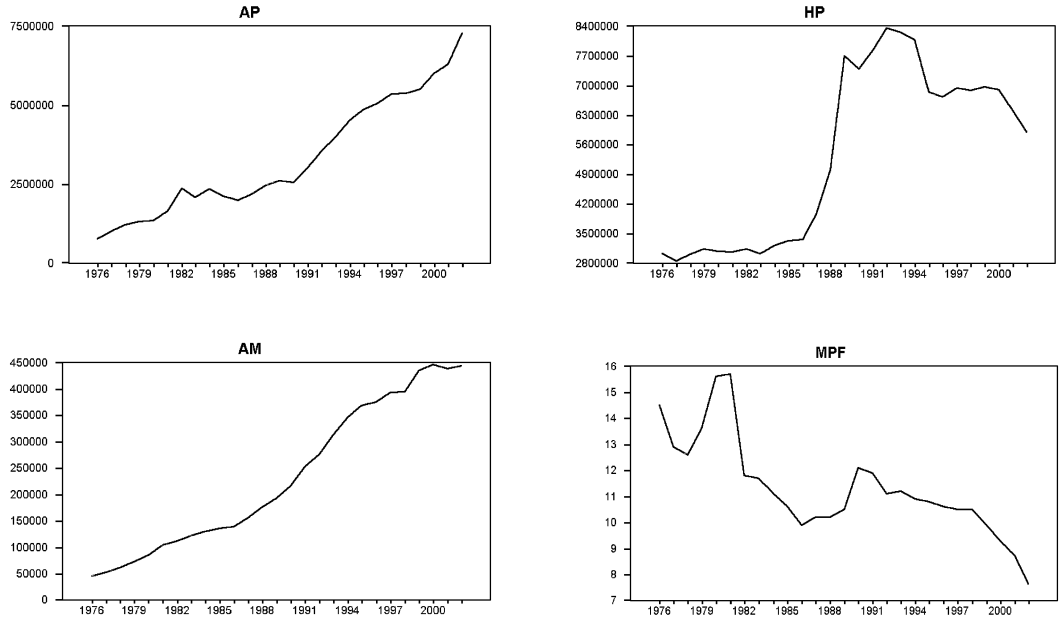

Figure 1. Trends for selected series

irregular change in the trends during the observation period for each series. This finding leads us to employ the Perron's (1989) method to test the data in order to identify their integrated property.

For expository convenience, let $(x_t)_{t=1}^{T}$ be the data set from the stochastic process $\{X_t\}$ that would be tested. To begin with, we run a regression in the following form:

$$X_t = \alpha + \beta t + \delta DT_t^* + \varepsilon_t, \quad \text{t=1,2,...,T,} \quad \text{..... (14)}$$

where t stands for time and DT_t^* is a dummy variable for the periods whose value equals to $t - t_B^4$ when $t > t_B$, t_B=12 and 0 otherwise and ε_t is the error term with 0 - mean and σ^2 - variance. Note that the value of t_B is set equal to 12 since the trend for the dependent variable HP appears to have a structural change in the year 1989 which is the twelfth observations year in the time series (see the HP trend of Figure 1).

Having this regression result, we can go through the detrend process with the fitted value of the series, $\hat{X}_t$, as follows:

$$\tilde{X}_t = X_t - \hat{X}_t \quad \text{..... (15)}$$

where the symbol "~" denotes the variable resulted from the detrend process. The graphs of detrended series are presented in Figure 2.

Now that the new series, $(\tilde{X}_t)_{t=1}^{T}$ are derived, we are able to embark on the standard ADF[5] test by running the following regression:

$$\tilde{X}_t = \rho X_{t-1} + \sum_{i=1}^{R} \gamma_i \tilde{X}_{t-i} + \varepsilon_t, \; t=1, 2, ..., T \quad \text{..... (16)}$$

