Modeling the Impact of Regional Economic Change on the Residential Real Estate Market

by

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and

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Abstract

Given the size of national investment in housing, a region's wealth is directly tied to its residential property market. This thesis looks at the impact of economic change on the regional economy and housing market by applying a modern time series approach; the restricted vector autoregressive (VAR) model. Upon review of the apparent shortcomings of prior research, an endogenous system is estimated using housing prices, single family stock, employment and wages at the metropolitan level.

Application of the VAR approach to regional level data in Atlanta, Boston, Detroit and Houston provide evidence that there is a persistent and dynamic linkage between the economy and housing market. Although the linkage between a housing market and the regional economy is well established, the model provides enough evidence to suggest that the reverse is also true: housing markets affect regional economic conditions.

Given these dependencies, the impacts of different economic shocks are estimated. These shocks include price inflation, a construction boom, adverse employment demand and wage hikes. At a metropolitan level, the model provides good estimates for movements in housing price and regional employment. Although the model does not provide good estimates for the supply of labor and housing, it does provide a reasonable description of the dynamics occurring within regions.

The responses to each "shock" or economic change are found to be highly correlated in regions exhibiting similar growth patterns. Further, the response of prices under different economic shocks appears to be predictable.

Thesis Supervisor: William C. Wheaton
Title: Professor of Economics

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Thanks mom and dad.

1. Introduction

Real estate comprises the largest component of national and individual wealth within the United States. Residential properties represent nearly 70% of all dollars invested in domestic real estate, of this over 80% held by private individuals[1]. Given the size of national investment in housing, a region's wealth is directly tied to its residential property market. Clearly, as housing prices respond to a positive or adverse shock (boom or slump), individual and regional wealth is directly affected. Therefore, as individuals and firms make investment and locational decisions, the issue is how real estate prices and values can be expected to change, given a sizable shock occurring in the region. Further, can the region be expected to return to normalcy, and if so when?

The objective of this research is to understand the effectiveness of modeling at the regional level and observe the movement of variables affecting the market for single family housing. With this purpose, a modern time series approach is applied to understand the linkage between the regional economy and its housing market. Further, by using a structural vector autoregressive (VAR) model, the impact of regional economic change is observed on the market for owner occupied housing, both as consumer and as investor. Specifically, this research strives to:

1. Provide a better understanding of the housing market by using metropolitan level data;
2. Uncover the linkage between the regional economy and its residential property market; and
3. Estimate the impact of economic change on the housing market.

With these in mind, a model estimating the dynamic responses between regional housing and employment is constructed. The research, methodology, results and findings are described within six chapters. This first chapter is the introduction, which establishes the research objectives and framework for the work.

Chapter two provides a foundational overview of empirical and theoretical work in housing market research and regional economics. This literary overview focuses on past research objectives and the inherent strengths and weaknesses found within their reduce form models, structural dynamic

[1] IREM Foundation and Arthur Anderson - "Managing the Future: Real Estate in the 1990's" Pages 29-33, 1991

models and current times series models. Using these observations as a base, the proposed model addresses the apparent shortcoming of prior work. In avoidance of past pitfalls, the proposed model shall 1) estimate the housing market using regional level data, 2) provide a more direct link between the regional economy and the housing market, 3) include estimates for the housing stock, 4) identify the impacts of economic change on regional economic factors.

From this brief model overview, chapter three addresses the need for good data. Within this chapter, data sources are identified, discussed and thoroughly critiqued as far as their ability to represent specific model inputs. Atlanta, Boston, Detroit and Houston are the four regions selected for estimation. Chapter three examines each data series by plotting past trends and patterns. This analysis produces a classification system whereby each region is grouped according to its growth characteristics. The two basic typologies are 1) established regions (i.e. Boston and Detroit) and 2) growth regions (i.e. Atlanta and Houston).

Chapter four describes the specifics of the restricted vector autoregressive (VAR) model. The basic premise of a VAR and methodology used to specify parameters and test assumptions are presented. This chapter then describes and details the exact variable selection, lag structure and linear form used in estimation. The chapter concludes by identifying the two primary methodologies used to evaluate the impact of an economic shock. These two estimation techniques are the impulse response function and the forecast error decomposition.

Upon application of the previously described methodology, estimates for housing price, housing supply, regional employment and wages are presented within chapter five. The impacts of four different economic shocks are then discussed. These include: 1) unanticipated house price inflation, 2) a construction boom, 3) adverse employment and 4) a wage hike. Generally, the analyses finds correlated responses in regions having similar growth patterns. Further, given these correlations under different economic shocks, housing prices appear to be predictable.

The conclusions in chapter six offer evidence to support the hypothesized dynamic linkage between regional economies and residential property markets. Although it is well established that regional economic factors affect housing, the model shows that the reverse is also true; housing significantly affects general economic conditions.

Aside from the evidence supporting regional economic dependencies, the model appears to be a good estimator for movements in housing price and regional employment. Although the model does not provide good estimates for the supply of labor and housing, it does seem to provide a reasonable description of the inherent dynamics of regional economic relationships.

2. Literature Review

How does the market for single family housing respond to economic shocks at the metropolitan level? This chapter reviews research relevant to answering this question by surveying past theoretical and empirical work in housing markets and regional growth.

The review of prior work is important in two ways. First, understanding the success and failure of past work provides opportunities for better estimation. Second, by comprehending different econometric approaches and results, new theory and methodologies emerge.

In an attempt to estimate the dynamics of metropolitan housing markets, a general understanding of the theory is required. More specifically, this chapter reviews the areas of; 1) housing market research, 2) endogenous growth theory, and 3) regional evolutions. The concluding section of this literature review introduces a new model and its apparent need given the shortcomings of prior work.

2.1. Housing Market Research

Housing market research traditionally follows one of two different approaches, separated by assumptions in housing price (demand) and the housing stock (supply). The first body of theory stems from a market equilibrium approach where the housing stock and price are assumed to clear quickly; the resulting theories are termed reduced form models since there are no endogenous variables on the right-hand side of the equations. The second approach is the stock-flow model. Stock flow models assume that the stock is unable to respond instantly to price, but adjusts more slowly; such approaches are labeled dynamic or structural models.

The review of the prior models is organized by the fundamental assumptions they make about the housing market. They include 1) reduced form models, 2) structural/dynamic models, and 3) endogenous reduced form models.

