Rent Adjustment Mechanism for the Multifamily Housing Market

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ABSTRACT

This study has analyzed the rent adjustment mechanism for the multifamily rental housing in the US during the period 1993-2003 for twenty-four US metropolitan areas. The rent adjustment model employed incorporates the principal argument of search theory that vacancy ultimately determines rent levels. Various time lags on the vacancy rate are tested for each metropolitan area in order to better understand the timing of the effect of the vacancy rate on market rents and to find the best fitting model for each metropolitan area. Two kinds of rents are analyzed : the CPI (Consumer Price Index), 'sitting tenant rent' actually paid by the tenants, and MPF (Market Product Fact), the 'asking rent' for the vacant unit.

The results of this study clearly indicate that the rent adjustment models under study explain the MPF rent adjustment mechanism better than the CPI rent adjustment model. Chaning the vacancy lag does not improve the CPI rent adjustment mechanism. The results of this study suggest further studies to explore the behaviors of lessors and lessees to explain why CPI rents behaves as they do.

The findings identified through this research provide a helpful basis for advancing an improved theoretical and empirical formulation that highlights the complexities of the rent adjustment process. From a practical point of view, the results can help real estate investment analysts to better model and forecast rent changes in residential real estate market.

Thesis Supervisor : Henry Pollakowski
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PART 1: PROLOGUE

Chapter 1: Introduction

1. Overview

In the wake of ongoing and sizable fluctuations in rental housing market activity, analysts, investors, and lenders alike have sought improved methods by which to evaluate risk and return to investment in residential properties.[1] Like other businesses, multifamily housing markets are constantly in flux. The housing demand changes according to the preferences, needs, and affordability of the tenants to purchase or rent houses, while competing properties continuously attempt to differentiate their products based on quality and/or price. Since the pricing is constantly changing in these manners, it is particularly important to find a relevant mechanism that captures how the rental system operates, given the large percentage of the leases expiring each year.

To that end, academic analyses often have examined a number of issues such as the estimates of housing supply and demand elasticity, studies of market volatility or efficiency, and the investigations on the relationship between price or rent movements and housing vacancy rates.[2] In particular, the relationship between rent and vacancy rates has received special attention due to the fact that vacancy rates have been proven to be directly and significantly related to the rental adjustment process.

Existing empirical studies are mostly based on a simple rental adjustment equation that does not have a strong theoretical basis. It is therefore necessary to build a more sophisticated model and to validate the model in various multifamily housing markets. Therefore, the goal of this research is to examine the role of vacancy rates in determining the rental price adjustments based on a sound theoretical framework.

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[1] Tse and MacGregor (1999).
[2] Sivitanides (1997).

2. Objective and Scope

This thesis is an attempt to analyze the rent adjustment mechanism for the multifamily rental housing in the US during 1993-2003 period[3] for twenty-four US metropolitan areas. In reference to a number of recent theoretical models which describe the interrelations of tenant search, rents, and vacancy, this study aims at formulating a more sophisticated rental adjustment equation. Once the model is established, it would incorporate the principal argument of the search theory that vacancy ultimately determines rent levels. Various time lags on the vacancy rate could also be inferred from the model and be tested for each metropolitan area in order to find out the effect of timing of vacancy rate on market rents. Using both time-series and cross-section data, it is possible not only to compare markets contemporaneously, but also to make forecasts of individual markets.

3. Methodology

General trends and characteristics in rents are explicated by performing data analysis based on 17-year quarterly rent data. Regression analysis is used to explain the rent adjustment. Since vacancy rate data is available only from 1993, the time period for the regression analysis is 10 years, which is equivalent to 40 quarters. A systematic methodological procedure is established for this research: First, the originally estimated model that includes one quarter lag on the vacancy rate is tested. Next, the models that include no lag on the vacancy rate and two quarter lags on the vacancy rate are evaluated. Finally, the best fitting model for each metropolitan area is selected followed by the implications of that model.

4. Organization

In this thesis, the implications of the rent adjustment mechanism for the multifamily rental housing market is introduced first mainly through literature reviews. The subsequent sections of the study discuss the data source, information about the rents

[3] The regression analysis is based on the data from 1993 to 2003 due to the lack of the vacancy rate data, whereas the data analysis covers the period between 1985 and 2003 by making use of the data sets available for this time interval.

and vacancy rates, and the methodological issues that arises in the construction of the rent adjustment model. After introducing a relevant rent adjustment model, the analysis section which contains regression equations, estimation results, and the economic interpretations of the findings comes next. This section also includes the examination of rental movement over time, its characteristic behavior in each market, and the tests of the different models in order to find the one best-fits to each market. Finally, major findings as well as the suggestions for further studies are described in the conclusion part of the thesis.

5. Implications

This research possesses implications in both academic and practical domains. First, those findings identified through this research would be insightful from an academic point of view because they could provide a reliable basis for advancing an improved theoretical and empirical formulation that highlights the complexities of the rent adjustment process. It could also claim a notable importance considering the fact that there have not been sufficient studies on the rent adjustment mechanism with lagged vacancy rate targeted for multifamily housing.[4]

Second, this type of study would also be promising from a practical point of view as well in such a manner that they can help real estate investment analysts to better model and forecast rent changes in residential real estate market. The multifamily housing market has been attracting more and more investors since early 2000s mainly for its being considered as a stable and profitable commodity in comparison to other commercial properties which are prone to low interest rate and unstable profits. A sophisticated model validated through extensive data sets – quarterly ten year time-series rent data for twenty four metropolitan areas in the US - would give investors a better insight into the up-to-date multifamily rental housing market behaviors.

[4] There was a study for office rent cases. Sivitanides(1997) used one, two and three semesters' lag on the vacancy rate to account for the rent adjustment mechanism for commercial properties. In his study, he showed that various lagged model may be more appropriate than the traditional (unlagged) one in explaining office rent changes during the period 1980-1988.

PART 2: THORETICAL BACKGROUND

Chapter 2: Understanding Multifamily Housing Rents

1. Theories of Vacancies and Rents[5]

There have been contradictory views on the relationship between rent and vacancy. One of the major features of this analysis is that vacancy rates are pivotal in explaining rents since rents vary inversely with the vacancy rate within a critical zone of occupancy. These analyses[6] often assume that the responsiveness of rents to vacancy rate declines as vacancy rates increase, and that there is a certain lower limit to rents beyond which the dwelling is practically abandoned. However, a doubt has been cast upon this traditional view by De Leeuw and Ekanem (1971) who found that the vacancy variable is insignificant in explaining the rent on rental dwellings after taking into account income, price, and cost variables.

Although there have been a number of contradictory views, the frequently observed negative correlation between vacancy rates and the changes in real rents has considerable intuitive appeal.[7] High vacancies put downward pressure on rents as landlords bid against each other to secure tenants. With low vacancies, prospective tenants become the bidders, boosting rents in the attempt to secure housing. The intuition of this relationship has been formalized in search theory, and numerous cross-sectional empirical studies have found the expected relationships to hold, for both housing and office markets.

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[5] To explain the determination of the market rent for multifamily housing, many empirical works have produced substantial lists of attributes and characteristics. These factors range from physical attributes to vacancy rates. In this study, the attribute for determining rents is confined to vacancy rates.
[6] See Eubank and Sirmans (1979); Rosen and Smith (1983); Hendershott and Haurin (1988); DiPasquale and Wheaton (1992); Belsky and Goodman (1996); Tse and MacGregor (1999).
[7] Belsky and Goodman (1996).

Search theory[8] explains how uncertainty and costly search can influence the behavior of various market participants. In the short run, the number of units and households is assumed to be fixed. A household periodically "changes" and therefore seeks to move from an existing house that no longer suits their needs to another. The prospect of remaining in such a "mismatched" state determines both the search "effort" and the offer price made by buyers. Sellers are merely buyers who have found a new unit and are seeking to dispose of their old one. Their reservations are determined by the expectations for sales time and the costs of holding two units. Greater vacancy will increase sales time and lead to lower market prices.[9]

The combination of price and expected sales time determines the "expected price" for a house. Reasonable values are produced for house prices which are very sensitive to the small changes in "demand" or "supply" (i.e., vacancy). House prices also increase significantly in response to a greater rate of household change or market turnover. This leads to a higher long-term vacancy rate in the markets with more exogenous growth, change, or mobility.[10]

In terms of rental housing market, the rent-setting decision that each individual landlord faces is theoretically linked to the market-wide balance of supply and demand.[11] When the vacancy rate rises through new construction, emigration, or other means, it takes longer to fill vacancy units, because there are fewer searchers per vacancy. In response, landlords lower their asking rents in an attempt to fill their units. As rents fall, more households are attracted to the rental market and the additions to supply slows down until vacancies and rents come back into equilibrium.

In setting initial and subsequent asking rents, a landlord seeks to maximize his or her net income. Each time a prospective tenant arrives to inspect a vacant unit; the landlord is essentially drawing a sample from the distribution of people in the market to rent. The probability on any one trial of finding the person who is willing to pay at or near the highest rent for that unit is relatively low. Landlords cannot know with certainty

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[8] Search theory also explains the labor market, in which workers depart from jobs and then find new employment from among the vacancies so created. With uncertainty in the worker-job match, decisions about job acceptance determine vacancy duration, while wages are based on the gains from filled employment.
[9] Wheaton (1990).
[10] Ibid, pp.1273.
[11] Much of this paragraph is based on Belsky and Goodman (1996).

the highest rent that a tenant will be willing to pay. Nor can the landlord know how long it will take before that tenant arrives. Hence, landlords experiment in setting rents to test the market; they typically will start with a high rent to see if it will be accepted quickly before lowering the price in an effort to shorten the duration of the vacancy.[12]

On the demand side, utility-maximizing tenants weigh the costs and benefits of searching longer for the best unit at the best price. Tenants typically must search over several units to find the one that is attractively priced and is suited to their needs and tastes. But searching is costly in terms of time and money, and the returns to further search diminish at certain point.[13]

In sum, economic theory establishes that the rate of change in real rents is a function of the balance of supply and demand in local submarkets as proxied by rental vacancy rates. Downward pressure is exerted on real rents as vacancy rates rise above the equilibrium rate, while upward pressure is exerted as vacancy rates fall below it.

2. Empirical Studies on Rents and Vacancy Rates

Most empirical studies have found evidence supporting the view of the inverse relationship between rent change and vacancy rates. Some studies have proposed a natural vacancy rate and have measured the rate of change in rent relative to the deviation of the observed vacancy rate from the natural rate. Others have attempted to estimate the impact of vacancy on real rent.[14]

Blank and Winnick (1953) are credited with being the first to explicate the relationship between rent change and vacancy rates. Their data pertaining to the vacancy rate and rents in six U.S. cities for varying time periods between 1932 and 1937 provides an opportunity to test the relationship between rent and vacancy rate. Since then, the relationship has been repeatedly tested in both residential and commercial office markets.

[12] Belsky and Goodman (1996).

[13] The theory and empirical analysis of tenant and landlord search behaviors are well described by Stull (1978), Engle and Marshall (1983), Gausch and Marshall (1985), Hendershott and Haurin (1988), and Read (1988, 1991).

[14] Sirmans and Benjamin (1991).

The operation of any real estate market is essentially a matching process between tenants or buyers searching for a new space and the owners having available space. Because the search or matching process is time consuming and because every parcel of a space is slightly different, the market is not strictly "competitive". A property owner is not a pure "price taker", but rather realizes that if he/she sets rents somewhat higher than his/her neighbors, it may merely take him/her longer to find a tenant.[15] Setting rents below the competition results in a more rapid lease-up. In this context, it is economically rational to set rents at a level that still leaves a positive vacancy.[16]

If the market turns out to be stronger than expected, vacant space will be leased more quickly than anticipated, and the steady-state level of vacancy will be lower than the "optimal" level. If the market is weaker than expected, the converse is true. Rational landlords presumably learn from their mistakes and, in subsequent periods, adjust rents up (or down) in response to a vacancy rate that was overly low (high). This is the adjustment price that empirical research seeks to identify.[17]

Chapter 3: Rent Adjustment Mechanism

1. Theory of the Rent Adjustment Mechanism

The rent (price) adjustment mechanism and rental housing market can be viewed as an entity operating in a typical stock-flow manner. At any moment, there is a stock of rental housing units providing housing services and the demand for these services. If we assume, as usual, that a standardized unit of housing stock yields a unit of housing services during each period of time, then the rent is the price for the flow of services from one standard dwelling unit, and the demand and supply of housing services can be considered as the demand and supply of the units of housing stock. Although the size of the standardized rental housing stock in any period is increased by the newly completed or converted rental dwellings and is diminished by removals, demolitions, and

[15] Wheaton, W.C. and R.G. Torto (1988).
[16] Eubank and Sirmans (1979).
[17] Ibid, pp. 433.

depreciation. The annual change in the stock is relatively small, hence the stock could be considered to be fixed in the short run.[18]

However, since numerous frictions and imperfections cause the market to adjust slowly, the rent level determined through this process may not completely clear the market in the sense that actual vacancies equal the normal or optimal vacancies. Market frictions such as high transactions and search costs, slow supply responses, credit market imperfections, and the existence of long-term contracts may all impede the quick adjustment of rents.

If rents are such that the housing stock demanded exceeds the available supply less the normal level of vacancies, then vacancies will be less than normal and upward pressure will be exerted on rents.[19] This will bring forth a new construction and the conversion of existing units as well as reducing demand from existing renters. Analogously, if rents are such that the housing stock demanded is less than the available supply less the normal level of vacancies, vacancies will be larger than normal, downward pressure will be exerted on rents, and new construction will be lower than in the market-clearing case.

The speed at which the market moves toward equilibrium depends, among other things, upon the supply-side response and the speed of rental price adjustment. This discussion implies that the rate of change in rents depends upon the vacancy rate, and that the variations in the arguments in the demand function or the supply will be reflected initially in the vacancy rate.[20]

These arguments became more explicit and concrete with Wheaton's searching behavior model (1990). As explained earlier, the searching model assumes that buyers and sellers have equal information. Thus one party may set an asking price, but the actual prices are the result of bargaining between the two parties, each of whom knows the other's options. Following this approach, a landlord with vacant space determines his reservation (minimum acceptable) rent based on the market vacancy rate and the number of tenants who are likely to be seeking space. The ratio of these two determines the expected lease-up time for a space. When a tenant who is suited for a particular parcel of

[18] Rosen and Smith (1983).
[19] Ibid, pp.779.
[20] Ibid, pp.780.

space finally arrives, the owner's cost of not accepting the tenant's offer is the likelihood of not finding another suitable prospect. A high expected lease up time makes this risk greater and lowers the landlord's reservation rent. On the tenant's side, much vacant space and few prospective users will facilitates the search process. Rejecting one parcel of space is of little consequence, since others can be easily found. Thus the tenant's opportunity cost moves inversely with the expected lease-up time—a high lease-up time reduce the maximum rent the tenant is willing to offer. In bargaining, the equilibrium rent level must lie somewhere between the landlord's minimum reservation and the tenant's maximum offer, both of which declines with greater expected lease-up times.[21]

2. Empirical Studies of the Rent Adjustment Mechanism[22]

Smith (1974) examines the effect of vacancy and property taxes on rent by using annual figures for five Canadian cities between 1961 and 1971. Smith's rent adjustment model stipulates that the rate of change in rent is a function of the vacancy rate, the vacancy rate lagged one period and the rate of change in property taxes. Assume that the demand for housing service D is a function of housing service (R), real income per household (Y), the price level (P), and number of household (H),

$$\mathbf{D = f\,(R, Y, P, H\,)}$$

And the Supply of housing services (S) is assumed to be fixed in the short run. The vacancy level (VL) is then a measure of the excess supply or demand. Then the equation is derived as the following:

$$\mathbf{VL = S - f\,(R, Y, P, H)}$$

Dividing by S gives the vacancy rate (V)

$$\mathrm{V} = \frac{VL}{S} = 1 - \frac{1}{S} f(R, Y, P, H)$$

[21] Wheaton and Torto (1994).

It is hypothesized that the rate of change of rents (R*) is a function of vacancy rate and property taxes (T). Therefore the rent adjustment model is:

$$R^* = 1 - \frac{1}{S}(a + bR + cY + dP + eH) + T$$

Based on this model, he finds that vacancy rate has a negative effect and that property taxes have a positive effect on the rate of change in rent. The author concludes that the vacancy rate does significantly affect the rate of change in rents and that landlords are able to pass along a significant portion of operating expenses in the form of higher rents.[23]

Applying Smith's model, Eubank and Sirmans (1979) examine the effect of vacancy levels and operating expenses on rent estimating a logged change in the Smith rent equation which includes vacancy, lagged vacancy, change in operating expenses, and dummy variable for apartment type as explanatory variables. The model is estimated for four cities and for pooled cities by building type as well as for pooled building type by city. The results differ from Smith's, showing that the vacancy rate is not significant in a majority of cases, but that operating expenses are significant.

Rosen and Smith (1983) provide a further test of the Smith's model. They examined the effect of vacancy and operating expenses on rent by estimating a rent model which includes the rate of change in operating expenses, the observed vacancy rate, and the vacancy rate lagged one period. Using apartment data in 17 U.S. cities for the period of 1969 to 1980, they find vacancy to be negative and significant for thirteen out of the seventeen cities.

In their work to further test Smith's model, Shilling, Sirmans and Corgel (1987) measure the rate of change in rent against operating expenses and the observed vacancy rate. Because the risk from holding commercial real estate increases as vacancies increase, their adaptation of the Rosen and Smith model adds an interaction variable consisting of the rate of change in rent times the vacancy rate because the risk from holding commercial real estate increases as vacancies increase. The authors find the

[22] Much of this chapter is based on Sirman and Benjamin (1991).
[23] Sirmans and Benjamin (1991).

vacancy variable is negative and significant for eleven of the seventeen cities and the interaction variable is significant for all cities. The authors conclude that vacancies play an important role in setting rents in the short run and that the greater the number of vacancies, the greater the risk.