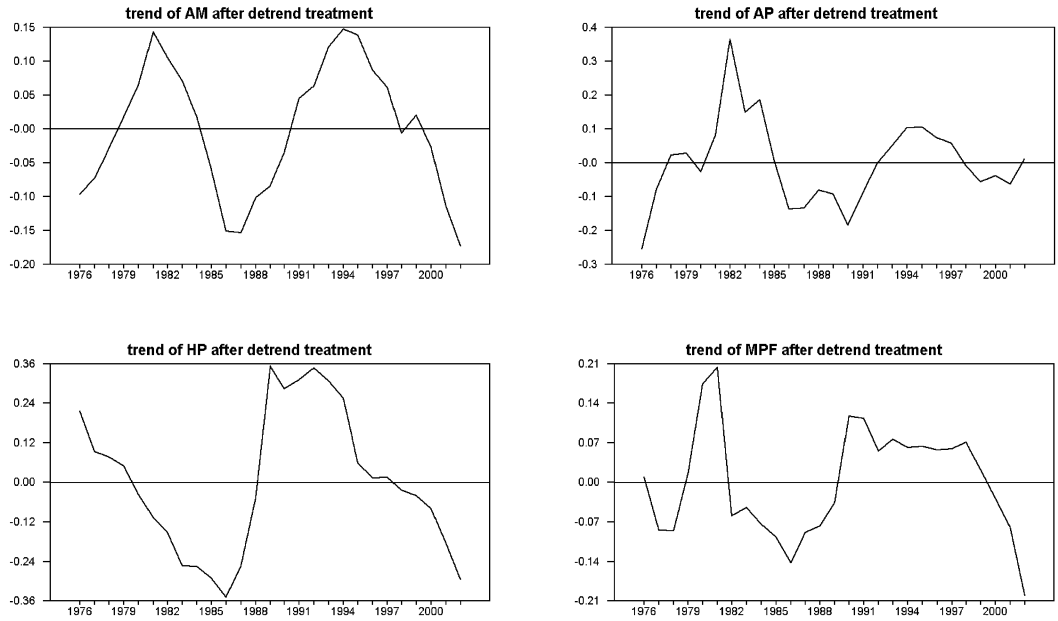

Figure 2. Trends for selected series after detrend treatment

The method of selecting the optimal value for *R* is the same as in the previous test. In consequence, it is found 1n $A\tilde{M}_t$, 1n $A\tilde{P}_t$, 1n $MP\tilde{F}_t$ are all I(0), and 1n $H\tilde{P}_t$ is nearly I(1) (with statistical value and critical value at 0.05 significant level being -1.763 and -1.955 respectively).

After several tries, unfortunately, it is found that the model of the regression of ln HP_t on the above-mentioned detrended variables as proposed in Section II failed to have good fit with the data. We suspect (with reasons to be explained later) that it might have something to do with the outliers of the HP series, i.e. the observations of the year 1987 and 1988. Thus, we delete the outlier data from the original series and execute the same ADF unit root test on the new series again.

Now, the result reads

1n $AM \sim I(3)$

1n $HP \sim I(0)$

1n $AP \sim I(1)$

1n $MPF \sim I(2)$

After the same ADF unit root test of Perron(1989), with Eq(16), on the new series comes out with 1n $A\tilde{M}_t$, 1n $A\tilde{P}_t$, 1n $MP\tilde{F}_t$ and 1n $H\tilde{P}_t$ are all I(0) (see table1). Now, we are at position for discussion of relations between HP_t and AP_t.

3.2 Statistical relationship between and

With the series of HP_t and AP_t redefined as those without the outliers of 1987 and 1988, their relationships are to be explored in this section. First, we explore the simple, long-term relationship between HP_t and AP_t as specified in Eq.(2). The results are presented in Table 2 as fellow. From the results, we have the following observations.

(1) The affordability price, AP_t, does have significant power in explaining the behavior of house prices on the market, HP_t, beside its correct direction. This implies that, by and large, the house price on the market had been moving in correspondent to the people's affordability during the whole observation periods except 1987 and 1988. Although the coefficient for the latter variable takes a value as low as 0.09, it is conceivable that some of their covariance are contained in the other trend variables, DT_t^*, $D2_t^*$, and the intercept which are expected to capture the trend of the whole economy.