I. Reduced From Models

Early modeling techniques of the 1960's, found supply and demand for owner-occupied housing determined exogenously by several economic elements. Notably, these early researchers assumed housing markets cleared quickly. Under this hypothesis, external economic factors are used to determine price and stock. Although these researchers preferred to determine price and stock simultaneously as functions of one another, they used exogenous variables to avoid simultaneity within their equation structure. For example, Alberts(1962) and Maisel(1963) used interest rates and other external factors to determine construction rates, while using employment and other macroeconomic variables to simultaneously determine housing price. Implied in these reduced form models is that current housing prices do not affect construction. Further, these static models have the housing market moving one for one with the economy. Figure 2-1 provides a simple illustration of the theory behind reduced form models. It is important to notice how prices have no feedback into (i.e. they do not determine) housing supply, housing demand or regional economic factors such as wages or employment.

The limitations of reduced form models and their inability to estimate the dynamics of the housing market dissatisfied researchers. As these static models produced poor estimates of actual housing cycles, researchers observed that the housing supply was slow to adjust to changes in price, hence, it takes time to build the stock.

II. Structural "Dynamic" Models

Despite disagreements as to what economic factors best estimate housing price and stock, a general consensus regarding the delayed response of the housing stock with respect to price, or the persistence of disequilibrium in the market became well accepted.

Despite the vast amount of research on housing dynamics, a number of authors provide good and exhaustive summaries of the work to date. Therefore, this section only briefly outlines the development of structural models with a more detailed review deferred to these other authors[2].

First, summarizing the evolution of structural models is not a simple task. In general, these models developed from the poorly performing models preceding them. Further, researchers recognized the persistence of disequilibrium in the housing market, thus conjecturing that lagged prices determine the level of today's stock. Noted work in the area of these dynamic models include Kearl, Poterba, DiPasquale Wheaton and Case Shiller.

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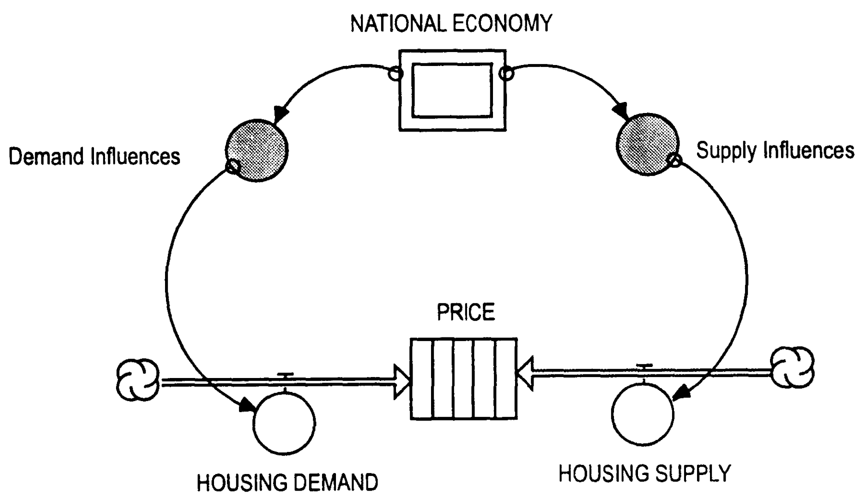
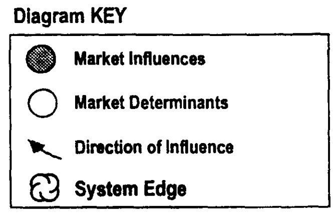
[2] See Bartnik (1991), DiPasquale Wheaton (1992, 1994)

Figure 2-1

Reduced Form Models (Exogenous Economy)





Dynamic modelers like Kearl (1979) endogenize price as a determinant of ownership cost with stock in the price equation. The work of Poterba (1982, 1991) identifies price as a variable of foresight expectations[3]. Further, he finds expected home prices influencing future home prices. DiPasquale Wheaton (1992) construct a revised housing market model whereby price and stock are endogenized. They assume that there is a sufficient delay between the price of housing and the construction of the housing stock. Since they find a lag structure inherent in the determination of stock, both stock and price can then be determined endogenously through simultaneous equations without having a problem with the modeled parameters. This critical step provides the dynamic relationship between housing price and the stock, where cyclical patterns are internally created aside from any exogenous shock. **Figure 2-2** illustrates the relationships and variable flows of the dynamic model with stock and price used to determined each other. It is important to recognize that current supply and demand influence current housing price but only lagged prices influence supply and influence demand.

DiPasquale Wheaton provide a good synthesis of the empirical results emerging from past and present uses of econometric models. They conclude the following:

1) *Housing markets have fairly predictable cycles with positive serial price correlation* ;
The residential real estate market is highly cyclical, with recurring movements in prices and construction. Prices and construction are not altogether endogenous or exogenous as they exhibit continual interdependence (dynamic relationship).

2) *Housing markets appear to exhibit significant disequilibrium whereas prices are not a sufficient statistic in estimating supply* ;
General macro economic conditions appear to add significantly in the forecasts of a supply equation[4]. This is to say that a purely endogenous housing market with price and stock internalized is not a good forecasting system.

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[3] Poterba theorized that "Liquidity constrained consumers may find initial nominal payment requirements prohibitive[in accessing the housing market]" and therefore their demand is determined endogenously by price foresights.