Using data for average vacancy rates from the Census Bureau for 16 U.S. cities from 1981 to 1985, Gabriel and Northaft (1988) argue that the rate of change in rents is partially due to the deviation of short-run vacancy rates from their long run or natural level. Results of a model treating vacancy as an exogenous variable show vacancy to have a negative effect on rent. Results in which vacancy is treated as endogenous show that natural vacancy rates are higher in the areas of high growth and vary positively with the level of median real rents.

To examine the relationship between the vacancy rate and the future of office rent, Wheaton and Torto (1988) examine the relationship between vacancy and the change in real rent by estimating a model to show the change in real rent on excess vacancy which is the difference in observed vacancy rate and a trending "structural"[24] vacancy rate for office market in the U.S. Rents move upward when the market is unexpectedly tight and decline when a soft market generates unexpectedly high vacancy. In an inflationary environment, abnormally high or low vacancy should move real and not just nominal rents.

In sum, studies that use adaptations of the Smith model do not consistently corroborate his findings. One finds no consistent effect on rent for the vacancy variable[25] while another does and additionally reports a concomitant risk relationship. In general, most empirical studies have supported the views of the inverse relationship between rent change and vacancy rates. Especially, empirical studies based on search theory explain well how uncertainty and costly search can influence the behavior of various market participants However, none of the up-to-date empirical studies based on search theory

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[24] Structural vacancy is defined as the desired or equilibrium inventory of vacant units that maximizes landlords' anticipated profits, and it depends on their expectations with respect to demand and marginal cost of holding vacancy units (Shilling et al., 1987).

[25] Even there are opponents of the existence of a rent adjustment mechanism. For example, Cairncross (1953) argues for the "stickiness" of rents, when seeking to discredit the efficiency of that mechanism in Glasgow's housing market, 1871-1913.

were done for multifamily housing markets. Therefore, this study focuses on an up-to-date empirical study for multifamily housing markets.

PART 3: THEORETICAL AND EMPIRICAL ANALYSIS

Chapter 4: Model Establishment

1. Rent Adjustment Model

A substantial literature, mostly empirical, which argues that rental movements can be explained largely by vacancy rates, has featured the development of a rent adjustment model. These studies[26] assume that a simple linear difference equation exists between the change in rents(R) and the amount of "excess" vacancy (V), above or below a market's "structural vacancy[27] rate".[28] This is reflected in (1) below, where V_{mkt} is a market's structural vacancy rate, and c is the speed of rental adjustment.[29]

$$\mathbf{R_t - R_{t-1} = c\,(V_{mkt} - V_{t-1})} \tag{1}$$

While this equation has become almost an institution in real estate, Wheaton and Torto (1994) point out that it lacks a theoretical justification. In fact, the model implies that rents will fall or rise forever, in response to continued high or low vacancy. Of course, if the vacancy rate were a negative function of rent, perhaps through a long-run demand equation, then this pair of equations would lead to a stable dynamic system that describes the market as a whole. These empirical studies of rental adjustment, however, have treated (1) as an independent equation that describes only how owners (and tenants) agree upon rents.

A number of authors have substantially developed formal models of the housing market in which product heterogeneity and consumer search lead to positive vacancy rates in equilibrium. These models also deal very explicitly with the simultaneous relationship between rents (or price) and vacancy rates. In none of this work does a

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26 Rosen and Smith(1983), Gabriel and Nothaft(1988), Heckman(1985), Shilling et al. (1987), and others.
27 See definition in Chapter 4.
28 Wheaton and Torto. (1994).
29 Much of the next three paragraphs is based on Sivitanides (1997).

relationship anything like (1) ever emerge. Rather, this research argues that vacancy rates and rent levels can coexist together in equilibrium, albeit inversely.

In the work of Read (1988) and Arnott (1989), there is asymmetric information in the market for rental housing. This means that homogeneous landlords have information about the reservations of heterogeneous tenants, who in turn have imperfect information about housing units. This allows landlords, in a seemingly competitive market, to effectively face a downward sloping demand schedule for any given unit, and to effectively set rents. In this situation, setting a lower rent leads to a faster rate of unit inspection by tenants, which ultimately reduces the length of time that a unit is vacant. Higher rents increase the duration of vacancy, but of course yield more income. In equilibrium landlords arrive at levels of rent where their vacancy duration equals that in the overall market.[30]

Wheaton (1990)'s model of search in the single family housing market assumes that buyers and sellers have equal (symmetric) information. Thus one party may set an asking price, but actual prices are the result of bargaining between the two parties, each of whom knows the other's options. Following this approach, a landlord with vacant space determines his reservation (minimum acceptable) rent based upon the market vacancy rate and the number of tenants likely to be seeking space. The ratio of these two determines the expected lease-up time for space. When a tenant finally arrives who is suited for a particular parcel of space, the owner's cost of not accepting the tenants offer is the likelihood of not finding another suitable prospect. A high expected lease up time makes this risk greater and lowers the landlord's reservation rent. On the tenant's side, much vacant space and few prospective users will facilitate the search process. Rejecting one parcel of space is of little consequence, since others can be easily found. Thus the tenant's opportunity cost moves inversely with the expected lease-up time -- a high lease-up time reduces the maximum rent the tenant is willing to offer. In bargaining, the equilibrium rent level must lie somewhere between the landlord's minimum reservation and the tenant's maximum offer, both of which decline with greater expected lease-up times.[31]

[30] Wheaton and Torto (1994).
[31] Much of this paragraph is based on Wheaton and Torto (1994).

Wheaton and Torto (1988) have estimated two rent adjustment models. The first model, referred to as the traditional rent adjustment model and described by (2), postulates that real, as opposed to nominal, rent change RR* is a function of the deviation of the nominal vacancy rate, V, from the natural or structural vacancy rate, V^n, which is assumed to be intertemporally constant.[32]

$$\mathbf{RR^*_{(t)} = \alpha\ [\ V^n - V_{(t-1)}\ ]} \qquad \mathbf{(2)}$$

The use of real rent change in the right-hand side of equation (2) allows the exclusion of operating expenses from the left-hand side of the equation, since real rent change accounts for any increase in rents due to inflationary increases in operating expenses.

The second model estimated by Wheaton and Torto allows the structural vacancy rate to vary, in some way, through time. The latter is expressed as function of time t as in (3), thereby reflecting the assumption that V^n has been trending upwardly or downwardly through time.[33]

$$\mathbf{RR^*_{(t)} = \alpha\ [\ (b_1 + b_2\,t) - V_{(t-1)}\ ]} \qquad \mathbf{(3)}$$

Equation (3) can be rewritten in a statistical form as:

$$\mathbf{RR^*_{(t)} = a + b\,t - c\,V_{(t-1)}} \qquad \mathbf{(4)}$$

As shown above, this model accounts for the intertemporal variability of V^n by including the time variable, t, that presumably reflects such variations. Estimates of (4) suggest that the structural vacancy rate has been increasingly through time.

Despite the fact that Wheaton's searching behavior model explains the rent adjustment process thoroughly and despite his empirical evidence to this effect, none of

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[32] Sivitanides (1997).

[33] Ibid, pp.198

up-to-date empirical studies of the rent adjustment process are performed for multifamily housing markets, from the perspective of searching behavior model.

2. Model to be Estimated

For this research, a mathematical framework is developed based on Wheaton's rent adjustment model. In his study (1994), he pointed out that none of the search-based theories suggests continual long-term declines (or rises) in reaction to vacancy that are above (below) a structural rate, while it might be argued that rents require a year or two to react their equilibrium level in response to a given vacancy rate. Furthermore, since both bargaining and rent setting are based on the expected lease-up time for property, a measure of the flow of new tenants, or tenant mobility (A) should be as important as vacancy in determining rent levels.[34] A simple rent adjustment model which incorporates these features is,

$$\begin{aligned} R^* &= \tau_0 + \tau_1 A_{t-1} + \tau_2 V_{t-1} \\ R_t - R_{t-1} &= \mu [R^* - R_{t-1}] \\ &= \mu (\tau_0 + \tau_1 A_{t-1} + \tau_2 V_{t-1} - R_{t-1}) \end{aligned} \qquad (5)$$

In (5), R* is the equilibrium level of rent that will prevail when expected leasing times are determined by tenant flow rates (A) and vacancy (V). Rents move (at a rate of μ per period) only until actual rents equal R*.

The reduced form parameters of the model (5) are a subset of those in the search-based model (6). Thus the statistical significance of the lagged rent and absorption variables is a direct test of the superiority of the search model like :

$$R(t) - R(t-1) = a + b\,VAC(t-1) + c\,R(t-1) \qquad (6)$$

[34] Sivitanides (1997).

Where (a) parameter identifies the structural vacancy rate, (b) is how sensitive it is to vacancy rate, (c) indicates how quickly rent changes in response to vacancy.[35]

If the equation is put to zero, we could get so-called a 'reservation rent[36]' (R*) which is expressed as :

$$R* = \frac{[a + b\,VAC(t)]}{-c} \quad (7)$$

This equilibrium rent (R*) is an indifferent rent that landlord accepts after going through searching behavior. In bargaining, the equilibrium rent level must lie somewhere between the landlord's minimum reservation and the tenant's maximum offer, both of which declines with greater expected lease-up times.[37]

In a strong market with increasing rents landlords may be inclined to hold more vacant units in order to be able to capitalize on future rent increases and strong demand. On the other hand, in a weakening market with increasing vacancies, landlords may tend to hold fewer vacant units in order to minimize their losses from weak demand and declining rents. The optimal or structural vacancy rate should, therefore, fluctuate through time depending on landlords' perceptions of market strength.[38]

From this reasoning, one could estimate that the coefficient (c) should be negative sign, considering that the structural vacancy rate (a) and the equilibrium rent (R*) are

[35] Frequently, rent adjustment equation is expressed with a percentage change in rents on the left-hand side. This ensures that rents never become negative, but still assumes continual rental movements in response to disequilibrium vacancy. Some authors have measured the rent change in current dollars and then added a term on the right-hand side for the current dollar change in operating costs. Other authors have measured rental movement in real dollars and estimated equations like equation (6) directly (Wheaton, 1994).

[36] A landlord is not a pure "price taker", but rather realizes that if he sets rents somewhat higher than his neighbors, it may merely take him longer to find a tenant. Setting rents below the competition results in a more rapid lease-up. In this context, it economically rational to set rents at a level that still leaves a positive vacancy (Wheaton and Torto, 1988). Therefore, there is a gap between the landlord reservation rent and tenant reservation rent in current market, and R* is the equilibrium rent between them.

[37] Wheaton and Torto (1994).

[38] Sivitanides (1997).

always positive. Therefore, one of the criteria for examining the feasibility of a model is to look at this coefficient (c).[39]

By applying model (6) described above, it is possible to see the effect of the speed of searching behavior -- the speed at which the market moves toward equilibrium-- by replacing VAC(t-1) to VAC(t-m), where m is lag on the vacancy rate.[40]

$$\mathbf{R(t) - R(t\text{-}1) = a + b\ VAC(t\text{-}m) + c\ R(t\text{-}1)} \qquad \mathbf{(8)}$$

Where (a) parameter identifies the structural vacancy rate, (b) is how sensitive it is to vacancy rate, (c) indicates how quickly rent changes in response to vacancy rate, and (m) stands for time lags.[41]

In this research, originally proposed model (6) is tested for twenty-four Metropolitan areas in the US, and the test of the applied model (8) follows next. This procedure gives more comprehensive understanding about the interrelated behaviors of rents and vacancy rates.

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[39] If coefficient (c) is not negative, we see that rent is increasing as vacancy rate is increasing. However, this is not how the market behaves. Therefore, in order to make the model practical, the coefficient c should be negative.

[40] It usually depends, among other things, upon the supply-side response and speed-of-rental price adjustment.

[41] In this study, both one quarter and two quarter vacancy lags are used for testing the rent adjustment process.

Chapter 5 : Data Analysis

1. Data Sources and Data Collection

The data used for the estimation of rent adjustment equations for twenty-four metropolitan multifamily housing markets, along with their sources, are listed in Table 5.1. The dependent variable in these equations is the quarterly change in time-series rent indices, both CPI rent and MPF rent, which were developed for each metropolitan area through hedonic analysis.

CPI (Consumer Price Index) rent is defined as so-called 'sitting tenant rent', which is actually paid by tenant. It is average weighted rents for certain period of time and is used as a rent composition for CPI index. On the other hand, MPF rent is 'vacant apartment rent' or 'asking rent' which is suggested by landlord for the vacant unit.

The CPI Housing Survey[42] is the source of the data on CPI rents used to calculate changes in rents for the Rent of primary residence index. The CPI Housing survey also uses these rent data in calculating changes in the rental value of owned homes for the Owners' equivalent rent of primary residence index. Rent of primary residence (rent) and Owners' equivalent rent of primary residence (rental equivalence) are the two main shelter components of the CPI rents. For renter-occupied housing, Bureau of Labor Statistics (BLS) collects data on the contract rent, that is, the rent paid by tenants and received by landlords, and any rent reductions.

MPF (Market Product Facts) rent data on multi-housing rents and vacancy rates (VAC) are collected and estimated by M/PF Research Company.[43] M/PF maintains a database of over 25,000 professionally managed rental properties (over 5 million units) in 59 markets nationwide and surveys over half of these properties every quarter. Thus, M/PF's quarterly sample accounts for about 40 percent of 12.5 million rental multi-housing units in properties with 5 or more units in structure estimated to exist across the 59 markets which it surveys.

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42 See http://www.bls.gov/cpi/

43 M/PF Research is a Dallas-based company focusing on multi-housing-market intelligence since 1961. (http://www.mpfresearch.com/)

Rent and vacancy data are collected through questionnaires completed by multi-housing community owners or managers. MPF Rent obtained through quarterly MPF surveys represent effective rates that take into account the impact of concessions offered in the form of free-rent periods or prorated discounts. Vacancy rate (VAC) is estimated from the surveyed gross occupancy, comparing the number of physically occupied units to the existing unit count. Information is collected by individual floor plan, rather than by general bedroom type or by property average, and a project's overall occupancy reflects results weighted by the number of units in each floor plan. Trends in total and common sample vacancy rates closely track each other, but because total sample represents a larger number of properties its measure of vacancy is considered more reliable.

Table 5.1 Data Used for the Estimation of the Rent Adjustment Equation

Variable	Definition	Data Description	Data Source
Government Index Rent	CPI Rent	Contract rent for the same housing quarterly surveyed by the government for 1985-2002 period	Bureau of Labor Statistics (BLS)
Market Rent	MPF Rent	Asking rent for vacant spaces proposed by landlord for 1985-2002 period	M/PF Research Company
Vacancy Rate at time t	VAC (t)	Estimated from the surveyed gross occupancy, comparing the number of physically occupied units to the existing unit count for 1993-2002 period.	M/PF Research Company

2. Rent Growth and Volatility

Exhibit 5.2 shows the quarterly average percentage of changes in rents and the volatility in each rent which is expressed by standard deviation. As can be seen from Exhibit 5.2, multifamily housing rents vary significantly across the markets. The average percentage changes of both CPI rent and MPF rent show almost the same rates, ranging from 0.4% to1.2%. However, the range of standard deviation for MPF rent is three times as large as that of CPI rent.