(2) The value of the estimated coefficient for DT_t^* is negative, reflecting the down trend of the later half series of lnHP_t which can be learned from Figure 3. It can also be found from the figure that there is no discernible trend for the first half of the same series.

Table 1. The results of Perron(1989) unit root test for detrended data

1n *HP*	-4.929**a
1n *AM*	-4.264**
1n *MPF*	-2.285**
1n *AP*	-5.476**b

Note: a. ***denotes significance at 0.05 level.

b. To reject Ho, the regression equation for testing $lnA\tilde{P}$ needs to add intercept and trend variable.

Table 2. The results of simple regression between HP_t and AP_t[a]

Model: $\ln HP_t = c_0 + c_1 DT_t^* + c_2 D2_t + c_3 lnAP_t + \varepsilon_t$[b]			
Explainary variable	Estimated coefficients	t-value	$\overline{R}^2$=0.985 F統計值=535.6**
Constant	13.668	21.946***[c]	D.W.=1.236
DT_t^*	-0.026	-5.488***	Q(6)=34.636***
$D2_t$	0.09	23.674***	
ln AP_t	23.674***	2.06**	

Note: a. There are 25 observation data used in model estimation.

b. DT_t and $D2_t$ are used for detrending the dependent and explainary variables at the same time because lnHP_t and ln AP_t have different order of accumulations. The definitions of other variables remain the same as before, And $D2_t$ = 1, when $t \geq t_B$ = 12, and $D2_t$ = 0 otherwise.

c. ***denotes statistical significance at 0.01level.

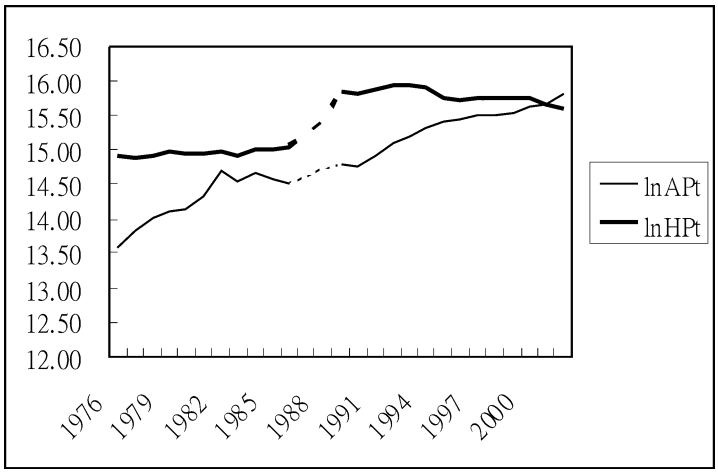

Figure 3. Trends for lnHP_t and lnAP_t

(3) The reason why $D2_t$ is added into the model is that the new series for lnHP_t, after the outlier data are deleted, have exhibited a clear 2-stage trend. The value of its coefficient is high (0.938) as well as significant, indicating that there is a need to thoroughly investigate the meaning of the gap in the trend.

(4) The D.W.value for the regression in Table 2 is 1.236, indicating that there is a minor positive serial correlation among the residuals. The movement of the residuals is presented in Figure 4.

(5) After the deletion of the outliers, the model as presented in Table 2 is able to explain more than 98% of the movements of . Hence, the room left for us to investigate the bubble content of house price with the information contained in the residuals is rather limited. This leaves us to assume that the bubble information is contained in the movements of the whole economy, an issue that is beyond our concern in this study.