[4] If the market were clearing rapidly and in equilibrium, such factors would be fully incorporated into house prices which then would be the sole determinant of new supply (DiPasquale Wheaton 1992)

Figure 2-2

Structural Dynamic Models (Exogenous Economy and Endogenized Stock)

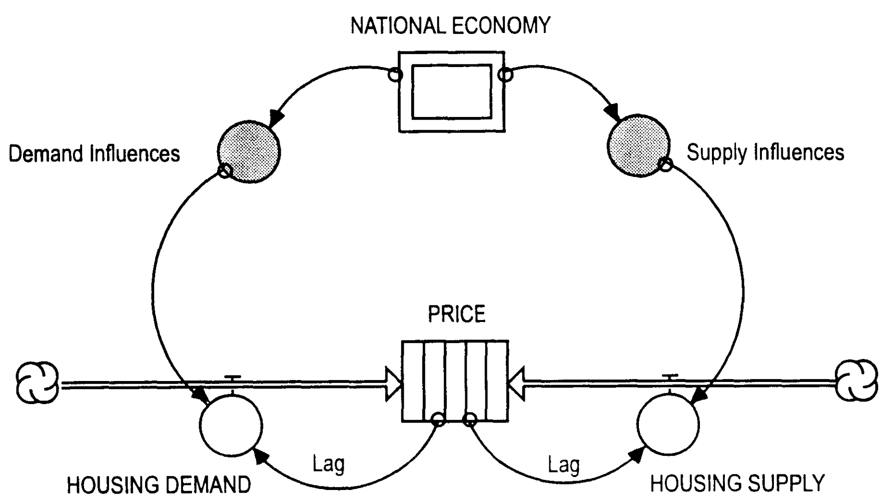
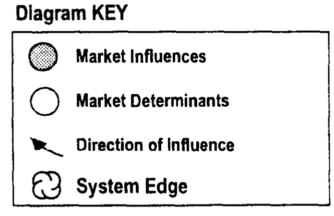


Diagram KEY



3) *Connection between housing construction and various factor markets is puzzling* ;

Housing investment equations poorly estimate the relationship between housing construction and the land market. Constructing a well fitted supply model for the housing market is largely unattainable since there are limited data.

4) *Gradual price adjustments result from a market that doesn't clear quickly*

Rapid price movements appear irrational when considering the heterogeneity of the housing asset and the high costs associated with making a transaction.

5) *Expectations of price adjustments determines household responses.*

Household behavior is determined by the expectations of future price, rational or irrational. More specifically, myopic or "backward looking," expectations appear to influence price, where recent price behavior appears to affect price adjustments in the market[5].

Clearly, by assuming disequilibrium in the housing market, a more dynamic model is produced. As the impact of price expectations appear to largely determine supply, the system of equations generates cyclical patterns which are separate from any exogenous effects. Further, by including expectations in a dynamic structural model, consumer anticipation will lead to the amplification of various shocks, thereby intensifying the overall impact.

The dynamic estimations of structural models provide information on the sensitivity of the housing market to economic variables. However, despite their dynamic structure, these models assume that the price of land and housing have no impact on the regional economy. Further, the locational decisions of firms and workers is ignored as interactions between the local labor and housing market are omitted from models.

[5] This says that expected price inflation in each period is related to current or past price movements. Therefore, as the initial price rises from expectations of future price inflation, construction is pushed upward until the stock overshoots its steady state target. As this happens prices peak and then they begin to drop. Then negative expectations set in, reducing demand and thus prices.

III. Endogenized Reduced Form Models

Clearly, housing prices and construction activity are important considerations within the regional economy. How can the dynamic relationship between housing and the regional economy be included in a model? Dua and Ray (1995) discuss two fundamental problems with the use of structural models. First, they find that there are sizable issues with misspecification through the improper identification of equations and the determination of the correct number of variables. Further, the exclusion of certain variables is often carried out with minimal economic theoretical justification[6]. Secondly, Dua and Ray conclude that structural models are poorly suited for forecasting since they depend on the projected future values of exogenous variables. They offer an alternative approach, the vector autoregressive (VAR) model, which is thought of as an approximation to the reduced form of a simultaneous equations with the economy endogenized. Further, Dua and Ray find VAR modeling particularly useful in analyzing regional adjustments where there is a lack of sufficient data points to warrant the use of a large structural model. **Figure 2-3** illustrates the concept of a reduced form endogenous system, where innovations in the housing market and economy are interdependent. It is important to notice that housing demand feeds back into the economy through labor supply, and that the economy and housing demand are contemporaneously determined by the response of other variables within the system, with housing supply the exception. Most importantly, when these endogenous models omit housing supply, they ignore the important dynamics between housing price and supply as observed by DiPasquale Wheaton.

Aside from questions regarding structural form, most prior housing models focus on national or state level data, which present some forecasting issues. To better understand the dynamics between housing markets and the regional economy, a metropolitan level model appears most logical. Use of VAR modeling in regional forecasting was first pioneered by Anderson (1979). More recent applications have been by Kinal and Ratner (1986), Crone (1992) and Shoesmith (1992). In general, Anderson showed that the VAR technique uses regularities in historical data to forecast regional economic variables. Although the VAR approach is criticized as being completely atheoretical, Anderson applied economic theory in selecting the variables included in his model.

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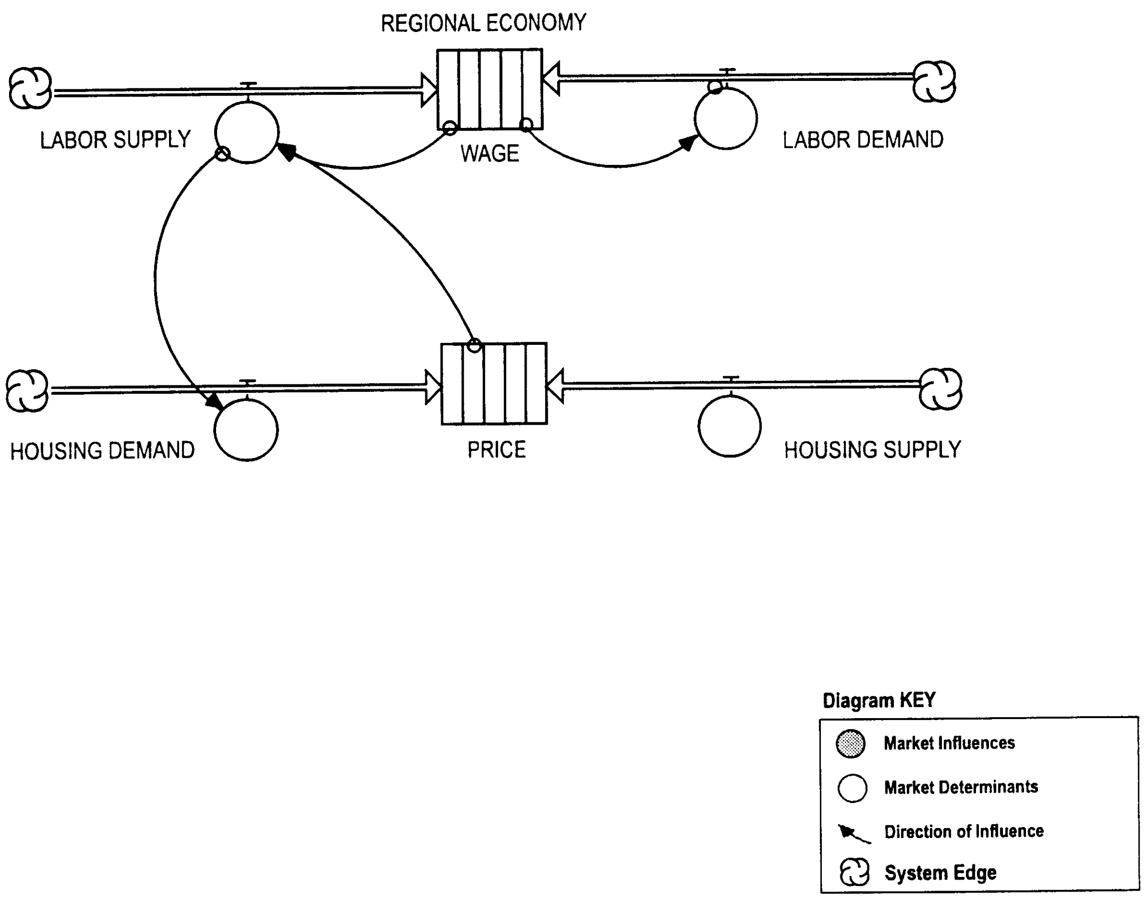
[6] Cooley and LeRoy (1985)