Exhibit 5.2 Average Quarterly Rent Growth Rate and Standard Deviation

Average Rent Growth and Standard Deviation[1]

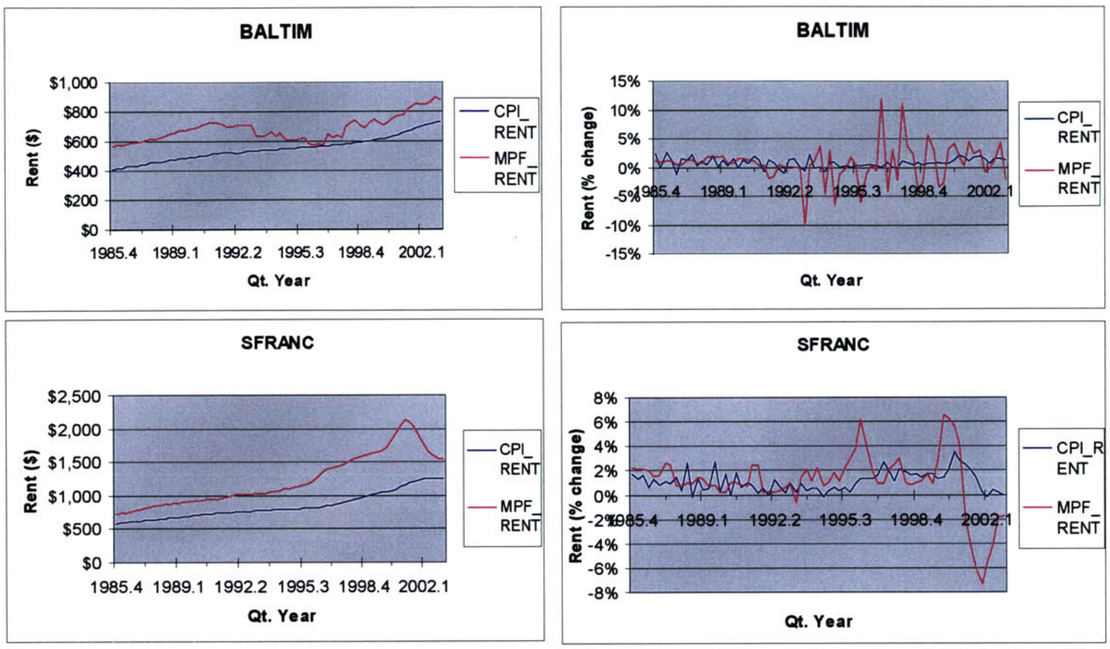
Metropolitan Area[2]	CPI Rent		MPF Rent	
	Growth rate[3]	Standard deviation[4]	Growth rate[3]	Standard deviation[4]
ATLANT	0.8%	0.8%	0.7%	0.8%
BALTIM	0.9%	0.8%	0.7%	3.3%
BOSTON	1.1%	1.1%	1.2%	1.3%
CHICAGO	1.0%	0.6%	0.7%	1.1%
CINCINATI	0.7%	0.5%	0.6%	1.3%
CLEVEL	0.8%	0.9%	0.3%	1.7%
DALLAS	0.7%	0.9%	0.7%	0.9%
DENVER	0.8%	1.1%	0.7%	1.3%
DETROI	0.7%	0.8%	0.5%	1.1%
FORTWO	0.7%	0.9%	0.7%	0.8%
HOUSTO	0.8%	1.2%	0.6%	1.6%
KANSAS	0.7%	0.7%	0.6%	1.1%
LANGEL	0.8%	0.8%	1.1%	1.6%
MIAMI	0.8%	1.2%	0.7%	1.1%
MINNEA	0.8%	0.6%	0.9%	1.3%
PHILAD	0.8%	0.8%	0.6%	1.3%
PITTSB	0.6%	0.7%	0.9%	1.6%
PORTLA	0.9%	0.6%	0.5%	1.0%
SDIEGO	0.9%	0.8%	0.9%	1.4%
SEATTL	0.9%	1.0%	0.7%	1.2%
SFRANC	1.1%	0.8%	1.1%	2.5%
SLOUIS	0.5%	0.9%	0.6%	1.1%
TAMPA	0.8%	0.4%	0.7%	1.0%
WASHIN	0.9%	1.1%	0.8%	1.3%

Notes: 1 estimated based on data from 1986:1 to 2002:4
2 cities listed in an alphabetical order
3 quarterly average percentage change in rents for each city
4 quarterly standard deviation of rents for each city

Figure 5.2.1 shows the cases of Baltimore and San Francisco. Both markets reveal three to four times bigger standard deviations in MPF rent than those in CPI rent. The MPF rent in Baltimore is more volatile in 1990s, whereas that of San Francisco is more volatile in late 1990s and early 2000s.[44]

[44] See Appendix for the graphs of all metropolitan areas examined

Figure 5.2.1 Rent and Percentage Change in Rents in Baltimore and San Francisco

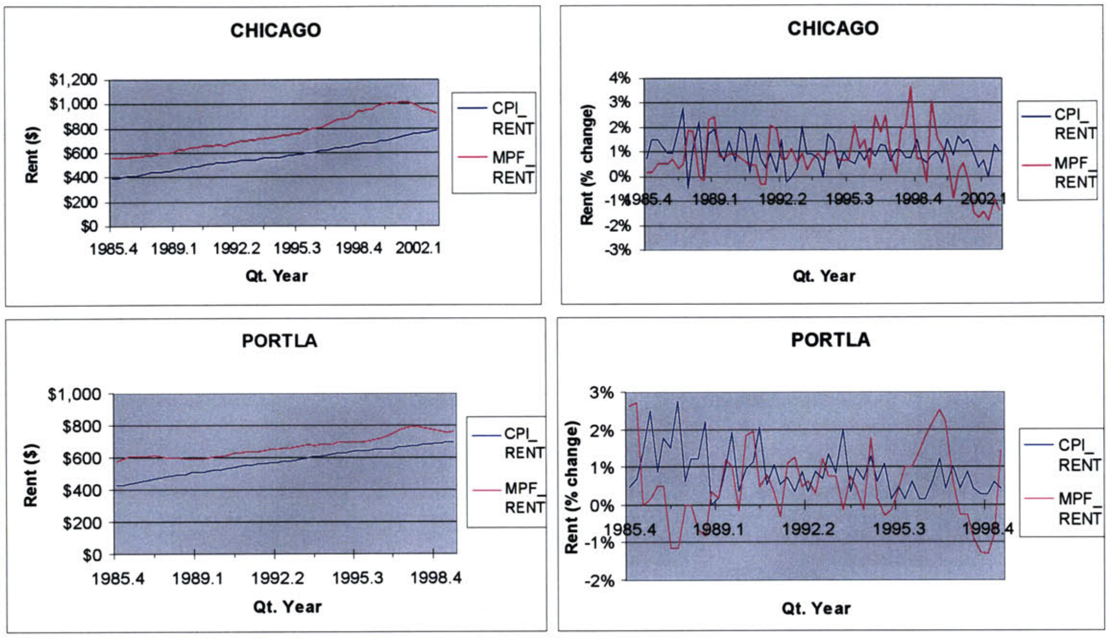


On the other hand, both CPI rent and MPF rent in Chicago and Portland are less volatile than the other metropolitan areas. Figure 5.2.2 shows that the range of percentage changes in CPI and MPF rents are not very different.

It is interesting to note that there are significant ranges of standard deviations for each market even though the average rent growth rates remain relatively stable. It is also noticeable that four of twenty four metropolitan areas are equal to or more volatile in CPI rents than in MPF rents. In general, MPF rents are more volatile than CPI rents because the landlord can increase or decrease the asking price more quickly in response to the market economy.[45] However, this data analysis shows that CPI rents can be more volatile in some metropolitan areas, depending on individual market situations as well as the searching behaviors of the tenants or landlords.

[45] It indicates that the asking rents suggested by landlords are more sensitive to their market situations than CPI rent.

Figure 5.2.2 Rent and Percentage change in rents in Chicago and Portland

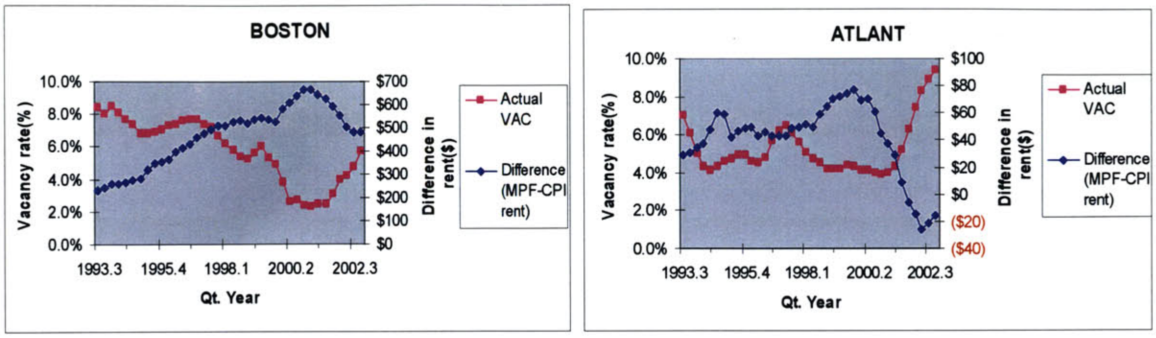


3. Relationships between Rent and Vacancy Rate

Figure 5.3.1 compares the actual vacancy rate with the difference between MPF rent and CPI rent in Boston and Atlanta.[46] A visual inspection of Figure 5.3.1 reveals a strong rent adjustment mechanism. When vacancy is above average, the difference of rents is falling, and in the opposite case, the difference of rents rises. The gap between MPF rent and CPI rent could be explained as follows: When the market situation is fluctuating, how fast the rents adjust to the change is different for both rents, and it causes the gap between MPF and CPI rents at certain point. If the market softens, the vacancy rate gets higher and the gap of two rents becomes smaller. Landlord cannot ask too much higher rent than the actual rent when the market is softening. Boston and Atlanta reveal a significant contrast in high vacancy rate and the gap between two rents in early 2000.

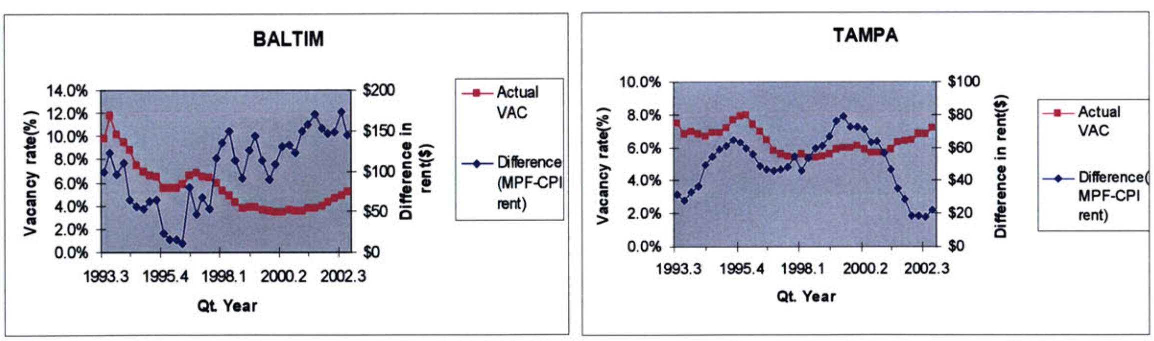
[46] See Appendix for the graphs of all the metropolitan cities

Figure 5.3.1 Vacancy Rate and Rent Differences in Boston and Atlanta



While Boston and Atlanta are characterized by their negative relationship between vacancy rate and rent difference, some other metropolitan areas do not show the same kind of reverse relationships (see Figure 5.3.2).[47] For example, in the cases of Baltimore and Tampa, the rent difference and vacancy rate are not in mutually reversed patterns. This tendency can be interpreted that there are other factors that have strong impact on rents rather than vacancy rates.

Figure 5.3.2 Vacancy Rate and the Rent Differences in Baltimore and Tampa



This result implies the behavior of landlords experimenting in setting rents to test the market; Landlords typically start with a high rent to see if it would be accepted quickly before lowering the reservation price in an effort to shorten the duration of the vacancy. If the market turns out to be stronger than expected, the vacant space would be

[47] See Appendix for the graphs of all the metropolitan cities

leased more quickly than anticipated, and the steady-state level of vacancy becomes lower than the "optimal" level. If the market is weaker than expected, the opposite is true. Therefore this analysis result provides the basic explanation why the rent adjustment mechanism happens in general.

4. Lag Correlation Analysis between CPI Rents and MPF Rents

A correlation analysis including lag difference was used in order to find the relationship between CPI rent and MPF rent. This analysis focuses on how much one rent is correlated with the other, considering the time difference. In reference to the relationship between vacancy rate and rent differences described in the previous chapter, one could assume that the speed of adjustment to the market situation (demand and supply shock) can be different for each rent. If one rent is adjusting faster than the other, it could be assumed that the rent is correlated more with the other 'one lag-behind' rent. Since the data is estimated quarterly, one quarter lag is equivalent to three months and two quarter lags are six months. Exhibit 5.4 shows the result of the lag correction analysis. In general, five metropolitan areas – Dallas, Denver, Fort Worth, Houston, and Kansas City-- have high correlation in 0, 1, and 2 quarter lags time periods. It is interesting that eight out of twenty four metropolitan cities show higher correlation in accordance with the increase in lags. In the case of San Francisco, for example, while CPI rent and MPF rent in the same period show 29% correlation, CPI rent and one lag-behind MPF rent show a 42% correlation. Furthermore, CPI rent and two lag-behind MPF rents show much higher correlation(52%). This observation explains that the landlords respond more swiftly to the market situation and they set asking price based on that. In other words, the asking rents are forward-looking indications of market conditions. In comparison to the asking rent, actual rents for the current housing respond more slowly.

Exhibit 5.4 Summary of the Lag Correlation Analysis

	Lag Correlation Summary (0,1,2 Lags)[1]				
Metropolitan Area[2]	*0 lag*	*1 lag*		*2 lags*	
	CPIt & MPFt	CPIt & MPFt-1	CPIt-1 & MPFt	CPIt & MPFt-2	CPIt-2 & MPFt
ATLANT	-1%	13%	1%	**29%**	-2%
BALTIM	**20%**	9%	4%	15%	5%
BOSTON	**37%**	11%	0%	23%	5%
CHICAGO	6%	12%	-8%	1%	4%
CINCINATI	-22%	-20%	-21%	-3%	-18%
CLEVEL	6%	-3%	-7%	-10%	-8%
DALLAS	**44%**	**44%**	**50%**	**52%**	**38%**
DENVER	**50%**	**46%**	**48%**	**55%**	**41%**
DETROI	3%	-9%	4%	-5%	-1%
FORTWO	**50%**	**45%**	**47%**	**45%**	**45%**
HOUSTO	**42%**	**45%**	**47%**	**45%**	**45%**
KANSAS	**35%**	**37%**	**34%**	**54%**	28%
LANGEL	9%	24%	20%	30%	3%
MIAMI	-22%	2%	8%	3%	-6%
MINNEA	2%	2%	8%	3%	-6%
PHILAD	-10%	-3%	-7%	5%	1%
PITTSB	-19%	2%	-26%	5%	-11%
PORTLA	-19%	6%	-22%	**25%**	-22%
SDIEGO	26%	**33%**	**34%**	**41%**	27%
SEATTL	13%	20%	16%	**28%**	10%
SFRANC	**29%**	**42%**	6%	**52%**	-14%
SLOUIS	11%	-8%	1%	8%	**27%**
TAMPA	-5%	-3%	-1%	-4%	-10%
WASHIN	18%	18%	7%	14%	5%

Notes: 1 estimated using data from 1986:1 to 2002:4
2 cities ordered by alphabetical order

The reason why the lag correlation result is different for each Metropolitan area could be explained with the following interpretations: First, as is demonstrated in Wheaton's searching behavior model[48], if the market turns out to be stronger than expected, vacant space will be leased more quickly than anticipated, and the steady-state level of vacancy would be lower than the "optimal" level. If the market is weaker than expected, the opposite becomes true. Rational landlords presumably learn from their own

[48] Wheaton (1990)'s model of search in the housing market assumes that buyers and sellers have equal (symmetric) information. Thus one party may set an asking price, but actual prices are the result of bargaining between the two prices, each of who knows the other's options.

mistakes, and in subsequent periods adjust rents up (or down) in response to a vacancy rate that was overly low (high). This is the adjustment price process that empirical research seeks to identify (Wheaton, 1988).

Second, even though there is no clear link to a theoretical framework, this time (lag) difference between rents may well be explained by tenants' behavior. In spite of the demand or supply shock, it is possible that the tenants would not want to move out for some reasons. One might prefer to be adjacent to his/her job and to be close to their relatives. Others might have location-based preference. These kinds of demographic and location related reasons make tenants stay at their housing units longer even though asking rents become higher, which results in lag correlation between CPI rents and MPF rents.

Chapter 6 : Rent Adjustment Mechanism: Empirical Results

1. Overview

In order to explain the rent adjustment mechanism, a regression analysis is performed. Since vacancy rate data is available only from 1993, the time period for the regression analysis is 10 years (40 quarters). For this analysis, quarterly estimated rent and vacancy data are used.

The proposed model discussed in Chapter 4 is estimated for each metropolitan area in the sample. The vacancy rate is represented as lagged one, two, and zero quarters. These results should be viewed with some caution because of the addition or substitution of even one-quarter vacancy might affect the magnitudes of the coefficients of the explanatory variables, along with the precision of the measurement. However, it is generally assumed that only one or two quarters of the total forty quarters do not affect the result significantly.

The following procedure for analysis is adopted: First, the originally estimated model that includes one quarter lag on the vacancy rate is discussed. The model which include no lag on the vacancy rate and two quarter lags on the vacancy rate are tested next. Finally, the best fitting model for each metropolitan area is selected and the implications of the results are discussed.

2. Regression Analysis Outcomes

Exhibit 6.2 shows the results of the regression analysis performed based on the model which includes one quarter lag on the vacancy rate. The parameters of equations estimated for twenty-four metropolitan areas are reported. These areas vary in terms of market size, current market conditions, and regional location, but have some common patterns in the estimated coefficients, as well as some interesting differences among markets.

First, the model generally fits for the assumption that rent change is in an inverse relationship with vacancy rate. Looking at coefficient (b), which shows rental sensitivity to vacancy rate, nineteen out of twenty four metropolitan areas have negative coefficient b with MPF rent adjustment model and twenty two out of twenty four metropolitan areas have negative coefficient b with CPI rent adjustment model. For the metropolitan areas which have negative coefficient b, fourteen out of nineteen metropolitan areas are statistically significant with MPF rent adjustment model and seven out of twenty two metropolitan areas are significant with CPI rent adjustment model at 95% level. This indicates that even though both rents have negative relationship with one lagged vacancy rates for most metropolitan areas, CPI rent adjustment model does not perform well, in that only seven out of twenty two metropolitan areas are statistically significant. In terms of sensitivity, the MPF rents in Chicago, Minneapolis, San Diego, and San Francisco show high sensitivity to one quarterly lagged vacancy rates which indicate –7.44, -8.33, -8.63, and –29.89, respectively.

The second coefficient of interest is that for $R_{(t-1)}$. Considering that the coefficient 'c' determines how quickly the rent changes in response to the vacancy rate[49], the fact that only six out of twenty four metropolitan areas -- Cleveland, Dallas, FortWorth, Kansas City, Portland, and Tampa -- have negative coefficient c with CPI rent adjustment model indicates that this model performs poorly. On the other hand, twenty out of twenty four metropolitan areas show negative coefficient c with MPF rent adjustment model. For

[49] If the given equation R(t)-R(t-1)=a+bVAC(t-1)+cR(t-1) equals zero, the equilibrium status of rent becomes $R* = \frac{[a + b\,VAC(t)]}{-c}$. Since rent and structured vacancy rate(a) are always positive, the coefficients (c) should be negative (see the chapter 4).

the metropolitan areas which have negative coefficient c, only one of six metropolitan areas –Tampa-- is statistically significant with CPI rent adjustment model and seven out of twenty two metropolitan areas are significant with MPF rent adjustment model at 95% level. This indicates that the model is not very suitable for explaining the CPI rent adjustment mechanism for most of the metropolitan areas.[50] Among these twenty four metropolitan areas, thirteen metropolitan areas[51] have a substantial adjusted R square at above 30% level for the MPF model.