Nevertheless, we do estimate the regression model as specified in Eq.(12) with the same data as

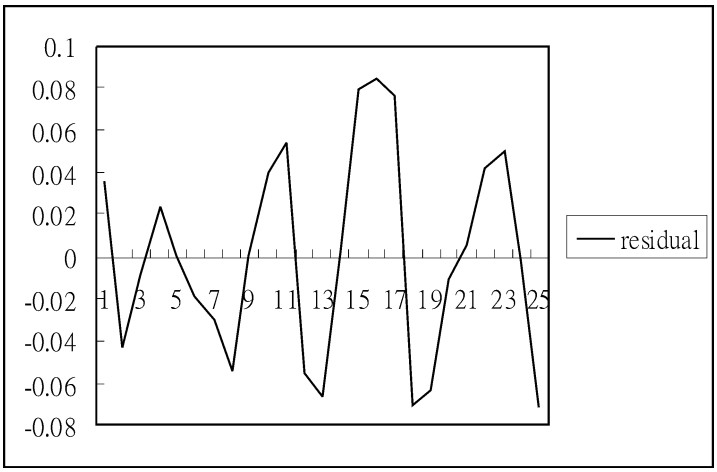

Figure 4. The residual plot of the model: $\ln HP_t = c_o + c_1 DT_t + {}_{C2} D2_t + {}_{C3} \ln AP_t + \varepsilon_t$

mentioned above. Two estimated models with and without trend variables DT_t^* are presented as table 3 and table 4 respectively.

The estimated results of the both models exhibit that the house prices on the market can be explained by the affordability of the people. The signs for 's coefficients in the two models are different, however. For the result presented in Table 3, this can be partly explained by the significance of the coefficient of DT_t^* and the following observations: (1)the level of HP_t exhibits a downward trend for the latter half period while that of AP_t remains increasing but with diminishing pace; hence, the opposite behaviors of the two variables tend to become more acute in the latter period. (2) Since there is a term, DT_t^* in the model to take account of the trend, the estimated coefficient for $\ln AP_t$, therefore, does not exhibit any time trend. But, the negative coefficient sign of AP_t is a result uncompatible with our theoretical expectation indeed. Normally, we would expect the sign of the coefficient to be positive in the belief that the house price on the market, HP_t, would behave in the same way as that of people's affordability, AP_t, implicitly assuming that people's demand would go hand in hand with their affordability. This belief, however, is defied by the above-mentioned empirical result that is hard to explain in ordinary situation. In our case, nevertheless, there is an abnormality deserves mentioning. During the observation period of the study, there had been a glut of housing supply prompted by the extraordering boom in the beginning. It is conceivable that the glut of houses in the beginning period had exerted a tremendous price pressure on the market and thus caused the market price to decline for most of the rest period. The decline of the market price, in turn, had caused the demand to dwindle as the potential purchasers are discouraged to engage in their purchases sheerly by the price signal lest that the price decline should still go further. It is in this inordinate situation that the market price exhibited a downward trace despite that people's affordability were gradually improved in the same time by the overall conditions of the growing economy as a whole, and this might be the reason why we have the unexpected result with regard to the coefficients sign of the variable AP_t.

Table 3. An estimated relationship of HP_t, AP_t, and lagged $HP_t^{'s}$ (with DT_t^* variable)

$\ln HP_t = {}_{c0} + {}_{c1} DT_t^* + {}_{c2} D2_1 + {}_{c3} \ln AP_t + {}_{c4} \ln HP_{t-1} + {}_{c5} \Delta \ln HP_{t-1} + \varepsilon_1$ Explanatory variables			
Explainary variable	Estimated coefficients	t-value	$\bar{R}^2$=0.986
Constant	12.084	10.066***	F-statistics=305.73***
DT_t^*	-0.027	-4.582***	D.W. =1.233
$D2_t$	0.865	14.787***	Q(5) =21.104***
$\ln AP_t$	0.056	0.830	
$\ln HP_{t-1}$	0.139	2.096**	
$\Delta \ln HP_{t-1}$	-0.084	-1.194	

Table 4. Another estimated relationship of variables HP_t, AP_t and lagged HP_t (without DT_t^* variable)

Model: $\ln HP_t = {}_{c0} + {}_{c1} D2_t + {}_{c2} \ln AP_t + {}_{c3} \ln HP_{t-1} + {}_{c4} \Delta \ln HP_{t-2} + \varepsilon_t$			
Explainary variable	Estimated coefficients	t-value	$\bar{R}^2$=0.97
Constant	15.70	11.203***	7F-Statistics=172.6***
$D2_t$	0.876	10.504***	D.W.= 1.06
$\ln AP_t$	-0.178	-3.008***	Q(5)=6.536
$-\ln HP_{t-1}$	0.122	1.342	
$\Delta \ln HP_{t-2}$	0.023	0.255	