Figure 2-3

Reduced Form Endogenous Growth Models (No Estimation of Housing Supply)



An inherent difference between structural and VAR models has led to some fundamental criticisms of VAR approaches. First, since a VAR model does not identify shock instruments or other external variables, the model cannot answer how certain disturbances or innovations in the system actually occur. On the other hand, a VAR model can use economic theory or judgments to design experiments that may be of interest for conditional forecasting or policy analysis[7]. McNees (1987) in his critique of VAR modeling found the technique to be the most accurate in estimating real GNP, unemployment and nonresidential fixed investment, while being least accurate in estimating inflation and interest rates.

Despite issues of data point sufficiency and having too many variables of estimation, selection and organization of parameters appears most important. Dua and Ray use a restricted VAR approach to model employment, income and housing construction on the state level. They use time series data between 1960 to 1984 to observe how well different models and forecasts were able to estimate actual results occurring between 1983 and 1994. They conclude that the VAR approach is more accurate in estimating construction (i.e. housing permits) while a restricted VAR is best for employment and income. Generally, they find the VAR approach outperforming forecasts produced by structural models.

Lastly, McNees in his article concludes by saying that, "it would seem more fruitful to regard the two approaches (structural and VAR modeling) less as rivals and as complementary tools that can shed different kinds of light on our murky view of what the future will be like and what we can do about it."

The structure of VAR models is explained through a body of theory termed endogenous growth. The next two sections of this chapter address the fundamentals of endogenous growth theory and present the empirical work of Blanchard and Katz (1992) in the area of regional evolutions.

[7] McNees (1986)

2.2. Endogenous Growth Theory

Assuming that the housing market is determined by the economy and the economy is partially determined by movements in the housing market, notions about endogenous growth must be explored. Endogenous growth is a fairly recent body of theoretical work emphasizing economic growth as an internal effect of an economic system, rather than those of external forces. As a result, endogenous growth doesn't use exogenous agents to explain changes in the market, instead it focuses on the internal forces (i.e. public and private) that cause the rate of growth to vary among different geographical areas.

The origins of endogenous growth theory as observed by Romer (1994)[8] stem from the poor fit of neoclassical economic growth models toward issues of technological innovation, information and knowledge within an urban market. Neoclassical growth models typically assume that technological change (growth) is exogenous and that technological advances occur outside[9]. Therefore, under these assumptions, neoclassical theory finds technology to be the same in different geographies. Romer poses that the basic evidence of endogenous growth is taken for granted by economists. He states that technological advances come from the things people do, and although these advances appear beyond control, the total rate of discovery is still determined by the endogenous activities of people in the system.

Despite the intellectual appeal of endogenous growth theory, much of it has led to little tested empirical knowledge[10].

2.3. Regional Evolutions

The work of Blanchard and Katz (1992) apply endogenous growth theory to provide an insightful investigation of regional dynamics at the US state level. They look at the behavior of employment, unemployment, wages and housing prices through an endogenous model, thus suggesting that these variables determine economic activity, and growth at the state level. In their research, they find

[8] Romer, Paul - Journal of Economic Perspectives - Vol. 8, No. 1 Winter 1994 Pg. 3-22

[9] Neo-classical growth models identify the sources of growth as being population and technological process with capital accumulation determining the capital to labor ratio in a steady state . Recall the simple neoclassical model of the Cobb-Douglas form $Y = A(t)\ K^{1-\beta}L^{\beta}$, Where Y is the net national product (growth), K is the stock of both human and physical capital, L is the stock of labor and A is the level of technology. With technology (A) shown as a function of time (t), there is exogeneity of technological growth (see Romer 1994).

[10] Pack (1994)

trends in regional growth rates that are different from one location to the next, implying the persistence of endogenous innovations as noted by Romer. Further, as a region experiences growth, then an economic shock, it has a strong tendency to drift back to its original growth rate. From these results, Blanchard and Katz suggest that there are internal mechanisms that counteract a shock at the state level.

Specifically they formalize movement in the labor force by estimating employment and unemployment then wages through the following bivariate system (later substituting wages for unemployment):

Changes in Employed Workers

$$\Delta emp_t = \alpha + \beta\Delta(L)emp_{t-1} + \beta\Delta(L)uemp_{t-1} + \varepsilon_t$$

Rate of Unemployment

$$uemp_t = \alpha + \beta\Delta(L)emp_t + \beta\Delta(L)uemp_{t-1} + \varepsilon_t$$

The lag structure rooted in their equations allow for current changes in employment to affect current values of unemployment and wage but not vice versa. **Figure 2-3** illustrates the structure of their model. The following summarizes key points about regional evolutions discovered in their approach:

1. There are a series of dynamic responses. In general, most of the adjustment process to an adverse shock in employment is through the out-migration of labor rather than the in-migration and creation of jobs. Blanchard and Katz suggest that the relative affect of an adverse shock on wages is weak an may not trigger much job creation;

2. Innovations (shocks) in labor demand and supply permanently affect the level of employment as wages tend to converge towards a stationary distribution overtime[11] ;

3. By running a bivariate system, pooling 39 MSAs, the joint response of employment and housing price to an adverse shock in employment are estimated by the following:

[11] See Barrio and Sala-i-Martin(1991) - " regarding the convergence controversy"

$$\Delta emp_t = \alpha + \beta\Delta(L)emp_{t-1} + \beta\Delta(L)price_{t-1} + \varepsilon_t$$
$$price_t = \alpha + \beta\Delta(L)emp_t + \beta\Delta(L)price_{t-1} + \varepsilon_t$$

Where price in each MSA at time t, is denoted as the logarithm(L) of the median sales price of existing home in that MSA minus the log of the national median price (i.e. the MSA deviation from the national average). Employment is also expressed in terms of a difference from the national average.