In sum, the model which includes one quarter lag on the vacancy rate much better explains the MPF rent adjustment mechanism than the CPI rent adjustment model. It is useful to verify if this finding can be generalized with different lagged vacancy model. A possible explanation for this is described as follows.

[50] This is also the case with metropolitan areas with positive coefficient c. For example, using CPI rent model in Baltimore, Los Angeles, San Diego, and San Francisco has a high adjusted R square and seem to fit the model quite well at a first glance. However, regarding the coefficient c which is supposed to be negative, all four coefficients have positive signs. For example, even though San Francisco and San Diego have high R squares in CPI rent which are 73% and 67%, respectively, the coefficients c for both cities are positive signs which are 0.06 and 0.03, respectively.

[51] Atlanta, Chicago, Cincinnati, Dallas, Denver, FortWorth, Kansas City, Minneapolis, Pittsburgh, San Diego, Seattle, San Francisco, and Washington.

Exhibit 6.2 Result of Analysis based on the Model including One Quarter Vacancy Lag

Regression Result using one Vacancy Lag[1]

R(t) - R(t-1) = a + b VAC(t-1) + c R(t-1)

Metropolitan Area[2]	MPF_RENT a[3] (Std. Err)	MPF_RENT b[4] (Std. Err)	MPF_RENT c[5] (Std. Err)	MPF_RENT Adj. R^2	CPI_RENT a[3] (Std. Err)	CPI_RENT b[4] (Std. Err)	CPI_RENT c[5] (Std. Err)	CPI_RENT Adj. R^2
ATLANT	51.51	-1.52	-0.05	0.51	16.22	-1.38	0.00	0.06
	(7.45)	(0.48)	(0.01)		(8.69)	(0.71)	(0.01)	
BALTIM	34.61	-2.00	-0.02	-0.04	-23.14	-0.40	0.05	0.61
	(49.31)	(2.49)	(0.06)		(7.26)	(0.27)	(0.01)	
BOSTON	128.65	-5.72	-0.06	0.08	6.14	-1.53	0.02	0.35
	(54.03)	(3.40)	(0.03)		(16.49)	(0.85)	(0.02)	
CHICAGO	86.27	-7.44	-0.05	0.31	2.39	-0.78	0.01	0.07
	(19.05)	(2.02)	(0.02)		(5.02)	(0.57)	(0.01)	
CINCINATI	89.21	-3.01	-0.09	0.55	1.52	-0.13	0.01	-0.04
	(12.60)	(0.54)	(0.01)		(4.81)	(0.18)	(0.01)	
CLEVEL	-14.46	2.55	0.00	0.22	24.08	-0.76	-0.03	0.10
	(31.54)	(1.06)	(0.04)		(11.06)	(0.31)	(0.02)	
DALLAS	50.48	-3.64	-0.04	0.76	18.47	-1.23	-0.01	0.10
	(4.20)	(0.35)	(0.00)		(6.93)	(0.50)	(0.01)	
DENVER	35.39	-3.37	-0.02	0.60	15.54	-1.29	0.00	0.04
	(5.33)	(0.48)	(0.01)		(6.94)	(0.72)	(0.01)	
DETROI	46.65	-2.50	-0.04	0.13	-15.17	0.84	0.03	0.15
	(23.41)	(1.08)	(0.03)		(7.40)	(0.53)	(0.01)	
FORTWO	42.05	-2.40	-0.04	0.33	24.01	-1.37	-0.02	0.07
	(8.23)	(0.58)	(0.01)		(9.69)	(0.63)	(0.01)	
HOUSTO	11.14	-1.23	0.01	0.29	-0.35	-0.23	0.01	-0.01
	(5.66)	(0.31)	(0.01)		(7.36)	(0.33)	(0.01)	
KANSAS	53.34	-2.76	-0.05	0.43	11.18	-0.53	-0.01	-0.01
	(9.36)	(0.59)	(0.01)		(7.24)	(0.44)	(0.01)	
LANGEL	-113.02	2.27	0.19	0.35	-6.13	-1.06	0.03	0.58
	(35.48)	(1.37)	(0.05)		(19.19)	(0.57)	(0.02)	
MIAMI	15.45	0.52	-0.02	0.02	2.75	-0.47	0.01	0.04
	(17.07)	(0.64)	(0.02)		(11.91)	(0.33)	(0.02)	
MINNEA	129.67	-8.33	-0.11	0.51	5.23	-1.32	0.01	0.23
	(19.51)	(1.67)	(0.02)		(5.77)	(0.45)	(0.01)	
PHILAD	55.36	0.26	-0.06	0.07	-1.03	-0.30	0.01	0.03
	(43.09)	(1.23)	(0.04)		(15.47)	(0.44)	(0.02)	
PITTSB	65.04	1.22	-0.09	0.33	5.00	-0.37	0.00	-0.03
	(17.45)	(1.13)	(0.02)		(8.89)	(0.37)	(0.02)	
PORTLA	35.34	-1.13	-0.03	0.02	18.37	-0.60	-0.02	0.09
	(18.62)	(1.18)	(0.02)		(5.92)	(0.41)	(0.01)	
SDIEGO	73.44	-8.63	-0.03	0.30	2.70	-3.39	0.03	0.67
	(21.94)	(2.21)	(0.02)		(9.28)	(0.82)	(0.01)	
SEATTL	52.16	-5.43	-0.03	0.48	6.54	-2.29	0.01	0.34
	(10.83)	(1.05)	(0.01)		(5.28)	(0.50)	(0.01)	
SFRANC	139.43	-29.89	-0.01	0.44	-15.79	-8.62	0.06	0.73
	(35.43)	(5.79)	(0.02)		(5.21)	(0.91)	(0.01)	
SLOUIS	19.71	-0.30	-0.02	-0.02	4.83	-0.27	0.00	-0.03
	(14.91)	(0.72)	(0.02)		(8.81)	(0.30)	(0.02)	
TAMPA	52.30	-2.31	-0.05	0.21	52.30	-2.31	-0.05	0.21
	(14.45)	(1.10)	(0.02)		(14.45)	(1.10)	(0.02)	
WASHIN	-36.16	-0.32	0.06	0.56	-2.66	0.95	0.00	-0.04
	(6.34)	(0.39)	(0.01)		(16.27)	(1.26)	(0.02)	

Notes: * significant at the 95% level
1 estimated using data from 1993:3 to 2002:4
2 cities ordered by alphabetical order
3 structural vacancy rate
4 sensitivity to vacancy
5 how quickly rent changes in response to vacancy

3. Lag Analysis Outcomes

In the previous section, the model which includes one quarter lag on the vacancy rate explains the MPF rent adjustment mechanism much better than the CPI rent adjustment model. Is this because CPI rents have slower adjustments than MPF rents? If so, a two-quarter lag on the vacancy rate might work better. In this section, the two alternative models which include unlagged vacancy rate and two-quarter lag on the vacancy rate are tested. Exhibits 6.3.1 and 6.3.2 show the results of the regression analyses.

First, in terms of MPF rent, twenty out of twenty four metropolitan areas have negative coefficient b with unlagged vacancy model and eighteen out of twenty four metropolitan areas have negative coefficient b with two vacancy lag model. In terms of CPI rents, twenty three out of twenty four metropolitan areas show negative coefficient b with both no vacancy lag and two vacancy lag model. For the metropolitan areas which have negative coefficient b, fifteen out of twenty metropolitan areas are statistically significant with MPF rent adjustment model and seven out of twenty three metropolitan areas are significant with CPI rent adjustment model at 95% level with unlagged vacancy model. With two vacancy lag model, thirteen of twenty three metropolitan areas are statistically significant with MPF rent adjustment model and seven out of twenty three metropolitan areas are significant with CPI rent adjustment model at 95% level. These significance levels for both models are not different from that for one lagged vacancy model.

Second, considering that the coefficient 'c' determines how quickly the rent changes in response to the vacancy rate, it is noticeable that no vacancy lag model is a somewhat better fit than two vacancy lag model in MPF rent. However, using CPI rents instead of MPF rents yielded a poorer fit. For example, in terms of MPF rent, twenty out of twenty four metropolitan areas in no vacancy lag model and eighteen out of twenty four metropolitan areas in two vacancy lag model show negative coefficient c. In terms of CPI rent, only three out of twenty four metropolitan areas in no vacancy lag model and eight out of twenty four metropolitan areas in two vacancy lag model show negative coefficient c. For the metropolitan areas which have negative coefficient c, eleven out of twenty metropolitan areas are statistically significant with MPF rent adjustment model, but none of three metropolitan areas are significant with CPI rent adjustment model at 95% level with unlagged vacancy model. With two vacancy lag model, eleven out of eighteen metropolitan areas are statistically significant with MPF rent adjustment model, but only one out of eight metropolitan areas is significant with CPI rent adjustment model at 95% level. This result shows that both unlagged and two vacancy lagged rent adjustment models do not explain the CPI rent adjustment mechanism.

Third, the timing for the effect of no-quarter and two-quarter vacancy rent differences on multifamily housing rents, reflected in the number of quarters by which this rate is lagged, is not the same in all metropolitan areas. In terms of MPF rent, Dallas, Denver, Atlanta, Cincinnati, and Kansas City are explained significantly by both no lag and two quarter vacancy lag models.

In sum, this lagged analysis shows that no lag on the vacancy rate is a better fitting model than the two-vacancy lag model. It also shows that both unlagged and two vacancy lagged rent adjustment models do not explain CPI rent adjustment mechanism. The best fitting model for each metropolitan area is described in the following section.

Exhibit 6.3.1 Result of Analysis based on the Model including Unlagged Vacancy

Regression Result using no Vacancy Lag[1]

R(t) - R(t-1) = a + b VAC(t) + c R(t-1)

Metropolitan Area[2]	MPF_RENT				CPI_RENT			
	a[3] (Std. Err)	b[4] (Std. Err)	c[5] (Std. Err)	Adj. R^2	a[3] (Std. Err)	b[4] (Std. Err)	c[5] (Std. Err)	Adj. R^2
ATLANT	48.20	-1.63	-0.05	0.57	12.92	-1.13	0.00	0.04
	(6.71)	(0.41)	(0.01)		(8.79)	(0.70)	(0.01)	
BALTIM	27.33	-1.62	-0.02	-0.05	-22.41	-0.49	0.05	0.62
	(48.32)	(2.58)	(0.06)		(6.65)	(0.26)	(0.01)	
BOSTON	156.67	-7.95	-0.07	0.19	2.10	-1.41	0.02	0.36
	(43.23)	(2.80)	(0.02)		(13.93)	(0.75)	(0.01)	
CHICAGO	76.18	-6.78	-0.04	0.37	0.99	-0.70	0.01	0.07
	(16.00)	(1.61)	(0.01)		(4.57)	(0.50)	(0.01)	
CINCINATI	77.55	-2.84	-0.08	0.56	0.92	-0.10	0.01	-0.04
	(11.06)	(0.50)	(0.01)		(4.74)	(0.19)	(0.01)	
CLEVEL	-9.55	2.55	-0.01	0.19	15.28	-0.55	-0.01	0.02
	(33.44)	(1.23)	(0.04)		(10.48)	(0.33)	(0.02)	
DALLAS	41.21	-3.30	-0.02	0.85	12.93	-0.91	0.00	0.05
	(2.71)	(0.24)	(0.00)		(5.90)	(0.45)	(0.01)	
DENVER	32.51	-3.49	-0.01	0.79	15.35	-1.53	0.00	0.10
	(3.71)	(0.31)	(0.01)		(6.40)	(0.62)	(0.01)	
DETROI	40.68	-2.85	-0.03	0.19	-14.21	0.69	0.03	0.13
	(22.37)	(0.99)	(0.03)		(7.40)	(0.51)	(0.01)	
FORTWO	38.45	-2.41	-0.03	0.46	19.00	-1.16	-0.01	0.06
	(5.81)	(0.44)	(0.01)		(7.80)	(0.55)	(0.01)	
HOUSTO	11.65	-1.53	0.01	0.46	0.01	-0.32	0.01	0.00
	(4.75)	(0.27)	(0.01)		(7.15)	(0.33)	(0.01)	
KANSAS	49.86	-2.70	-0.04	0.47	10.46	-0.52	0.00	-0.01
	(8.42)	(0.53)	(0.01)		(6.87)	(0.42)	(0.01)	
LANGEL	55.85	-3.59	-0.02	0.06	-11.99	-0.88	0.03	0.58
	(49.99)	(2.98)	(0.03)		(18.34)	(0.54)	(0.02)	
MIAMI	9.65	0.76	-0.01	0.03	-2.39	-0.22	0.01	0.00
	(18.61)	(0.69)	(0.02)		(12.85)	(0.36)	(0.02)	
MINNEA	103.58	-6.59	-0.09	0.46	2.66	-1.41	0.01	0.28
	(16.80)	(1.50)	(0.02)		(5.02)	(0.42)	(0.01)	
PHILAD	38.04	0.94	-0.04	0.08	-0.41	-0.35	0.01	0.04
	(42.77)	(1.27)	(0.04)		(14.67)	(0.43)	(0.02)	
PITTSB	64.95	1.84	-0.10	0.35	4.26	-0.39	0.00	-0.03
	(16.46)	(1.23)	(0.02)		(8.67)	(0.40)	(0.02)	
PORTLA	41.59	-2.29	-0.03	0.11	15.98	-0.38	-0.01	0.06
	(16.13)	(1.09)	(0.02)		(5.63)	(0.42)	(0.01)	
SDIEGO	72.44	-9.15	-0.03	0.43	-3.78	-2.98	0.03	0.66
	(17.14)	(1.78)	(0.01)		(8.38)	(0.77)	(0.01)	
SEATTL	44.71	-5.02	-0.02	0.43	3.22	-2.17	0.02	0.30
	(10.97)	(1.08)	(0.01)		(5.39)	(0.52)	(0.01)	
SFRANC	129.01	-36.22	0.01	0.65	-18.52	-7.68	0.06	0.56
	(27.12)	(4.51)	(0.02)		(6.81)	(1.17)	(0.01)	
SLOUIS	17.67	-0.17	-0.02	-0.03	4.44	-0.26	0.00	-0.03
	(14.84)	(0.71)	(0.02)		(8.60)	(0.29)	(0.02)	
TAMPA	42.64	-1.54	-0.05	0.15	3.41	-0.67	0.01	0.03
	(13.74)	(1.10)	(0.02)		(6.98)	(0.59)	(0.01)	
WASHIN	4.56	-0.47	0.01	-0.05	-36.19	-0.36	0.06	0.56
	(16.44)	(1.29)	(0.02)		(6.32)	(0.40)	(0.01)	

Notes:
* significant at the 95% level
1 estimated using data from 1993:3 to 2002:4
2 cities ordered by alphabetical order
3 structural vacancy rate
4 sensitivity to vacancy
5 how quickly rent changes in response to vacancy

Exhibit 6.3.2 Result of Analysis based on the Model including Two Vacancy Lag

Regression Result using two Vacancy Lags[1]

R(t) - R(t-1) = a + b VAC(t-2) + c R(t-1)