3.3 Further investigation on the price determinants

Since $\ln AP_t$ is composed of $\ln AM_t$, $\ln K_t$, and $\ln MPF_t$ it calls for exploring how the latter variables explain the behavior of $\ln HP_t$. For this, we have tried two specifications in the regression models differentiated with inclusion or exclusion of a trend variable, DT_t^* to explore the relationship between $\ln HP_t$ and the components of $\ln AP_t$. The results of the estimation are presented in Table 5 and Table 6 respectively.

Table 5 presents the model with DT_t^*. The coefficients estimated for the three directional trend variables are quite consistent with those of Table 2 and Table 3 but the coefficients estimated for the three stochastic explanatory variables are not statistically significant (their P-values are 0.14, 0.264, 0. 354 for $\ln MPF_t$ and respectively). We surmise that it is due to the common trend that is shared by these variables and the term DT_t^*. So, we tried another model without the term. The estimation of this different model is presented in Table 6. It can be seem from DT_t^* the result that the coefficients for $-\ln K_t$ and $\ln MPF_t$ are significant at 1% level while the coefficient of $\ln AM_t$ is not quite significant. The signs of the coefficients, except that of $\ln AM_t$, are consistent with those in Table 4, indicating that the model has provided us with a certain explanation about the behavior of $\ln HP_t$ (adjusted R^2=0.973, D. W.=1.274, and Q(6) statistics is not significant). That is, we may regard $-\ln K_t$ and $\ln MPF_t$ as the determinants of house price in the market.

Similar to the results obtained in Section (II), the values of $\bar{R}^2$ for the two model are high enough (they are 0.986 and 0.973 respectively) for us to infer that it is hard to extract further information from

Table 5. An estimated relationship for HP_t, AM_t, K_t and MPF_t

Model: $\ln HP_t^t = c_0 + c_1 DT_t^* + c_2 D2_t + c_3 \ln AM_t + c_4(-\ln K_t) + c_5 \ln MPF_t + \varepsilon_t$			
Explainary variable	Estimated coefficients	t-value	$\overline{R}^2$=0.986
Constant	14.498	19.225***	F-Statistics=349.2***
DT_t^*	-0.0227	-4.552***	D.W.= 1.40
$D2_t$	0.857	14.989***	Q(6)=23.022***
$\ln AM_t$	0.076	1.527	
$-\ln K_t$	-0.162	-1.151	
$\ln MPF_t$	0.137	0.948	

a: $\ln AM_t$, $-\ln K_t$ and $\ln MPF_t$ are components of the variable $\ln AP_t$

Table 6. Another estimated relationship between HP_t and AM_t, K_t and MPF_t

Model: $\ln HP_t^t = c_0 + c_1 D2_t + c_2 \ln AM_t + c_3(-\ln K_t) + c_4 \ln MPF_t + \varepsilon_t$			
Explanatory variables	Coefficients estimated	t-value	$\overline{R}^2$=0.973
Constant	16.840	21.676***	F-Statistics=217.21***
$D2_t$	0.765	10.149***	D.W.= 1.274
$\ln AM_t$	-0.042	-0.702	Q(6)=3.688
$-\ln K_t$	-0.479	-2.775***	
$\ln MPF_t$	0.498	2.911***	

the residuals as far as the house price bubbles are concerned.

Similarly, we specify two different regression models in correspondent to Eq(13) with and without the term DT_t^* respectively and present the estimation results in Tables 7 and 8 separately. From Table 7, we found that the estimated statistics of the three directional trend variables are consistent with what we had before. Yet all the coefficients of the stochastic explanatory variables are insignificant. We suspect it may have to do with the paucity of the observation data, the overload of the explanatory variables in the regression model and the possibility of collinearity among some of the explanatory variables as well as DT_t^*.