The observed responses from this system of equations implies predictable but relatively small excess returns. Further, the effects of an adverse shock on employment are largely permanent, while the long run effects on relative housing prices appear not to be[12]. Although, Bartik(1991) finds similar responses in housing price to adverse employment shocks, he concludes that there is some evidence that such employment shocks have small permanent effects on housing price, largely through hysteresis[13]

4. From an adverse shock in employment, housing prices decreasing to a much deeper tough than wages. This decrease may reduce incentives of the existing owners to migrate for better employment opportunities. However, with lower housing prices there is a capital loss, and workers may stay to recapture this loss if they "expect" the market to pick up.

2.4. Model Shortcomings

As previously discussed, reduce form models fail to capture housing market dynamics and the cyclicality of the real estate market. Arguably, the dynamic-structural models fail to account for the impact of real estate prices on the regional economy. Both of these models failed to explain how housing prices affect regional wealth.

The work of Blanchard and Katz and Bartnik present a cursory exploration of employment growth on housing price, yet their focus is largely on employment innovations rather than the effects on

[12] Implicitly assuming that there is a flat long-run supply of land in each MSA.

[13] A term used by scientist to describe the circumstance in which the equilibrium of a system depends on the history of that system (i.e. that there are permanent effects by the temporary application of a shock).

housing price and especially housing stock. Furthermore, the prior work of dynamic modelers such as DiPasquale Wheaton, who emphasize the importance of linking housing price and stock, appear largely ignored by the reduced form endogenous models of Bartik and Blanchard and Katz.

Another obvious shortcoming of prior models is their scale of estimation. Most dynamic structural models estimate national housing prices, while the endogenous model of Blanchard and Katz use regional level housing prices and state level data for estimation. Obviously, by assuming that regional price data and state economic data are directly proportional is a bit presumptuous. Presumptuous in that Detroit housing prices are not exactly determined by Michigan state level data, or that prices in Los Angeles are not exactly determined by California state level data.

Perhaps by specifying the relationships between the housing market and the economy on the same level and by regions will provide greater insight as to the dynamic relationships existing between the residential market and regional economic variables. Given this direction, a proposed model shall:

1. Model the housing market using regional level data;
2. provide a more direct link between the regional economy and the residential property market;
3. estimate the housing stock; and
4. identify the impacts of economic growth on regional economic factors.

2.5. Proposed Model and Theoretical Assumptions

This section presents the foundation for a new model in estimating the dynamics of the housing market at the metropolitan level. As prior sections reviewed evolutions in housing theory and research, this section proposes a new model built upon the past work. The description of the proposed model is proceeded by the identification of its inherent strengths and weaknesses.

I. Theory and Objectives

The intent of the proposed model is to estimate housing market using metropolitan. From this objective the model shall estimate the impact of economic change on the regional economy and its housing market.

Given this directive, the system of variables must best represent measures of supply and demand within the housing and labor markets. Each variables is discussed in terms of its ideal state. Although the specific relationships are generally described below, this section provides a cursory look at the model prior to the search for good data. Actual data sources and model structure are later specified in chapters three and four.

a) Housing Demand

Price is the proxy for the quantity of housing demanded. Variables affecting price(t) are the last period's housing price (t-1), the current level of the housing stock (t), current employment (t) and current wages(t). This definition of price is rather structural in its form, only one variable is lagged (price) based on the notion that household expectations determine future price movements[14].

b) Housing Supply

Single family housing stock is the proxy for the quantity of housing supplied. Variables affecting stock(t) are stock and housing price. With adjustment to the housing stock occurring quite slowly, stock(t) is determined by prior stock levels in the preceding three periods (t-1, t-2, t-3).

Stock(t) is also determined by housing prices occurring two and three periods prior. This implies that today's stock level is an innovation of prices observed two and three years prior. Although some economist may consider this lag structure particularly long, the delay is accounting for first, the behavior of individual expectations; second, delays in the processing of a building permit; and third, delays in construction and eventual occupancy. Essentially this implies that today's price movements alter the behavior of firms and individuals, such that the actual stock level is not directly influenced until two periods later.

c) Labor Demand

Employment is the proxy for the quantity of labor demanded at a specified level of employment. Variables that determine employment(t) include past employment and wages. Employment is most determined by the level of employment in the prior period (t-1). Secondly, the number of

[14] See DiPasquale Wheaton (1992)

employees demanded is strongly influenced by wage, where wages drop the demand for labor increases, with more firms moving in to capitalize on lower costs.

d) Labor Supply

Wages are the proxy used for the quantity of labor supplied at a particular rate. Given this structure of the labor market, it implies that as labor demand (employment) rises, so does labor supply (wage). Although this specification may appear counter-intuitive, it will provide for a more appropriate interpretation of the shocks to labor demand (employment).

Generally, the variables affecting current wages(t) include past wages, employment levels, and housing prices. Housing prices are included within the supply equation given that a strong correlation exists between housing costs and the migration patterns of a regional population.

Figure 2-4 provides a simple diagram of the proposed dynamic metropolitan model and its structural organization. Given this introduction to the new model, the fundamental strengths and weaknesses are reviewed. This analysis attempts to identify any frailties seeded in the logic of the metropolitan model. The econometric issues are intensely explored and analyzed in chapter four, the VAR Methodology.