Metropolitan Area[2]	MPF_RENT				CPI_RENT			
	a[3] (Std. Err)	b[4] (Std. Err)	c[5] (Std. Err)	Adj. R^2	a[3] (Std. Err)	b[4] (Std. Err)	c[5] (Std. Err)	Adj. R^2
ATLANT	52.75	-1.30	-0.06	0.43	19.23	-1.84	0.00	0.10
	(8.87)	(0.60)	(0.01)		(9.25)	(0.79)	(0.01)	
BALTIM	67.61	-4.15	-0.05	0.02	-21.42	-0.42	0.05	0.60
	(50.35)	(2.51)	(0.06)		(7.90)	(0.28)	(0.01)	
BOSTON	73.04	-1.55	-0.04	0.04	11.60	-1.62	0.01	0.31
	(63.12)	(3.84)	(0.03)		(19.93)	(1.00)	(0.02)	
CHICAGO	92.47	-7.13	-0.06	0.23	1.97	-0.54	0.01	0.03
	(24.62)	(2.66)	(0.02)		(6.02)	(0.68)	(0.01)	
CINCINATI	96.63	-3.02	-0.10	0.47	0.97	-0.22	0.01	0.00
	(15.98)	(0.67)	(0.02)		(5.01)	(0.19)	'(0.01)	
CLEVEL	-10.15	2.69	-0.01	0.28	19.77	-0.50	-0.02	0.00
	(29.61)	(0.96)	(0.03)		(13.03)	(0.35)	(0.02)	
DALLAS	58.56	-3.94	-0.05	0.62	23.30	-1.51	-0.01	0.10
	(6.81)	(0.55)	(0.01)		(8.65)	(0.61)	(0.01)	
DENVER	35.87	-2.86	-0.02	0.35	18.49	-1.22	-0.01	0.02
	(7.65)	(0.69)	(0.01)		(7.78)	(0.81)	(0.01)	
DETROI	56.29	-2.44	-0.06	0.09	-16.47	0.95	0.03	0.13
	(26.71)	(1.27)	(0.04)		(7.97)	(0.60)	(0.01)	
FORTWO	41.82	-2.16	-0.04	0.18	27.32	-1.51	-0.02	0.04
	(12.00)	(0.82)	(0.01)		(12.83)	(0.81)	(0.01)	
HOUSTO	8.89	-0.82	0.00	0.10	-5.26	-0.23	0.02	0.06
	(6.68)	(0.35)	(0.01)		(6.97)	(0.30)	(0.01)	
KANSAS	55.41	-2.60	-0.05	0.37	12.68	-0.53	-0.01	-0.01
	(10.85)	(0.65)	(0.01)		(7.72)	(0.45)	(0.01)	
LANGEL	-17.76	0.98	0.03	0.01	-9.30	-0.96	0.03	0.57
	(53.65)	(3.18)	(0.04)		(21.21)	(0.63)	(0.02)	
MIAMI	21.99	0.18	-0.02	0.00	23.16	-1.02	-0.02	0.25
	(17.93)	(0.64)	(0.02)		(10.31)	(0.28)	(0.01)	
MINNEA	168.84	-11.02	-0.15	0.58	7.59	-1.27	0.01	0.17
	(23.17)	(1.93)	(0.02)		(6.75)	(0.52)	(0.01)	
PHILAD	80.01	-0.86	-0.08	0.05	-4.57	-0.28	0.02	0.06
	(44.13)	(1.21)	(0.04)		(15.77)	(0.44)	(0.02)	
PITTSB	72.72	1.25	-0.10	0.34	3.52	-0.35	0.00	-0.03
	(18.67)	(1.14)	(0.02)		(9.37)	(0.37)	(0.02)	
PORTLA	15.80	0.51	-0.02	-0.02	19.88	-0.65	-0.02	0.10
	(20.52)	(1.25)	(0.02)		(6.40)	(0.43)	(0.01)	
SDIEGO	62.23	-7.13	-0.02	0.17	7.17	-3.53	0.02	0.67
	(26.42)	(2.61)	(0.02)		(9.67)	(0.84)	(0.01)	
SEATTL	59.09	-5.30	-0.04	0.46	8.09	-2.08	0.01	0.26
	(11.88)	(1.11)	(0.01)		(5.90)	(0.55)	(0.01)	
SFRANC	138.11	-20.36	-0.04	0.20	-9.80	-8.07	0.05	0.66
	(46.02)	(7.21)	(0.03)		(5.85)	(1.00)	(0.01)	
SLOUIS	30.75	-0.75	-0.03	0.02	15.09	-0.56	-0.02	0.05
	(15.63)	(0.72)	(0.02)		(8.97)	(0.29)	(0.02)	
TAMPA	68.67	-3.75	-0.06	0.31	7.48	-0.91	0.01	0.04
	(15.02)	(1.09)	(0.02)		(8.35)	(0.65)	(0.01)	
WASHIN	-8.84	2.20	0.00	0.03	-34.06	-0.44	0.06	0.55
	(16.33)	(1.24)	(0.02)		(6.39)	(0.38)	(0.01)	

Notes: * significant at the 95% level
1 estimated using data from 1993:3 to 2002:4
2 cities ordered by alphabetical order
3 structural vacancy rate
4 sensitivity to vacancy
5 how quickly rent changes in response to vacancy

4. Best Fitting Model for Each Metropolitan Area[52]

Up to now, the originally estimated model that includes one quarter lag on the vacancy rate has been tested, followed by the models which include no lag and two quarter lags on the vacancy rate. In this section, the best fitting model for each metropolitan area is selected and the implications of the results are discussed.

Exhibit 6.4 presents the estimation results of the best fitting model for twenty-four metropolitan areas. First, the result clearly indicates that the model with MPF rents is likely to be more powerful than the model with CPI rents in explaining the rent changes through time. Shaded cells indicate that either (or both) coefficient b or c is positive even though it is chosen to be the best fitting model.

In particular, fifteen out of twenty four metropolitan areas show the model with no lag on the vacancy rate for their best fitting model when considered in MPF rent. On the other hand, twelve out of twenty four metropolitan areas show the model with one quarter lag on the vacancy rate for their best fitting model.

Second, the rate of rental adjustment also varies considerably across metropolitan areas. Represented by the coefficient c, it ranges from –.08 in Philadelphia to –.01 in Denver and San Francisco. It is interesting to note that the markets located on the West Coast exhibit the lowest rate (considering absolute number) of rental adjustment. In particular, the rate of rental adjustment in San Diego, Los Angeles, and San Francisco is .03, .02, .01, respectively. The rate of adjustment seems to be also relatively slow in some major Eastern markets, such as Boston, Washington DC, and Philadelphia, which is estimated at .07, .06, .08, respectively.

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[52] The criteria for choosing the best fitting model are based on the answers for the following questions : first of all, which model has negative relationship between rents and vacancy rates? Secondly, which model has higher adjusted R square? Thirdly, which model has more statistically significant coefficients? Shaded cells indicate that either (or both) coefficient b or c is positive even though it is chosen to be the best fitting model. Usually the coefficients in all lagged models for shaded metropolitan area are all positive.

In sum, the model explains the MPF rent adjustment mechanism better than the CPI rent adjustment model. It is proved that this result is not due to timing variables, because CPI rents show poorer fit for lagged and unlagged vacancy models.

Why is it that CPI rents do not follow the conventional assumption of the rent adjustment mechanism for most of the metropolitan areas? The phenomenon that the actual rents surveyed for the same housing, does not show a strong negative relationship between rents and vacancy rates could be explained in two ways : one way of looking at it could be that the model used in this study is not relevant to explain the rent adjustment process. However, this explanation is difficult to be generalized because the model is proved to be quite useful in the case of MPF rents.

The other explanation is related to the behaviors of tenant and landlords. Tenants may have strong preferences for particular dwelling units that they have resided. Even when they decide to move, their search timing for new housing units is sensitive to their preferences. A tenant's expected search time will be longer or the willingness to accept a unit will be lower if he/she has more narrowly defined preference. Landlords may also have preference for certain tenants for their housing. It also costs advertising fee if there is vacancy for their housing. Moreover, landlords facing the same vacancy and significantly different absorption levels may perceive market strength, differently. Those preferences and perceptions may induce tenants not to move out and sometimes to endure increased rent and induce landlord not to increase rents too much even though market economy is changing. It may make CPI rents not respond to the market situation in an agile manner.

This calls for further studies to explore these possible explanations. Further research can help in explaining rent adjustment mechanism for both contract rents and asking rents, by better understanding the behavior of tenants and landlords.

Exhibit 6.4 Best Fitting Model for Each Metropolitan Area for 1993-2002

Regression Result of The Rent Adjustment Mechnism[1]

R(t) - R(t-1) = a + b VAC(t-Lag) + c R(t-1)

Metropolitan Area[2]	MPF_RENT a[3] (Std. Err)	MPF_RENT b[4] (Std. Err)	MPF_RENT c[5] (Std. Err)	MPF_RENT Adj. R^2	MPF_RENT Lag[6]	CPI_RENT a[3] (Std. Err)	CPI_RENT b[4] (Std. Err)	CPI_RENT c[5] (Std. Err)	CPI_RENT Adj. R^2	CPI_RENT Lag[6]
ATLANT	48.20	-1.63	-0.05	0.57	0	19.23	-1.84	0.00	0.10	2
	(6.71)	(0.41)	(0.01)			(9.25)	(0.79)	(0.01)		
BALTIM	67.61	-4.15	-0.05	0.02	2	-23.14	-0.40	0.05	0.61	1
	(50.35)	(2.51)	(0.06)			(7.26)	(0.27)	(0.01)		
BOSTON	156.67	-7.95	-0.07	0.19	0	2.10	-1.41	0.02	0.36	0
	(43.23)	(2.80)	(0.02)			(13.93)	(0.75)	(0.01)		
CHICAGO	76.18	-6.78	-0.04	0.37	0	0.99	-0.70	0.01	0.07	0
	(16.00)	(1.61)	(0.01)			(4.57)	(0.50)	(0.01)		
CINCINATI	76.18	-6.78	-0.04	0.37	0	0.97	-0.22	0.01	0.00	2
	(16.00)	(1.61)	(0.01)			(5.01)	(0.19)	'(0.01)		
CLEVEL	-10.15	2.69	-0.01	0.28	2	24.08	-0.76	-0.03	0.10	1
	(29.61)	(0.96)	(0.03)			(11.06)	(0.31)	(0.02)		
DALLAS	41.21	-3.30	-0.02	0.85	0	18.47	-1.23	-0.01	0.10	1
	(2.71)	(0.24)	(0.00)			(6.93)	(0.50)	(0.01)		
DENVER	32.51	-3.49	-0.01	0.79	0	18.49	-1.22	-0.01	0.02	2
	(3.71)	(0.31)	(0.01)			(7.78)	(0.81)	(0.01)		
DETROI	40.68	-2.85	-0.03	0.19	0	-15.17	0.84	0.03	0.15	1
	(22.37)	(0.99)	(0.03)			(7.40)	(0.53)	(0.01)		
FORTWO	38.45	-2.41	-0.03	0.46	0	24.01	-1.37	-0.02	0.07	1
	(5.81)	(0.44)	(0.01)			(9.69)	(0.63)	(0.01)		
HOUSTO	11.65	-1.53	0.01	0.46	0	-5.26	-0.23	0.02	0.06	2
	(4.75)	(0.27)	(0.01)			(6.97)	(0.30)	(0.01)		
KANSAS	49.86	-2.70	-0.04	0.47	0	11.18	-0.53	-0.01	-0.01	1
	(8.42)	(0.53)	(0.01)			(7.24)	(0.44)	(0.01)		
LANGEL	55.85	-3.59	-0.02	0.06	0	-11.99	-0.88	0.03	0.58	0
	(49.99)	(2.98)	(0.03)			(18.34)	(0.54)	(0.02)		
MIAMI	9.65	0.76	-0.01	0.03	0	23.16	-1.02	-0.02	0.25	2
	(18.61)	(0.69)	(0.02)			(10.31)	(0.28)	(0.01)		
MINNEA	7.59	-1.27	0.01	0.17	2	2.66	-1.41	0.01	0.28	0
	(6.75)	(0.52)	(0.01)			(5.02)	(0.42)	(0.01)		
PHILAD	80.01	-0.86	-0.08	0.05	2	-4.57	-0.28	0.02	0.06	2
	(44.13)	(1.21)	(0.04)			(15.77)	(0.44)	(0.02)		
PITTSB	64.95	1.84	-0.10	0.35	0	5.00	-0.37	0.00	-0.03	1
	(16.46)	(1.23)	(0.02)			(8.89)	(0.37)	(0.02)		
PORTLA	41.59	-2.29	-0.03	0.11	0	19.88	-0.65	-0.02	0.10	2
	(16.13)	(1.09)	(0.02)			(6.40)	(0.43)	(0.01)		
SDIEGO	72.44	-9.15	-0.03	0.43	0	2.70	-3.39	0.03	0.67	1
	(17.14)	(1.78)	(0.01)			(9.28)	(0.82)	(0.01)		
SEATTL	52.16	-5.43	-0.03	0.48	1	6.54	-2.29	0.01	0.34	1
	(10.83)	(1.05)	(0.01)			(5.28)	(0.50)	(0.01)		
SFRANC	139.43	-29.89	-0.01	0.44	1	-15.79	-8.62	0.06	0.73	1
	(35.43)	(5.79)	(0.02)			(5.21)	(0.91)	(0.01)		
SLOUIS	30.75	-0.75	-0.03	0.02	2	15.09	-0.56	-0.02	0.05	2
	(15.63)	(0.72)	(0.02)			(8.97)	(0.29)	(0.02)		
TAMPA	68.67	-3.75	-0.06	0.31	2	52.30	-2.31	-0.05	0.21	1
	(15.02)	(1.09)	(0.02)			(14.45)	(1.10)	(0.02)		
WASHIN	-36.16	-0.32	0.06	0.56	1	-36.19	-0.36	0.06	0.56	0
	(6.34)	(0.39)	(0.01)			(6.32)	(0.40)	(0.01)		

Notes: * significant at the 95% level
1 estimated using data from 1993:3 to 2002:4
2 cities ordered by alphabetical order
3 structural vacancy rate
4 sensitivity to vacancy
5 how quickly rent changes in response to vacancy
6 the best fitting model for each city : 0(using VACt), 1(using VACt-1), 2(using VACt-2)

PART 4 : EPILOGUE

Chapter 8 : Conclusion

This study has analyzed the rent adjustment mechanism for multifamily rental housing in the US during the period 1993-2003 for twenty-four US metropolitan areas. The rent adjustment model employed incorporates the principal argument of search theory that vacancy ultimately determines rent levels. Various time lags on the vacancy rate are tested for each metropolitan area in order to better understand the timing of the effect of the vacancy rate on market rents and to find the best fitting model for each metropolitan area. Two kinds of rents are analyzed : the CPI (Consumer Price Index), 'sitting tenant rent' actually paid by tenant, and MPF (Market Product Fact), the 'asking rent' for the vacant unit.

General trends and characteristics in rents are explicated by performing data analysis based on 17-year quarterly rent data during 1985-2003. Regression analysis is implemented using both time-series and cross-section data. A systematic methodological procedure has done for this research: First, the originally estimated model that includes one quarter lag on the vacancy rate is tested. Next, the models that include no lag on the vacancy rate and two quarter lags on the vacancy rate are evaluated. Finally, the best fitting model for each metropolitan area is selected followed by the implications of that model.

The twenty-four metropolitan areas in the US examined in this study show some interesting differences among markets but also share common patterns for the estimated coefficients at the same time. The results of this study also clearly indicate that the rent adjustment models under study explain the MPF rent adjustment mechanism better than the CPI rent adjustment model. The unlagged and two vacancy lagged rent adjustment models also do not explain CPI rent adjustment mechanism.

Several refinements and extensions of this study would be useful. First, use of a longer time-series of data for estimating rent adjustment equation would increase significance in the analysis results. Secondly, the outcomes of this study suggest further investigations to explore the behaviors of lessors and lessees to explain why CPI rents follow the conventional assumption of rent adjustment mechanism for most of the metropolitan areas. Further research can also help in explaining the rent adjustment mechanism for contract rents and asking rents, by verifying the behaviors of tenants and landlords.

This research possesses implications in both academic and practical domains. First, those findings identified through this research provide a reliable basis for advancing an improved theoretical and empirical formulation that highlights the complexities of the rent adjustment process. From a practical point of view, the results can help real estate investment analysts to better model and forecast rent changes in residential real estate market. A sophisticated model validated through extensive data sets – quarterly ten year time-series rent data for twenty four metropolitan areas in the US – and interesting mechanism between MPF and CPI rents would give investors a better insight into the up-to-date multifamily rental housing market behaviors.

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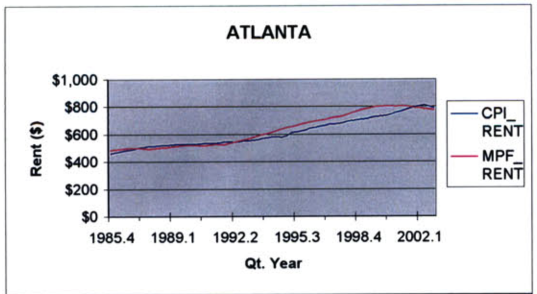
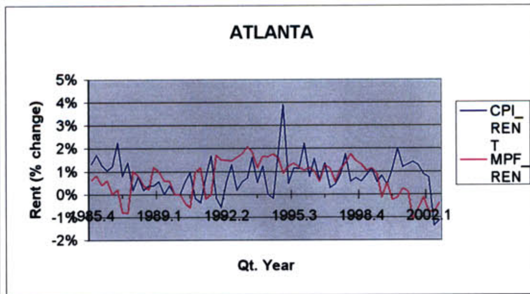
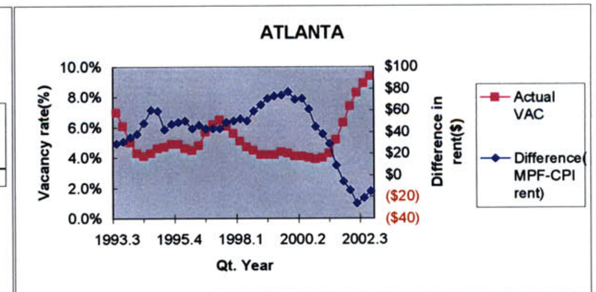
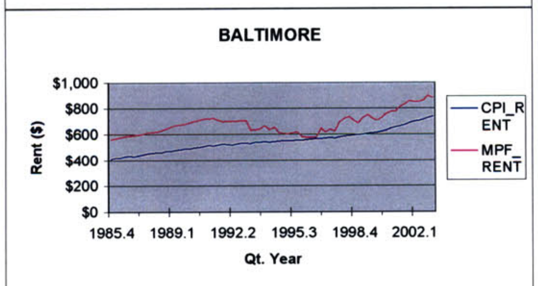
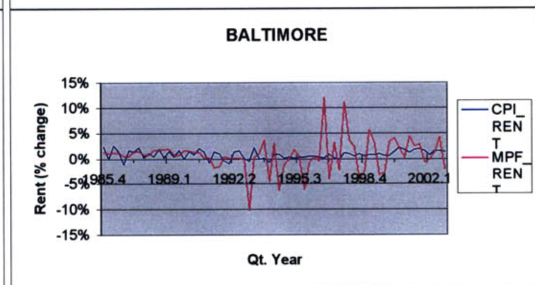
APPENDIX : RENT TRENDS (1985-2002), PERCENTAGE CHANGE IN RENT TRENDS (1985-2002), VACANCY RATE AND RENTS DIFFERENCE (1993-2002)