Thus, we remove the trend term DT_t^* and consider the appropriateness of excluding certain from the model in order to minimize the waste of the degree of freedom and to alleviate the problem of collinearity. The estimation results of the revised model are presented in Table 8.

For each variable included in both Table 8 and Table 6, the estimated results are similar. The coefficients for $-\ln K_t$ and $\ln MPF_t$ are significant alike in both estimation. Nevertheless, the $\overline{R}^2$-value for the more complicated model presented in Table 8 is unexpectedly lower than that in Table 6 despite that we have put more HP_t's lag variables in the former model.

Table 7. Estimation of the relationship between HP_t and AM_t, K_t and MPF_t, lagged HP_t... etc. (with DT_t^* variable)

Model: $\ln HP_t = c_0 + c_1 DT_t^* + c_2 D2_t + c_3 \ln AM_t + c_4(-\ln K_t) + c_5 \ln MPF_t + c_6 \ln HP_{t-1} + c_7 \ln HP_{t-2} + c_8 \Delta \ln HP_{t-3} + \varepsilon_t$

Explanatory variables	Coefficients estimated	t-value	$\overline{R}^2$=0.984
Constant	12.930	8.122***	F-Statistics=154.26***
DT_t^*	-0.026	-3.113***	D.W.= 1.625
$D2_t$	0.791	9.541***	Q(5)=12.545**
$\ln AM_t$	0.094	0.544	
$-\ln K_t$	-0.178	-1.093	
$\ln MPF_t$	0.104	0.543	
$\ln HP_{t-1}$	0.005	0.054	
$\ln HP_{t-2}$	0.081	0.948	
$\Delta \ln HP_{t-3}$	0.073	1.050	

Table 8. Estimation of the relationship between HP_t and AM_t, K_t and MPF_t, lagged HP_t... etc. (without DT_t^* variable)

Model: $\ln HP_t = c_0 + c_1 D2_t + c_2 \ln AM_t + c_3(-\ln K_t) + c_4 \ln MPF_t + \varepsilon_t^a$

Explanatory variables	Estimated Coefficients	t-value	$\overline{R}^2$=0.972
Constant	16.638	10.570***	F-Statistics=157.88***
$D2_t$	0.766	8.335***	D.W.= 1.445
$\ln AM_t$	-0.084	-1.132b	Q(6)=2.403
$-\ln K_t$	-0.491	-2.762***	
$\ln MPF_t$	0.468	2.491**	
$\ln HP_{t-1}$	0.043	0.417	

Note: a. We have also estimated the model with $\Delta \ln HP_{t-2}$, the significances of the estimated coefficients are similar to what we report here but the overall results are less satisfactory.

b. The p-value for this coefficient is 0.273.

3.4 A digression for the house prices of the years 1987 and 1988

Statistically speaking, the house prices for the years 1987 and 1988 resemble the outliers of the whole time series since they erupted so abruptly that their behaviors can't be explained either by the series' long-term trend or by the driven forces embodied in the demand model. Incidentally, we found that there exists a similar pattern of abruptness in the series of stock price index (SPI) occurred exactly in the same period of time as mentioned above (see Fig 5). More specifically, the price index for the stock market exhibited an increasing trend from the end of 1970's (with index value at around 560) until year 1986 (with index value at 945), with an annual trend value at around 10%. The index value for the subsequent two years, i.e. the years of 1987and 1988, however, had increased more than four times that