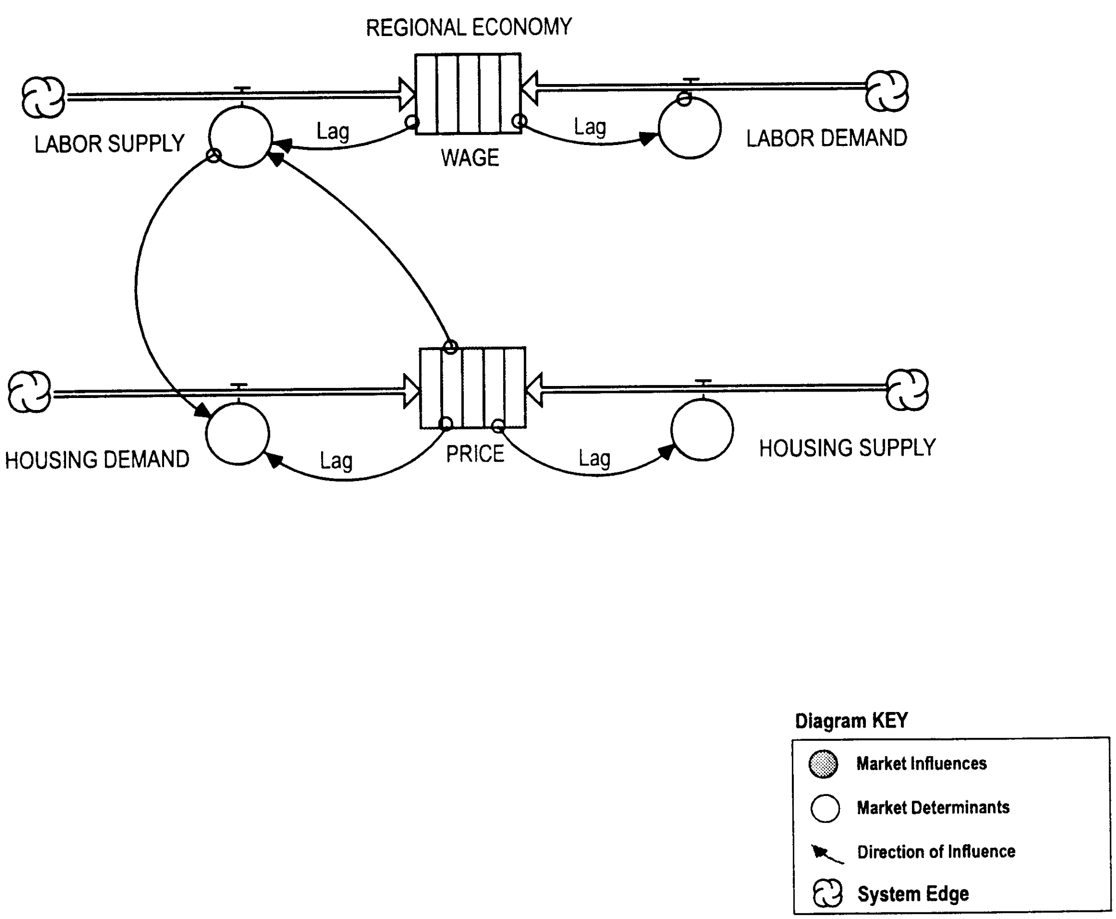
II. Strengths

The apparent strength of this model is the simplicity of its construction. By specifying an endogenous model, forecasting future effects are quite easy given that no assumptions in external variables are needed. Further, the defined theoretical structure has a basis in economic theory as opposed to the unrestricted VAR approach.

Most importantly, how the model accounts for the relationships occurring between the different factor markets is a strength. Obviously by reviewing **Figure 2-4**, the feedback relationships between the regional economy and the housing market are included. These relationships provide a far more dynamic series of responses than reduced form or largely exogenous models. The dynamic responses are characteristic of past economic trends and the cycles appearing within the housing market.

Figure 2-4

Proposed Dynamic Metropolitan Model



III. Weaknesses

Obviously by using a four variable model, misspecification is not only possible but likely. Aside from any econometric weaknesses, the model ignores the specificity of any particular exogenous shocks or broader macroeconomic effect. However, given that the intent of the model is to better understand the internal interactions or dynamics between the housing market and economy, the ambiguity of any certain exogenous shock is not disturbing. In general, there are two weaknesses associated with the model; 1) oversimplification of the housing market, and 2) oversimplification of the economy.

The first weakness inherent in the proposed model is its oversimplification of the housing market. With the myriad of variables used in past models, there seems to be a number of factors which determine the price of housing in a marketplace. Specifically these include the owner's cost of capital, rents, multi-family construction, industry mix, national macro economic conditions, demographic trends and construction costs.

The other weakness of the proposed model is the oversimplification of the regional economy through wages and employment levels. Important factors such as unemployment and labor participation may contribute to changing employment patterns that affect the regional economy, especially in terms of household formation and housing demand.

Despite the overall strengths and weaknesses of the proposed model, the approach is far more holistic in looking at the housing market through a metropolitan system. The next two chapters identify the data used, describe the specific methodology and confront the econometric issues observed in creating the model.

3. Data Description

Data selection and definition are exceedingly important in estimating a good model. In creating a model estimating housing and labor market movements, the choice of variables is heuristic (i.e. trial and error) with economic theory guiding the final selection. This chapter describes the process of selecting and defining each region, sources of data and their integrity are critically assessed. Following the discussion, the observable trends of each data series are explained.

3.1. Sample Selection

Each region is selected following three basic criteria. These criteria attempt to establish a selection methodology that will provide for good estimation. They include: 1) diversity in geographic location, 2) diversity in nonsystematic shocks and 3) diversity in market structure.

Geographic diversity is highly important in small sample modeling. Areas with less correlation have the ability to provide additional understanding and insight. This is especially true when variables in each of the different cities move differently in terms of their pace or level or both. Therefore, selecting geographically diverse areas is an important objective, leading to selecting a region in each quadrant of the United States (i.e. North, South, East and West).

Another important consideration in regional selection is diversity of economic shocks. Since the purpose of the model is to observe the effects of shocks on the regional economy, areas that have undergone extraordinary shocks are preferred. The intent is to clearly observe the impact of a shock rather than systematic effects (i.e. white noise or a shock which hits everyone). Clearly, some regions like Detroit and its automotive industry and Houston with its natural resource concentration experienced adverse shocks in their economy, and thus become good candidates.