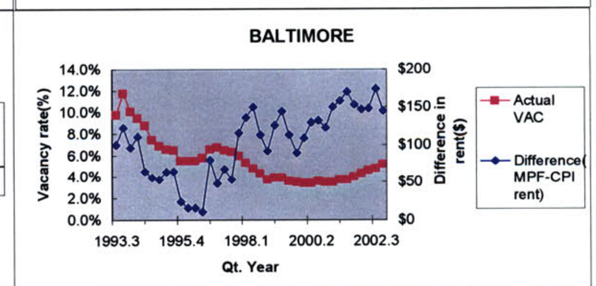


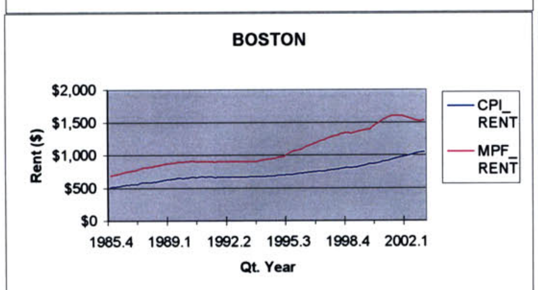


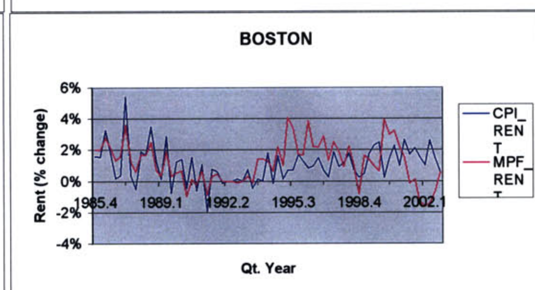


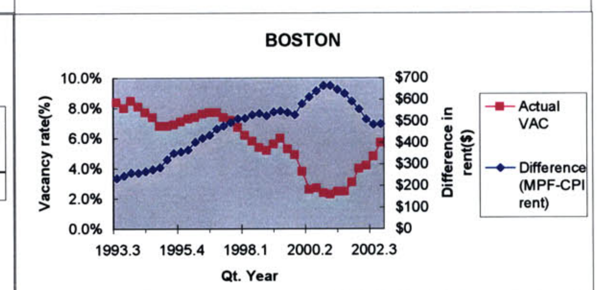


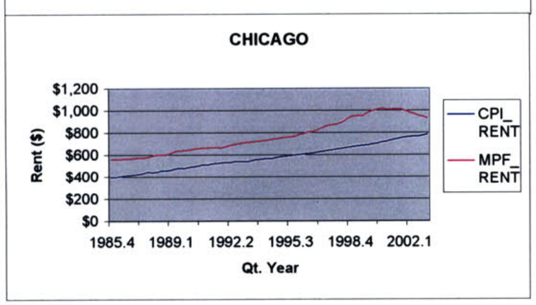


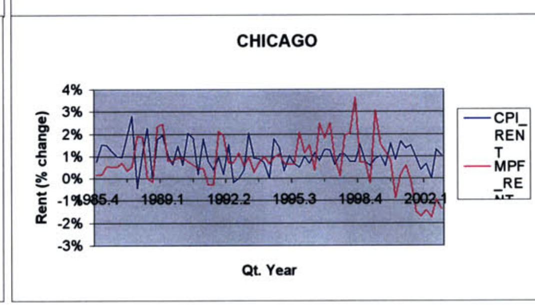


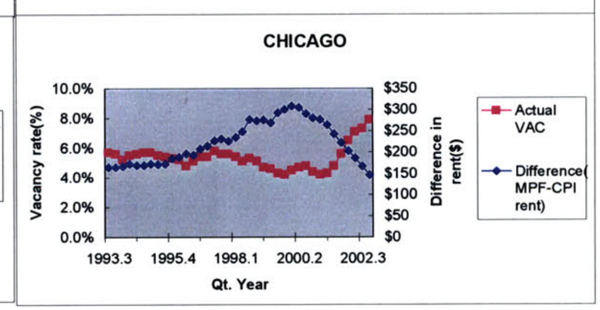


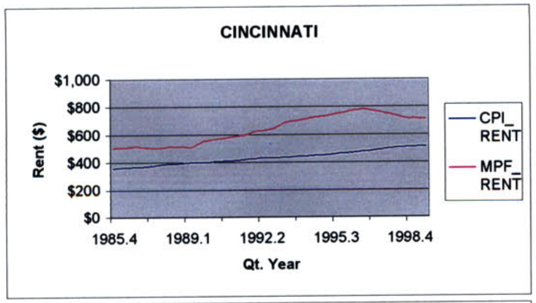


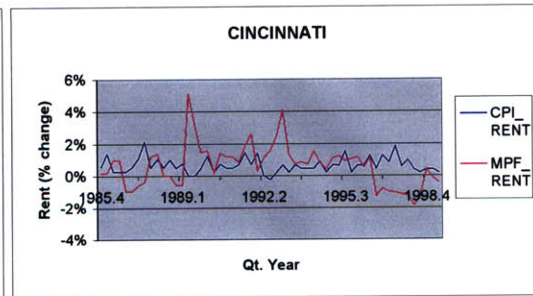


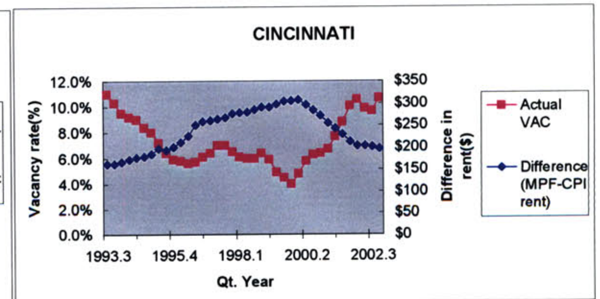


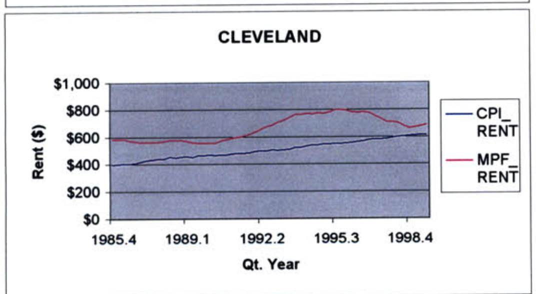


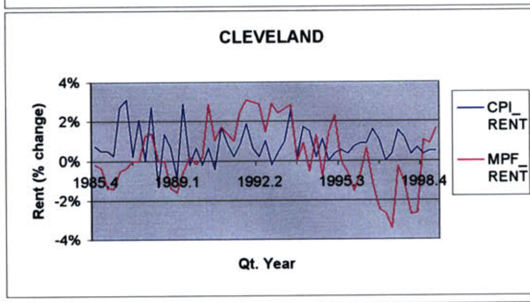


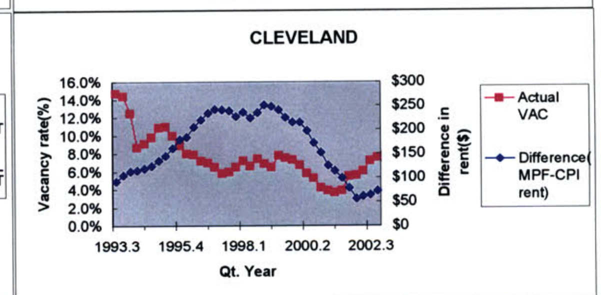

CINCINNATI
Rent ($)
$1,000
$800
$600
$400
$200
$0
1985.4
1989.1
1992.2
1995.3
1998.4
Qt. Year
CPI_RENT
MPF_RENT

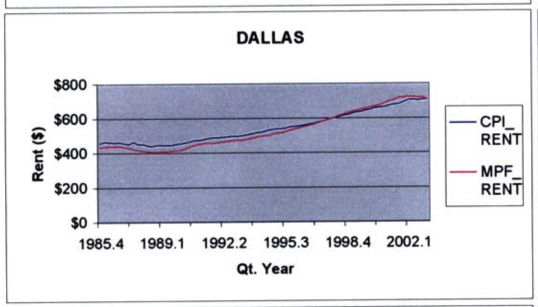

CINCINNATI
Rent (% change)
6%
4%
2%
0%
-2%
-4%
1985.4
1989.1
1992.2
1995.3
1998.4
Qt. Year
CPI_RENT
MPF_RENT

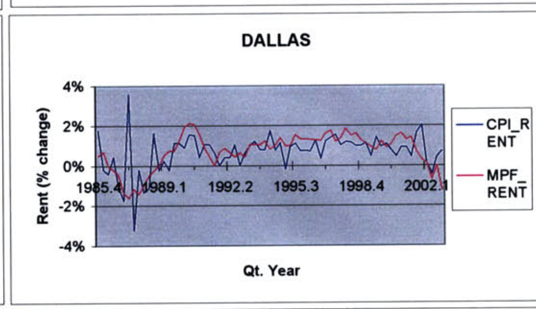

CINCINNATI
Vacancy rate(%)
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
$350
$300
$250
$200
$150
$100
$50
$0
Difference in rent($)
1993.3
1995.4
1998.1
2000.2
2002.3
Qt. Year
Actual VAC
Difference (MPF-CPI rent)

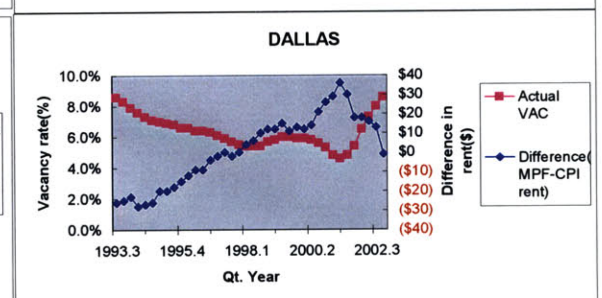

CLEVELAND
Rent ($)
$1,000
$800
$600
$400
$200
$0
1985.4
1989.1
1992.2
1995.3
1998.4
Qt. Year
CPI_RENT
MPF_RENT

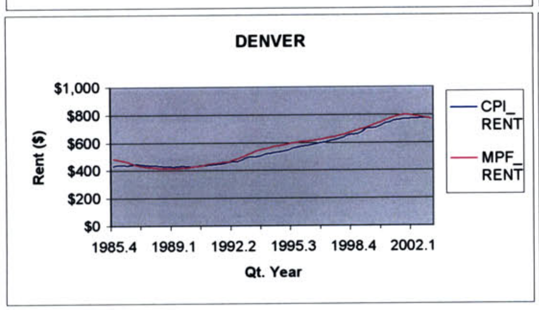

CLEVELAND
Rent (% change)
4%
2%
0%
-2%
-4%
1985.4
1989.1
1992.2
1995.3
1998.4
Qt. Year
CPI_RENT
MPF_RENT

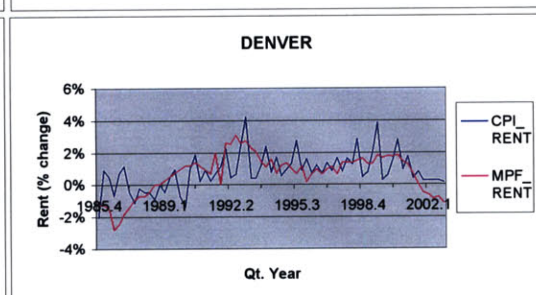

CLEVELAND
Vacancy rate(%)
16.0%
14.0%
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
$300
$250
$200
$150
$100
$50
$0
Difference in rent($)
1993.3
1995.4
1998.1
2000.2
2002.3
Qt. Year
Actual VAC
Difference(MPF-CPI rent)

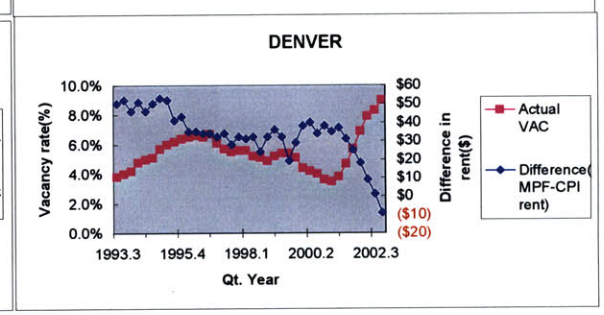

DALLAS
Rent ($)
$800
$600
$400
$200
$0
1985.4
1989.1
1992.2
1995.3
1998.4
2002.1
Qt. Year
CPI_RENT
MPF_RENT

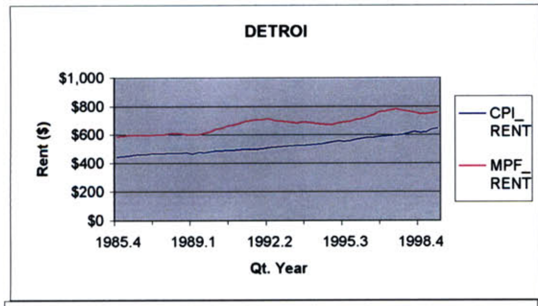

DALLAS
Rent (% change)
4%
2%
0%
-2%
-4%
1985.4
1989.1
1992.2
1995.3
1998.4
2002.1
Qt. Year
CPI_RENT
MPF_RENT

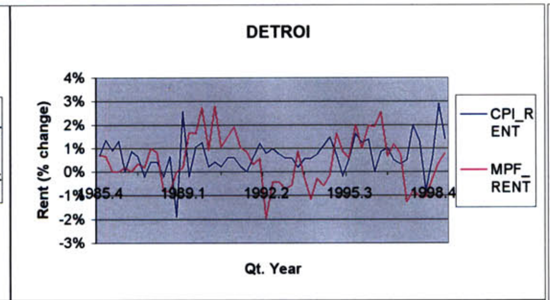

DALLAS
Vacancy rate(%)
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
$40
$30
$20
$10
$0
($10)
($20)
($30)
($40)
Difference in rent($)
1993.3
1995.4
1998.1
2000.2
2002.3
Qt. Year
Actual VAC
Difference(MPF-CPI rent)

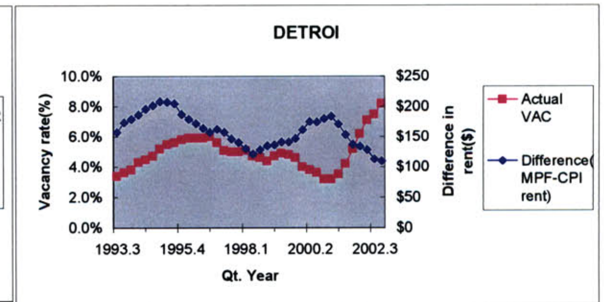

DENVER
Rent ($)
$1,000
$800
$600
$400
$200
$0
1985.4
1989.1
1992.2
1995.3
1998.4
2002.1
Qt. Year
CPI_RENT
MPF_RENT

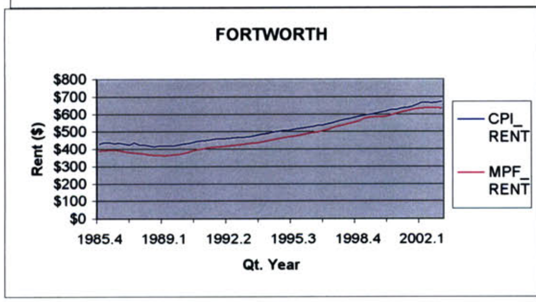

DENVER
Rent (% change)
6%
4%
2%
0%
-2%
-4%
1985.4
1989.1
1992.2
1995.3
1998.4
2002.1
Qt. Year
CPI_RENT
MPF_RENT

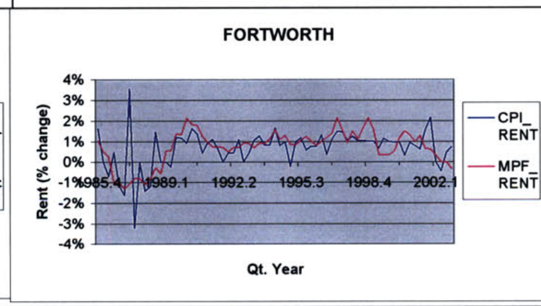

DENVER
Vacancy rate(%)
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
$60
$50
$40
$30
$20
$10
$0
($10)
($20)
Difference in rent($)
1993.3
1995.4
1998.1
2000.2
2002.3
Qt. Year
Actual VAC
Difference(MPF-CPI rent)

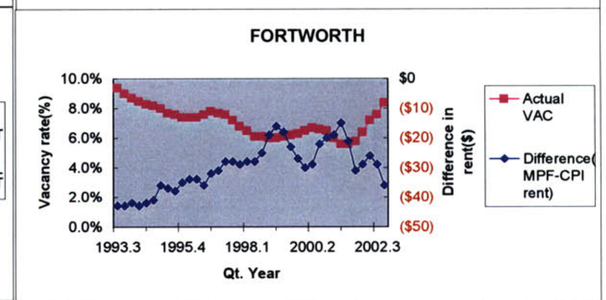

DETROI
Rent ($)
$1,000
$800
$600
$400
$200
$0
1985.4
1989.1
1992.2
1995.3
1998.4
Qt. Year
CPI_ RENT
MPF_ RENT

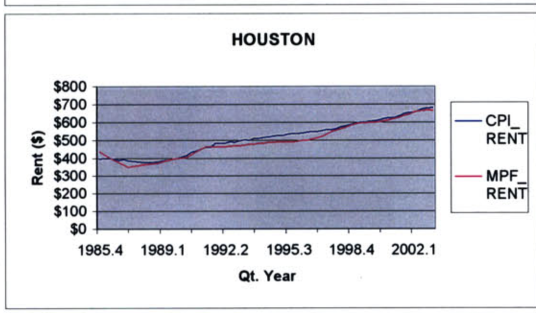

DETROI
Rent (% change)
4%
3%
2%
1%
0%
-1%
-2%
-3%
1985.4
1989.1
1992.2
1995.3
1998.4
Qt. Year
CPI_R ENT
MPF_ RENT