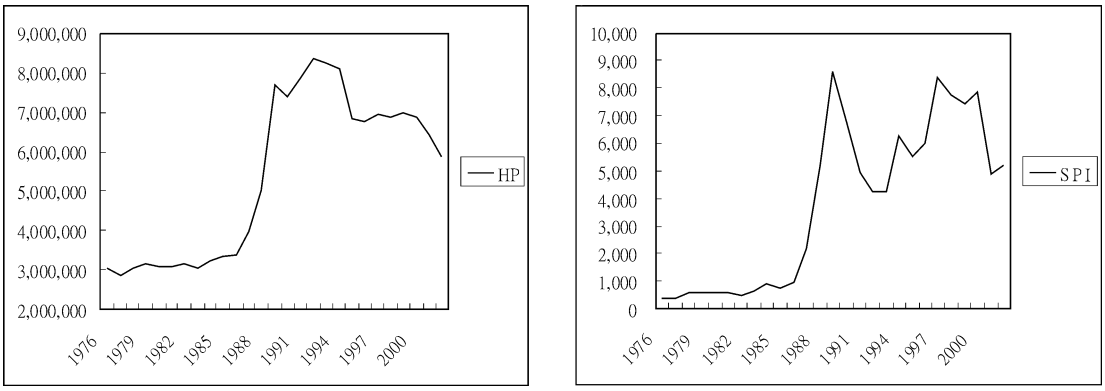

Figure 5. Trends of HP and SPI

of 1986, from 945 to 5202. This is really an extraordinary magnitude indeed. Nevertheless, the corresponding abruptness might have occurred without reasons, since the performances of both the housing market and the stock market have been widely believed to be sensitive to the volume of money supply. Statistics from the Central bank show that there had been big surges in money supplies in those two years due to the so-called hot money influx from oversea Capital market: the rates of increase for these two years are 26.8%t o 22.4% respectively.

3.5 Discussion

Based on the analytical model laid in Section II, the empirical work in this section has been proceeded with the following principle: let data speak and choose the most suitable estimation models that have the greatest goodness of fit among the nested structural models of equations (12) and (13). This result in the seven estimation models showed as table 2 up to table 8. The empirical results show that what we have obtained from these estimations are consistent with the conceptual framework that we have constructed with insights of the market behavior during the observation period from 1976 to 2003 and the model specifications that we have made to reflect the core of our thinking. That is, the empirical result shows that the affordability measure or its components, by and large have advanced quite closely with the market prices of housing during the observation period but, after1987, the purchaser's (consumers') affordability has never been able to keep pace with the market price due to the extraordinary price hike during the two consecutive years of 1987 and 1988. After 1989, however, the movement directions of the two series have restored their previous pattern. The market price of house exhibited a minor down trend from 1995 to 2003. While the level of AP_t advanced it slowly. From the estimation of the regression models it appears that we have grasped most of the above-mentioned trend.

It seems that the house-price bubble has been encompassed on the economy as a whole, with its height appeared in the 1987-89 period. After that, the bubble shrank into a negligible scale.

4. Summary and Conclusion

This paper tries to explain the phenomenon of housing price appreciation occurred in Taipei in the past with a concept of affordability which is rather different from the conventional one in that it takes

mortgage financing factors as well as household income levels into account rather than just consider the effect of the latter factor. This modification enables the author to construct a variable that can represent the changes of the economic fundamentals in a coherent way that the influence of this variable on the price of houses can be more readily estimated or analyzed. As such, the approach of study marks, to some extent, a departure from the convention ones.

After a careful testing of the stationarity of the time series used, the empirical work is proceeded with several models specified to explore the relationships between the house price and the affordability variable as well as other price determinants. It is evident from the analysis that the affordability variable or its components do have significant power in explaining the behavior of HP_t except the years of 1987 and 1988. The appearance of the most serious house-bubble in the above mentioned years ensue the hectic environment of the economy at the time.

Note

1. With formula $MPF_n = CPF_n = \frac{i(1+i)^n}{(1+i)^n - 1}$ for a mortgage loan of n years, and i is the annual interest rate.
2. In practice, it may be taken to be a product of household's disposable income (Y) and the share of housing expenditure (α) that the household is willing to appropriate.
3. eq. (9) is equivalent to $ph_t = ph_{t-1} + \tau(ph_t^* - ph_{t-1})$ In this estimation, the value of t_B.
4. In this estimation, the value of t_B is set to be 12 while the value of t is set to be 1 for 1976, 2 for 1977, and so on ...
5. Generally speaking, it is reasonable to assume that a time series' integrated property is composed of a deterministic component and a stochastic component.

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Appendix

Table A1: The actual price and the affordable price for a standard dwelling unit (in NT$) and other data used in the study.