A third selection criterion seeks regions with structural differences in their economies, namely their housing and labor markets. Metropolitan areas that exhibit structural differences can provide additional benefit in the analysis by comparing observed similarities and differences. Ideally, evaluating every major metropolitan area would enhance the model's estimating effectiveness, however, the magnitude this task is overwhelming. Therefore, applying a simple model to four reasonably different cities will generate conclusions about innovations at the metropolitan level, albeit not entirely significant in terms of statistics. Most importantly, the strength of any hypothesis is enhanced by the observation of synchronous movements between variables of each region.

Per the reasons identified above, the metropolitan areas of Atlanta, Boston, Detroit and Houston are chosen for estimation. The following section defines the geographic boundaries of each region, the specific data used and the observable trends, which are relevant to modeling regional economic effects.

3.2. Unit of Estimation

The most appropriate geographic measuring unit is the Metropolitan Statistical Area (MSA). MSAs are large population nuclei that include adjacent communities. MSAs have a high degree of economic and social integration with the nucleus or central city. They are defined by the United States Census Bureau for purposes of socioeconomic measurement and comparison. Each MSA usually consists of one or more entire counties or county equivalents. The exception is in New England, where MSAs are made up of towns and cities rather than counties. For Boston, the New England County Metropolitan Area (NECMAs) is used instead of the Boston MSA, since the NECMA definition is made up of entire counties and is consistent with the MSA definitions of other areas in the country.

Modifications to MSA definitions (i.e. the geographic boundary) occur when "outlying counties" meet the requirements of metropolitan character (such as population density and percent urban)[15]. In general, most MSAs across the US were modified in 1958, 1971, 1975, 1980, and 1990[16]. Changing definitions are a concern when quantifying data over time. Therefore, to provide a better estimate of the regional model, each MSA is based on a specific definition, which is held constant over time. The following MSA definitions are used in estimation and are depicted in **Appendix 3-1**:

[15] New England is the exceptions where MSAs are defined in terms of cities and towns rather than counties.

[16] Changes in the definitions of MSAs since the 1950 census have consisted chiefly of (1) the recognition of new areas as they reached the minimum required city or area population; and (2) the addition of counties or New England cities and towns to existing areas as new census data showed them to qualify. Also, former separate MA's have been merged with other areas, and occasionally territory has been transferred from one MA to another.

1. **Atlanta**
   (1982 MSA definition) - includes the counties of Clayton, Cobb, DeKalb, Fulton and Gwinnett Counties, GA

2. **Boston**
   (NECMA definition) - includes the counties of Essex, Middlesex, Norfolk, Plymouth and Suffolk Counties, MA

3. **Detroit**
   (1982 MSA definition) - includes the counties of Macomb, Oakland, Wayne Counties, MI.

4. **Houston**
   (1983 definition) - includes the counties of Brazori, Fort Bend, Harris, Liberty, and Montgomery Counties, TX

Although most MSA are considerably larger in 1990 than their 1960 definitions, the slightly older definitions used for the model are assumed to be a sufficient geographic boundary for estimation. Further, had 1960 data been adapted to fit the 1990 definitions, serious errors may have resulted in the construction of the housing stock series[17].

3.3. Data Description

This next section describes the specific sources of information and how each data series is constructed for estimation. Further, the integrity of the data is assessed in terms of the potential issues emerging from their use.

I. Single Family Housing Price

As stated in chapter two, housing price is a proxy for housing demand. The price series is constructed from MSA level data available from three different sources. The first source, Freddie Mac, a large securitizer of home mortgage loans, publishes a price series on existing house sales. "The series is based on a large sample of repeat sales and uses a match sales methodology, but goes back only to [1974]." (Wheaton 1992). This series by Freddie Mac series is the most desirable for its large sample size and given that it is generated from repeat sales, which controls the observed price index for housing quality. Yet, with the Freddie Mac data beginning in 1974, there would only be

[17] Refer to section 3.1.3 (b) for a detailed description of the methodology used to construct the stock series.

20 data points for the analysis. Given the small series of data points, other price data is necessary for a statistically significant sample.

Two other sources of house price data exist that begin as early as 1963. The US Department of Commerce produces a quality controlled index that is less desirable since it neglects land value by only pricing the house. Second, the Federal Home Loan Bank (FHLB) produces a non-quality controlled index covering existing units. This series has inherent sample biases given that it only covers the sale prices of homes with FHA mortgages. However, DiPasquale, Wheaton show that the FHLB and Freddie Mac indexes have similar movements between 1974 to 1990 and appear to reflect expected price cycles of boom and bust periods. Given the correlation between the two price series, the FHLB data is scaled with the Freddie Mac data so that a continuous price series is constructed with Freddie Mac repeat sales used for the period between 1974 and 1994, and the FHLB series used for the period between 1963 and 1973[18].

The integrity of this data largely depends on the quality and size of the sample of repeat sales occurring year to year. Further, given that the index is entirely comprised of resold homes, there is undoubtedly some bias toward homes that are resold. Nonetheless, it is the most reasonable proxy for demand available and it is assumed to be an acceptable estimate of future price movements.

II. Single Family Stock

Again, the single family stock series represents the supply of housing within the MSA. This series is calculated from two data sources. First, the Census bureau provides a total unit count by dwelling type[19] for each county within the country. Unfortunately, this unit count is only determined every ten years (i.e. 1960, 1970, 1980 and 1990). Therefore, some measure of how the stock changes year to year between decennial counts must be estimated.

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[18] Once a house price data series was created, the series needed to be deflated to correct for inflation. Converting the indexes from nominal to real terms was accomplished using the Consumer Price Index for All Urban Consumers (CPI-U) which is composed by the Bureau of Labor Statistics

[18] The following methodology converted the nominal price series to real values: Nominal Price = Real Price *(CPI-U/100) Finally, the two deflated indexes were scaled so they could be put together. This methodology required the calculation of a ratio for the Freddie Mac index value for the year 1974 to the FHLB index value for the same year. This ratio was then multiplied by the FHLB series for the preceding years (i.e. 1963 through 1973)

[19] Unit type refers to how the unit is structurally organized. This is to say that a unit that is attached to another unit and is not labeled single family attached, is considered to be multi-family stock and is not considered part of the single family stock series.