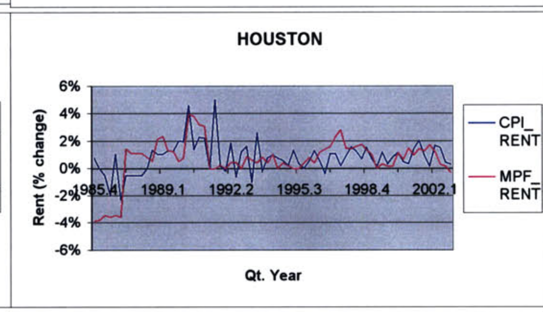

DETROI
Vacancy rate(%)
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
Difference in rent($)
$250
$200
$150
$100
$50
$0
1993.3
1995.4
1998.1
2000.2
2002.3
Qt. Year
Actual VAC
Difference(MPF-CPI rent)

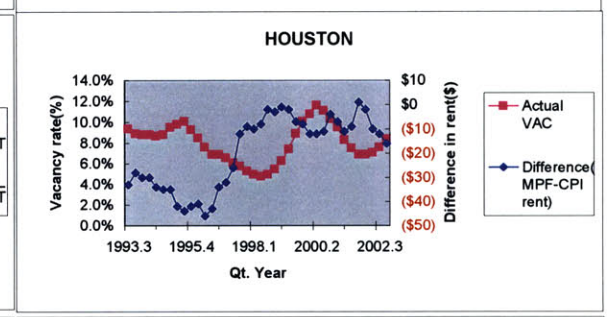

FORTWORTH
Rent ($)
$800
$700
$600
$500
$400
$300
$200
$100
$0
1985.4
1989.1
1992.2
1995.3
1998.4
2002.1
Qt. Year
CPI_ RENT
MPF_ RENT

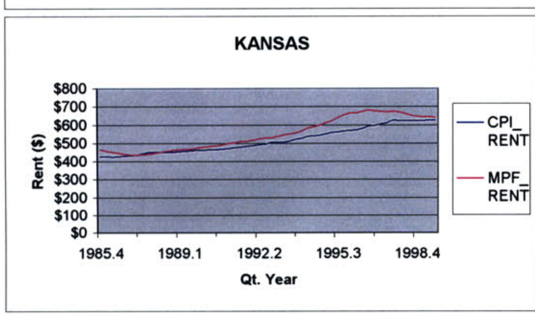

FORTWORTH
Rent (% change)
4%
3%
2%
1%
0%
-1%
-2%
-3%
-4%
1985.4
1989.1
1992.2
1995.3
1998.4
2002.1
Qt. Year
CPI_ RENT
MPF_ RENT

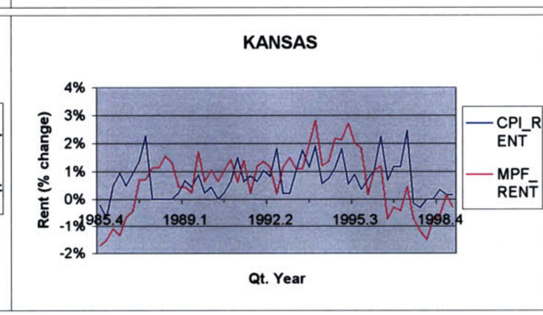

FORTWORTH
Vacancy rate(%)
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
Difference in rent($)
$0
($10)
($20)
($30)
($40)
($50)
1993.3
1995.4
1998.1
2000.2
2002.3
Qt. Year
Actual VAC
Difference(MPF-CPI rent)

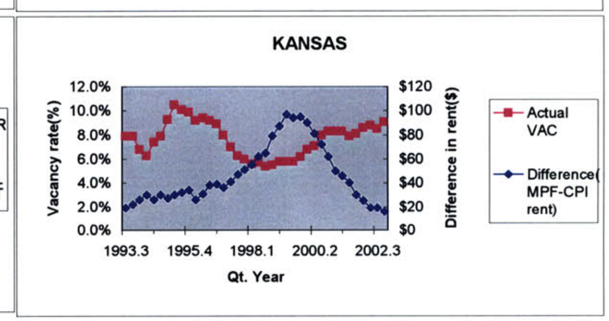

HOUSTON
Rent ($)
$800
$700
$600
$500
$400
$300
$200
$100
$0
1985.4
1989.1
1992.2
1995.3
1998.4
2002.1
Qt. Year
CPI_ RENT
MPF_ RENT

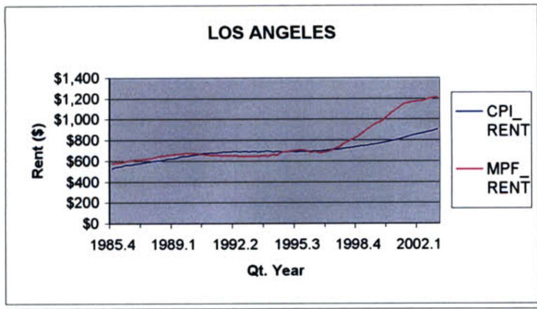

HOUSTON
Rent (% change)
6%
4%
2%
0%
-2%
-4%
-6%
1985.4
1989.1
1992.2
1995.3
1998.4
2002.1
Qt. Year
CPI_ RENT
MPF_ RENT

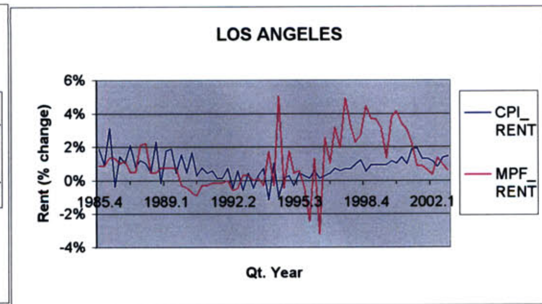

HOUSTON
Vacancy rate(%)
14.0%
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
Difference in rent($)
$10
$0
($10)
($20)
($30)
($40)
($50)
1993.3
1995.4
1998.1
2000.2
2002.3
Qt. Year
Actual VAC
Difference(MPF-CPI rent)

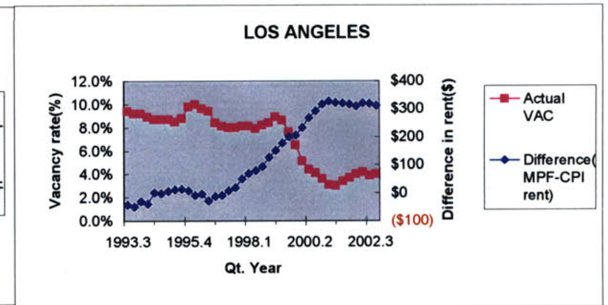

KANSAS
Rent ($)
$800
$700
$600
$500
$400
$300
$200
$100
$0
1985.4
1989.1
1992.2
1995.3
1998.4
Qt. Year
CPI_ RENT
MPF_ RENT

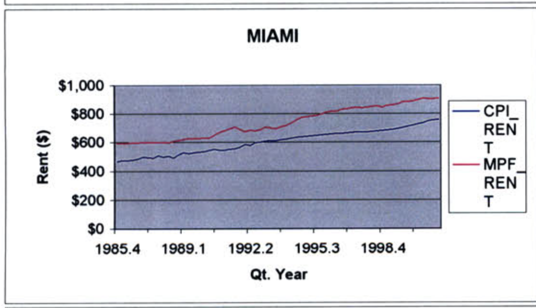

KANSAS
Rent (% change)
4%
3%
2%
1%
0%
-1%
-2%
1985.4
1989.1
1992.2
1995.3
1998.4
Qt. Year
CPI_R ENT
MPF_ RENT

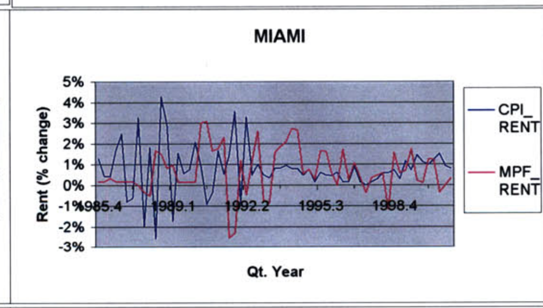

KANSAS
Vacancy rate(%)
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
Difference in rent($)
$120
$100
$80
$60
$40
$20
$0
1993.3
1995.4
1998.1
2000.2
2002.3
Qt. Year
Actual VAC
Difference(MPF-CPI rent)

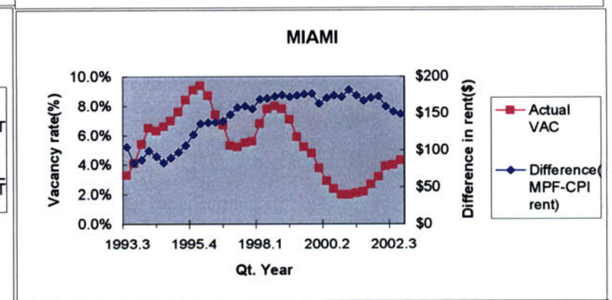

LOS ANGELES
Rent ($)
$1,400
$1,200
$1,000
$800
$600
$400
$200
$0
1985.4 1989.1 1992.2 1995.3 1998.4 2002.1
Qt. Year
CPI_RENT
MPF_RENT

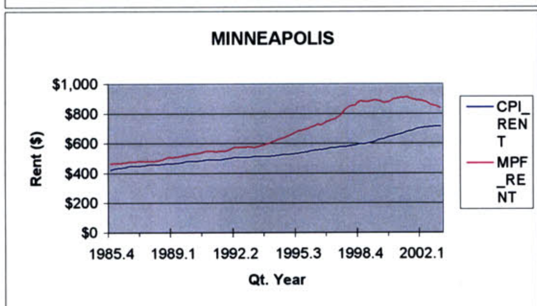

LOS ANGELES
Rent (% change)
6%
4%
2%
0%
-2%
-4%
1985.4 1989.1 1992.2 1995.3 1998.4 2002.1
Qt. Year
CPI_RENT
MPF_RENT

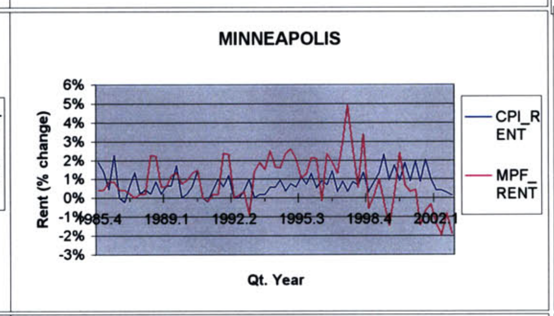

LOS ANGELES
Vacancy rate(%)
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
Difference in rent($)
$400
$300
$200
$100
$0
($100)
1993.3 1995.4 1998.1 2000.2 2002.3
Qt. Year
Actual VAC
Difference(MPF-CPI rent)

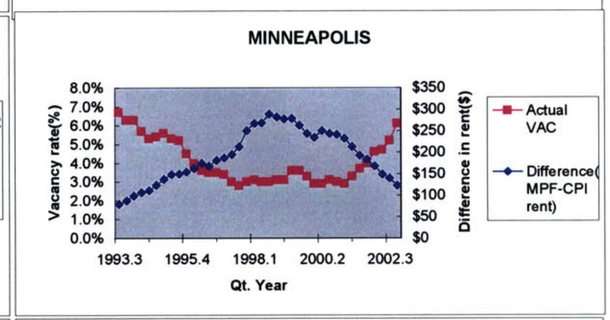

MIAMI
Rent ($)
$1,000
$800
$600
$400
$200
$0
1985.4 1989.1 1992.2 1995.3 1998.4
Qt. Year
CPI_RENT
MPF_RENT

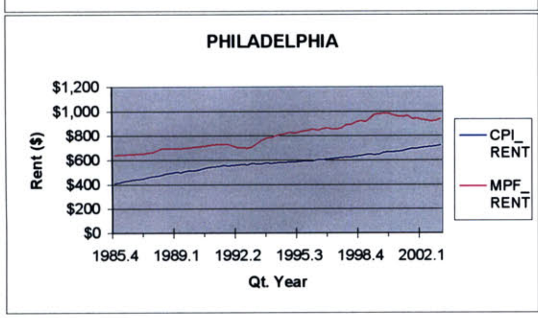

MIAMI
Rent (% change)
5%
4%
3%
2%
1%
0%
-1%
-2%
-3%
1985.4 1989.1 1992.2 1995.3 1998.4
Qt. Year
CPI_RENT
MPF_RENT

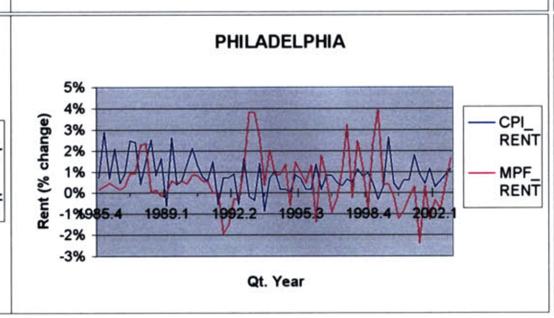

MIAMI
Vacancy rate(%)
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
Difference in rent($)
$200
$150
$100
$50
$0
1993.3 1995.4 1998.1 2000.2 2002.3
Qt. Year
Actual VAC
Difference(MPF-CPI rent)

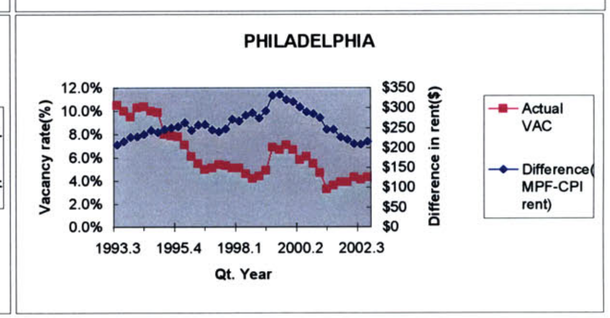

MINNEAPOLIS
Rent ($)
$1,000
$800
$600
$400
$200
$0
1985.4 1989.1 1992.2 1995.3 1998.4 2002.1
Qt. Year
CPI_RENT
MPF_RENT

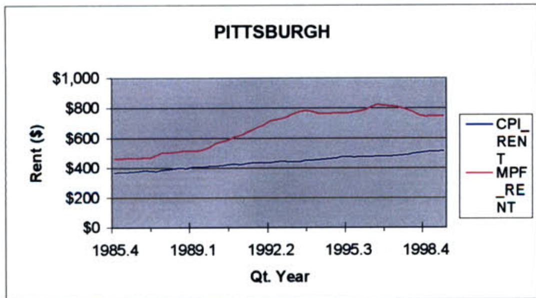

MINNEAPOLIS
Rent (% change)
6%
5%
4%
3%
2%
1%
0%
-1%
-2%
-3%
1985.4 1989.1 1992.2 1995.3 1998.4 2002.1
Qt. Year
CPI_RENT
MPF_RENT

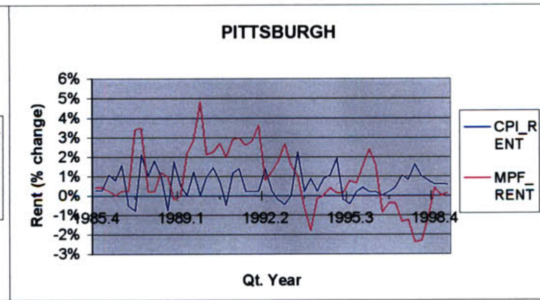

MINNEAPOLIS
Vacancy rate(%)
8.0%
7.0%
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
Difference in rent($)
$350
$300
$250
$200
$150
$100
$50
$0
1993.3 1995.4 1998.1 2000.2 2002.3
Qt. Year
Actual VAC
Difference(MPF-CPI rent)

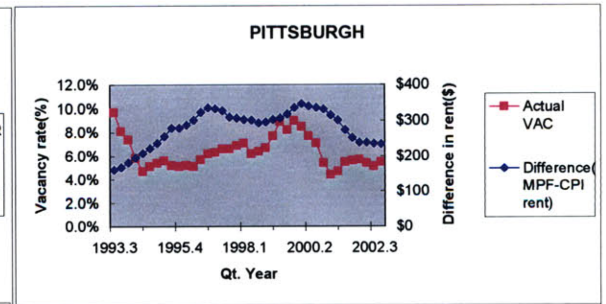

PHILADELPHIA
Rent ($)
$1,200
$1,000
$800
$600
$400
$200
$0
1985.4 1989.1 1992.2 1995.3 1998.4 2002.1
Qt. Year
CPI_RENT
MPF_RENT

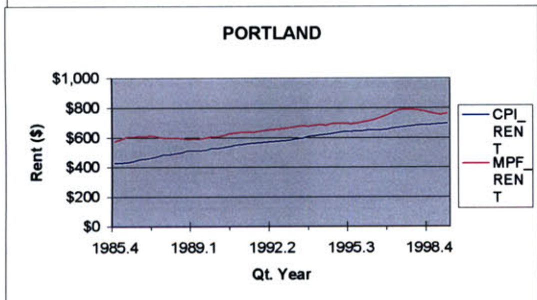

PHILADELPHIA
Rent (% change)
5%
4%
3%
2%
1%
0%
-1%
-2%
-3%
1985.4 1989.1 1992.2 1995.3 1998.4 2002.1
Qt. Year
CPI_RENT
MPF_RENT

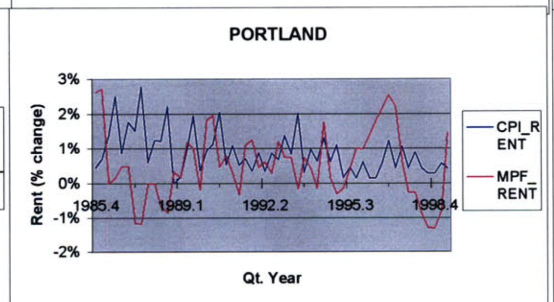

PHILADELPHIA
Vacancy rate(%)
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
Difference in rent($)
$350
$300
$250
$200
$150
$100
$50
$0
1993.3 1995.4 1998.1 2000.2 2002.3
Qt. Year
Actual VAC
Difference(MPF-CPI rent)