Year	Household Disposable Income (Y)	Share of Housing Expenditure (α)	Loan-to-value ratio (k)	Mortgage Interest rate(%) (i)	MPF (%)	AM	Amount of Loan affordable (in NT$) AM/MPF	Affordable house price (AP)	Actual house price (HP)
1976	151,551	0.3	40%	13.33	14.50	45,465	313,552	783,880	3,034,600
1977	174,414	0.3	40%	11.40	12.90	52,324	405,612	1,014,030	2,869,200
1978	204,792	0.3	40%	11.00	12.60	61,438	487,603	1,219,008	3,019,600
1979	241,257	0.3	40%	12.30	13.60	72,377	532,184	1,330,460	3,144,900
1980	284,263	0.3	40%	14.56	15.60	85,279	546,660	1,366,650	3,080,100
1981	334,428	0.31	40%	14.70	15.70	103,673	660,338	1,650,845	3,071,100
1982	362,210	0.31	40%	10.10	11.80	112,285	951,568	2,378,920	3,138,700
1983	393,544	0.31	50%	10.00	11.70	121,999	1,042,726	2,085,452	3,028,500
1984	406,682	0.32	50%	9.60	11.10	130,138	1,172,414	2,344,828	3,232,500
1985	422,864	0.32	60%	8.50	10.60	135,316	1,276,566	2,127,610	3,332,700
1986	434,098	0.32	70%	7.60	9.90	138,911	1,403,141	2,004,487	3,362,100
1987	472,016	0.33	70%	8.00	10.20	155,765	1,527,108	2,181,583	3,953,900
1988	533,711	0.33	70%	8.00	10.20	176,125	1,726,716	2,466,737	4,999,300
1989	583,003	0.33	70%	8.42	10.50	192,391	1,832,295	2,617,564	7,689,100
1990	657,607	0.33	70%	10.41	12.10	217,010	1,793,471	2,562,101	7,390,600
1991	764,325	0.33	70%	10.18	11.90	252,227	2,119,555	3,027,936	7,826,700
1992	835,862	0.33	70%	9.17	11.10	275,834	2,484,991	3,549,987	8,350,500
1993	951,179	0.33	70%	9.26	11.20	313,889	2,802,580	4,003,686	8,258,900
1994	1,048,002	0.33	70%	8.98	10.90	345,841	3,172,853	4,532,647	8,073,000
1995	1,116,234	0.33	70%	8.88	10.80	368,357	3,410,713	4,872,447	6,832,800
1996	1,137,761	0.33	70%	8.55	10.60	375,461	3,542,085	5,060,121	6,729,800
1997	1,191,250	0.33	70%	8.42	10.50	393,113	3,743,933	5,348,476	6,942,900
1998	1,196,141	0.33	70%	8.41	10.50	394,727	3,760,040	5,371,485	6,877,000
1999	1,208,578	0.36	80%	7.60	9.88	435,088	4,401,970	5,502,463	6,959,900
2000	1,237,777	0.36	80%	6.78	9.28	445,600	4,802,497	6,003,121	6,888,600
2001	1,217,932	0.36	80%	5.99	8.71	438,456	5,033,135	6,291,419	6,399,900
2002	1,232,387	0.36	80%	4.40	7.62	443,659	5,821,426	7,276,783	5,889,000

Sources: The price data are drawn jointly from Chang and Liu [1], Hsin-Yih Real Estate Inc., and the first author's calculation using statistics released by the Bureau of Budget, Accounting, and statistics of Taipei municipal government. Other data are drawn either from relevant governmental publications or from the calculation made by this study. And, the household's affordable annual mortgage payments are calculated from the household's annual income data by multiply them with the shares that are appropriated for housing purpose. The mortgage repayment factor is a factor that a bank teller would use to calculate the annual fixed amount of mortgage payment. For a mortgage loan of n years, with annual interest rate i, the factor can be obtained readily from the following formula : [i (1+i)n] / [(1+i)n-1]. Note also that the value of AM/MPF defines the amount of mortgage loan that is affordable to a typical household.