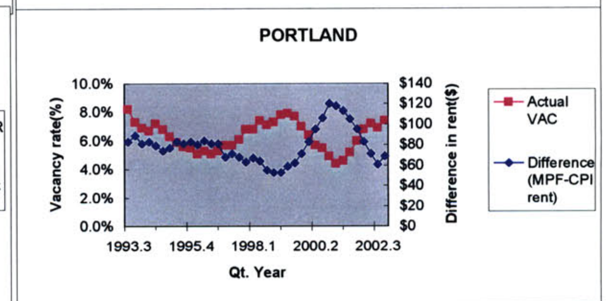

PITTSBURGH
Rent ($)
$1,000
$800
$600
$400
$200
$0
1985.4 1989.1 1992.2 1995.3 1998.4
Qt. Year
CPI_RENT
MPF_RENT

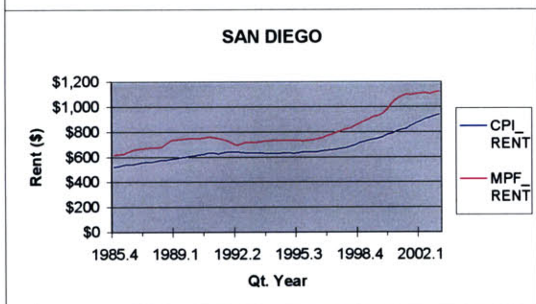

PITTSBURGH
Rent (% change)
6% 5% 4% 3% 2% 1% 0% -1% -2% -3%
1985.4 1989.1 1992.2 1995.3 1998.4
Qt. Year
CPI_RENT
MPF_RENT

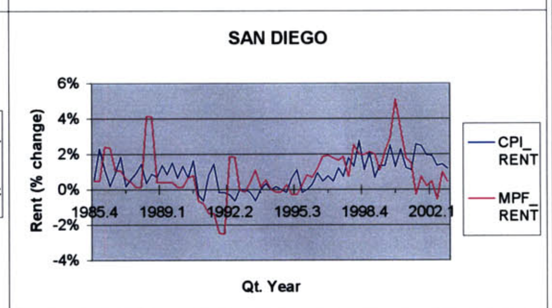

PITTSBURGH
Vacancy rate(%)
12.0% 10.0% 8.0% 6.0% 4.0% 2.0% 0.0%
Difference in rent($)
$400 $300 $200 $100 $0
1993.3 1995.4 1998.1 2000.2 2002.3
Qt. Year
Actual VAC
Difference(MPF-CPI rent)

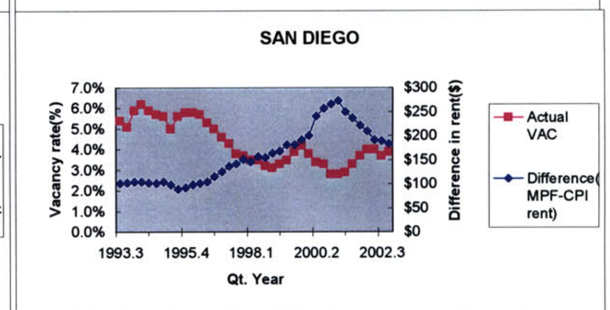

PORTLAND
Rent ($)
$1,000
$800
$600
$400
$200
$0
1985.4 1989.1 1992.2 1995.3 1998.4
Qt. Year
CPI_RENT
MPF_RENT

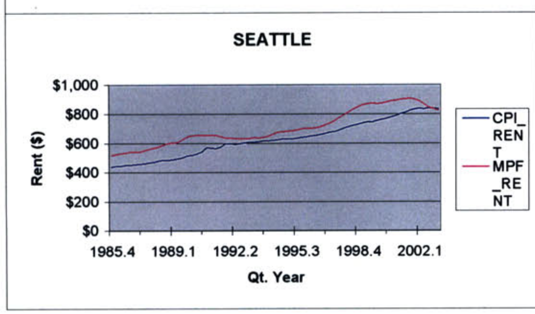

PORTLAND
Rent (% change)
3% 2% 1% 0% -1% -2%
1985.4 1989.1 1992.2 1995.3 1998.4
Qt. Year
CPI_RENT
MPF_RENT

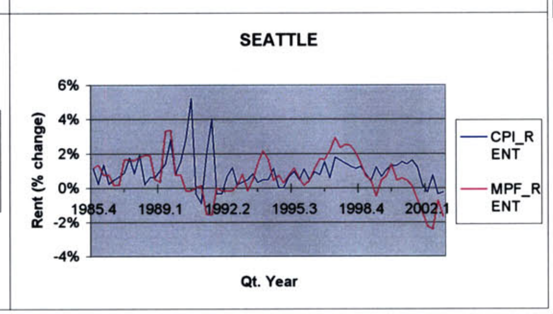

PORTLAND
Vacancy rate(%)
10.0% 8.0% 6.0% 4.0% 2.0% 0.0%
Difference in rent($)
$140 $120 $100 $80 $60 $40 $20 $0
1993.3 1995.4 1998.1 2000.2 2002.3
Qt. Year
Actual VAC
Difference (MPF-CPI rent)

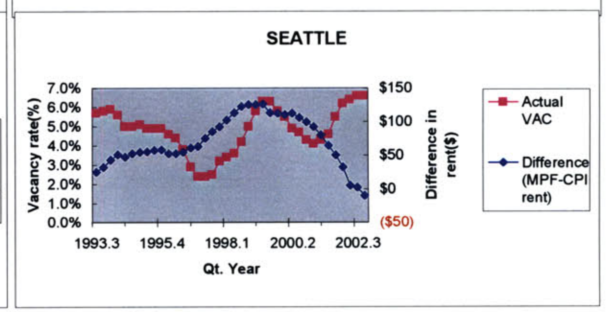

SAN DIEGO
Rent ($)
$1,200
$1,000
$800
$600
$400
$200
$0
1985.4 1989.1 1992.2 1995.3 1998.4 2002.1
Qt. Year
CPI_RENT
MPF_RENT

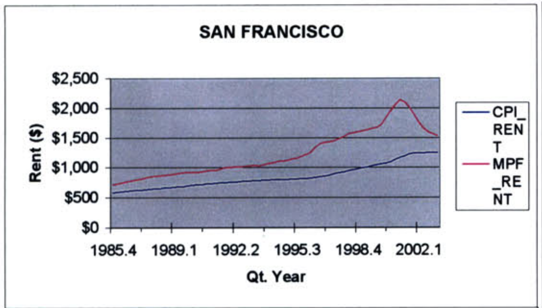

SAN DIEGO
Rent (% change)
6% 4% 2% 0% -2% -4%
1985.4 1989.1 1992.2 1995.3 1998.4 2002.1
Qt. Year
CPI_RENT
MPF_RENT

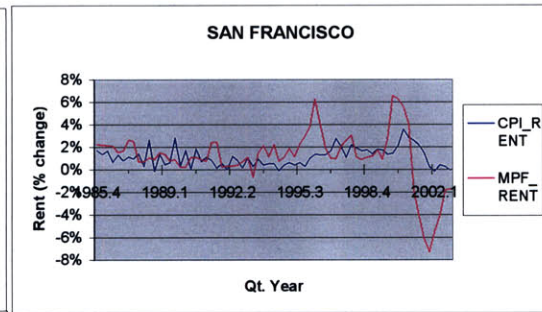

SAN DIEGO
Vacancy rate(%)
7.0% 6.0% 5.0% 4.0% 3.0% 2.0% 1.0% 0.0%
Difference in rent($)
$300 $250 $200 $150 $100 $50 $0
1993.3 1995.4 1998.1 2000.2 2002.3
Qt. Year
Actual VAC
Difference(MPF-CPI rent)

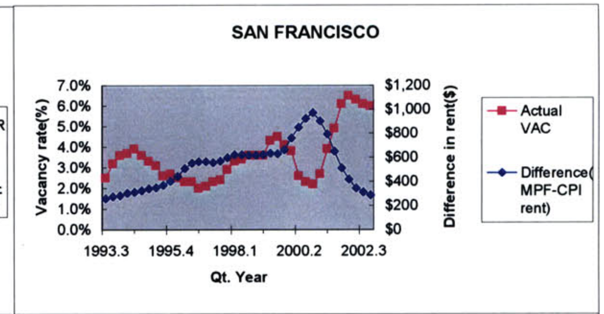

SEATTLE
Rent ($)
$1,000
$800
$600
$400
$200
$0
1985.4 1989.1 1992.2 1995.3 1998.4 2002.1
Qt. Year
CPI_RENT
MPF_RENT

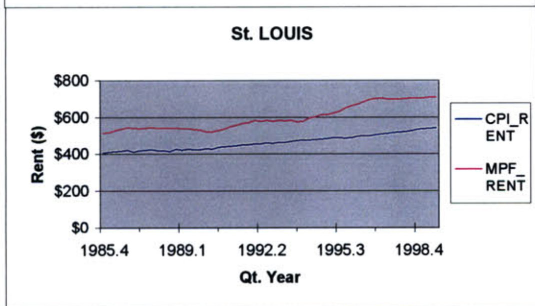

SEATTLE
Rent (% change)
6% 4% 2% 0% -2% -4%
1985.4 1989.1 1992.2 1995.3 1998.4 2002.1
Qt. Year
CPI_RENT
MPF_RENT

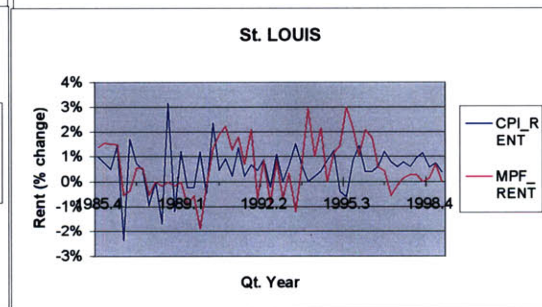

SEATTLE
Vacancy rate(%)
7.0% 6.0% 5.0% 4.0% 3.0% 2.0% 1.0% 0.0%
Difference in rent($)
$150 $100 $50 $0 ($50)
1993.3 1995.4 1998.1 2000.2 2002.3
Qt. Year
Actual VAC
Difference (MPF-CPI rent)

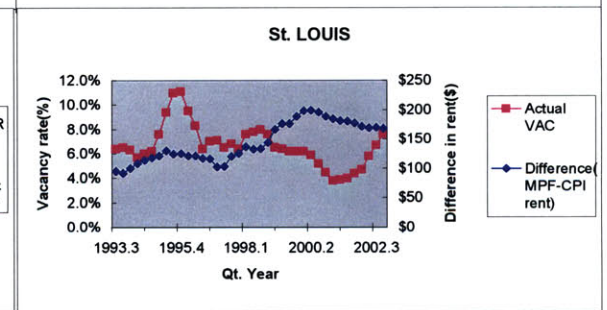

SAN FRANCISCO
Rent ($)
$2,500
$2,000
$1,500
$1,000
$500
$0
1985.4 1989.1 1992.2 1995.3 1998.4 2002.1
Qt. Year
CPI_RENT
MPF_RENT

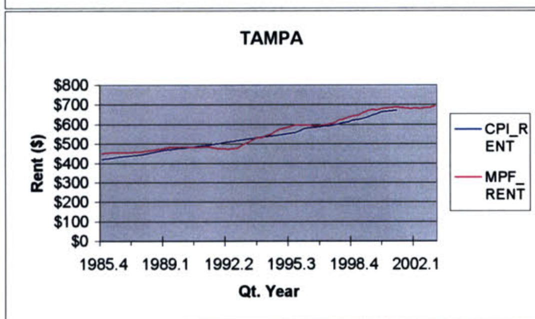

SAN FRANCISCO
Rent (% change)
8%
6%
4%
2%
0%
-2%
-4%
-6%
-8%
1985.4 1989.1 1992.2 1995.3 1998.4 2002.1
Qt. Year
CPI_RENT
MPF_RENT

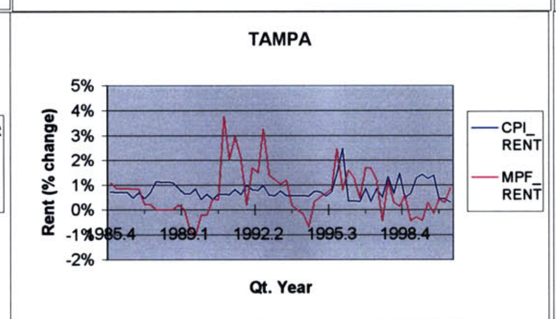

SAN FRANCISCO
Vacancy rate(%)
7.0%
6.0%
5.0%
4.0%
3.0%
2.0%
1.0%
0.0%
Difference in rent($)
$1,200
$1,000
$800
$600
$400
$200
$0
1993.3 1995.4 1998.1 2000.2 2002.3
Qt. Year
Actual VAC
Difference(MPF-CPI rent)

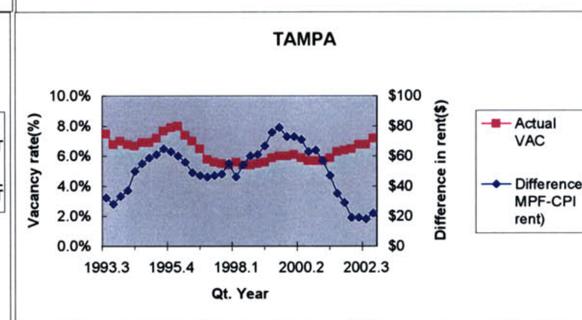

St. LOUIS
Rent ($)
$800
$600
$400
$200
$0
1985.4 1989.1 1992.2 1995.3 1998.4
Qt. Year
CPI_RENT
MPF_RENT

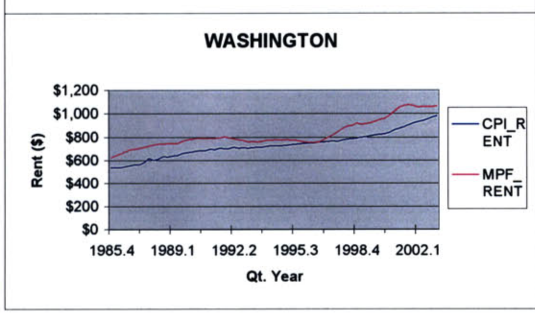

St. LOUIS
Rent (% change)
4%
3%
2%
1%
0%
-1%
-2%
-3%
1985.4 1989.1 1992.2 1995.3 1998.4
Qt. Year
CPI_RENT
MPF_RENT

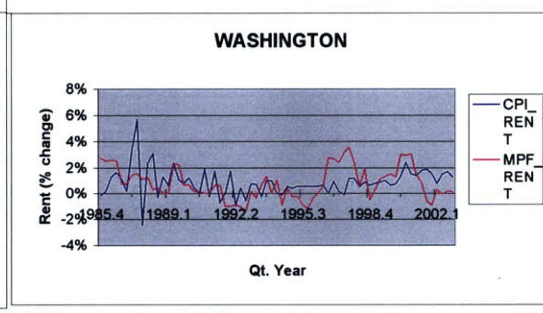

St. LOUIS
Vacancy rate(%)
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
Difference in rent($)
$250
$200
$150
$100
$50
$0
1993.3 1995.4 1998.1 2000.2 2002.3
Qt. Year
Actual VAC
Difference(MPF-CPI rent)

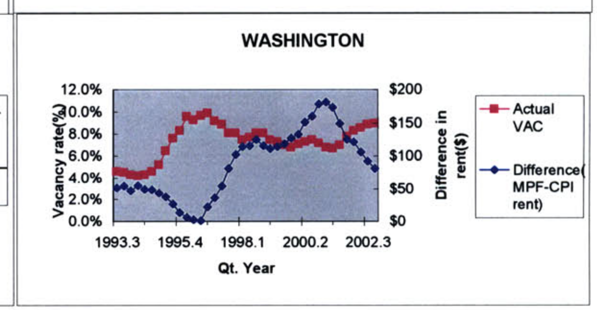

TAMPA
Rent ($)
$800
$700
$600
$500
$400
$300
$200
$100
$0
1985.4 1989.1 1992.2 1995.3 1998.4 2002.1
Qt. Year
CPI_RENT
MPF_RENT


TAMPA
Rent (% change)
5%
4%
3%
2%
1%
0%
-1%
-2%
1985.4 1989.1 1992.2 1995.3 1998.4
Qt. Year
CPI_RENT
MPF_RENT


TAMPA
Vacancy rate(%)
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
Difference in rent($)
$100
$80
$60
$40
$20
$0
1993.3 1995.4 1998.1 2000.2 2002.3
Qt. Year
Actual VAC
Difference(MPF-CPI rent)


WASHINGTON
Rent ($)
$1,200
$1,000
$800
$600
$400
$200
$0
1985.4 1989.1 1992.2 1995.3 1998.4 2002.1
Qt. Year
CPI_RENT
MPF_RENT


WASHINGTON
Rent (% change)
8%
6%
4%
2%
0%
-2%
-4%
1985.4 1989.1 1992.2 1995.3 1998.4 2002.1
Qt. Year
CPI_RENT
MPF_RENT


WASHINGTON
Vacancy rate(%)
12.0%
10.0%
8.0%
6.0%
4.0%
2.0%
0.0%
Difference in rent($)
$200
$150
$100
$50
$0
1993.3 1995.4 1998.1 2000.2 2002.3
Qt. Year
Actual VAC
Difference(MPF-CPI rent)