With no annual unit counts available, the most appropriate gage of an annual stock series appears to be construction activity. If the number of units constructed is measurable, conceivably these constructed units can be cumulatively added to the stock in each year beginning in 1960. However, if the only measure available gauging construction is the total number of building permits issued, a calculated scrappage rate must account for the numbers of permits not built and units built illegally. Moreover this permit scalar would also account for measurement errors and demolition or any decrease in the existing stock.

Generally, with absent annual unit counts, changes in the housing stock series are estimated by using the number of single family building permit issued. The source of this data is the Census Bureau's C-40 construction series, which lists the totals by unit type for MSAs, counties and all permit issuing places within the country. To compile this information, the Census Bureau surveys 8,300 out of 17,000 permit issuing places nationally, requesting figures on the number of residential and nonresidential permits issued in the preceding month. Using this data, the Census Bureau creates estimates of the permit issued for those places not responding to the survey or not included within the sample by first using the number of estimated permit figures occurring in the prior year's survey for the specific permit place and second, by using recent data collected in the survey from the current year.

Obviously without an actual count, the Bureau's methodology, inherently has some measurement and estimation error. However, these errors are assumed to occur systematically and should not severely affect the observed level changes occurring between the decennial census years. More specifically, the stock series is compiled through the following methodology:

Geographic definitions are chosen for each MSA (i.e. the 1983 definition) by first, taking a cursory look at the spatial organizations of the region and including those counties which appropriately consider the urban area of the region as it is today. Second, the included counties also attempt to simplify data collection and further avoid potential errors.

Once MSA definitions are determined (see Section 3.1.2), the number of permits issued between 1960 and 1994 is obtained from the C-40 series published by the Census Bureau. County totals are consolidated and aggregated into a total MSA count.

Because the total number of surveyed permit issuing places changed approximately every four years, the total permit count under each MSA required scaling. In most cases, a scaling factor is provided by the Census Bureau for each MSA in the years when the survey is expanded to include more permit issuing places[20]. Again, the purpose of the construction series is to gage changes in stock, hence, actual numbers are not as important as the observed ratio of one year's number to the next. Therefore, once each permit series is consolidated and scaled to correct for definitional changes and changes in survey size, the annual stock series for each MSA is constructed[21].

III. Employment

The basic measure of employment or labor supply is the establishment-based total nonagricultural employment series provided by the Bureau of Labor Statistics (BLS) Employment and Earnings. MSA data series is from 1960 to 1994 and expressed in terms of a level in thousands (x1000) of employees.

[20] The updating process involved adding permit issuance for the prior year to the prior year's stock level. However, because such addition includes unused building permits and ignores scrappage of housing units, unit totals for 1970, 1980, and 1990 are higher than those reported by the Census Bureau. The following example of the calculation of the unit total in 1961 demonstrates how these important issues were taken into account:

$$Stock_{1961} = Stock_{1960} + (Permits_{1960})\frac{Stock_{1970} - Stock_{1960}}{\sum_{1969}^{1960} Permits}$$

This process was repeated for each of the 30 years included in the study and for the single and multi-family housing stock series. For example, in Detroit (as in all other MSAs), the number of permitting places was increased 4 times between 1960 and 1994. Scalars are provided in the same year that an increase takes place, which meant that the following scalars were provided in Detroit: 100.4 in 1967, 103.3 in 1972, 102.0 in 1978, and 100.2 in 1984. The 1967 scalar may be interpreted to mean that the 1967 count of permits issued in Detroit is 0.4% higher than it would have been without the increase in number of permit issuing places from which permit counts were taken. This makes possible correction for increases in permit issuing places. For example, in order to convert the 1984 permit count to what it would have been with the number of permit issuing places used in 1960, the following calculation was made:

$$1985Permits_{Adjusted} = \frac{1985Permits_{Unadjusted}}{100.2 * 102.0 * 103.3 * 100.4}$$

The issue most apparent in using the BLS employment series is the lack of specificity in describing the type or quality of jobs present in the region. Further, if wages are assumed to be rising, what is the cause to this result? Is it higher paying jobs (i.e. increased skill levels) or a shortage of workers, or both? Attempting to control for both quality and quantity in a simple regional model is impractical, hence it is more efficient to observe level changes and speculate about potential structural changes.

IV. Wages

The wage series used in the analysis represents the real or deflated income received per worker in each MSA. The series is constructed from the annual nominal per capita income using both population and employment estimates provided by the BLS. This measure is constructed by multiplying income per capita by the population to arrive at the total amount of income earned in each MSA. This total income figure is then divided by total employment to arrive at income per worker, which is the proxy for wage[22].

Although income per worker is just a proxy for wage, and it represents total income over by total workers rather than average worker earnings, some demographic and socioeconomic dynamics that may go unnoticed. These dynamics include: 1) increases in actual earnings as labor participation decreases; or 2) increases or decreases in dual income households (i.e. changes in human capital[23]); or 3) changes in non-wage income; or 4) skill mix changes in the regional labor force.

Similar issues as with employment data, the wage series says nothing about why increases or decreases actually occur. Is the employment force increasing it skill level or is the supply of labor dropping or both? Moreover, these changes may seriously affect the understanding of results in estimation and analysis.

3.4. Descriptive Statistics

The prior section described data used in analyzing regional dynamics. However, to determine model fit, observing and understanding past movements and adjustments in prices, stock, employment and wages is important. The descriptive statistics for each data series are reported by MSA in **Table 3-2**

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[22] Specifically the methodology is described mathematically by: $YPC_t * POP_t = TME_t$ (Total Metro Earnings), then $TME_t / EMP_t = YPW_t$(Income per Worker), therefore $YPW_t = Wage_t$

[23] Changes in human values, skills, self-confidence and reputation whereby persons are more likely to be employed and in a better job.

below. These statistics provide the annualized rate of change and year to year variation (i.e. standard deviation) observed for a 30 year window (1964-1994).

Table 3-2
Descriptive Statistics for Price, Stock, Employment and Wage
in Atlanta, Boston, Detroit and Houston (1964-1994)

	Atlanta	Boston	Detroit	Houston	US(avg.)
Annual Population, Employment & Wage Growth					
Population Growth	2.78%	0.28%	0.13%	2.89%	N/A
St.Deviation of Growth	0.82%	0.40%	0.75%	1.60%	N/A
Employment Growth	4.8%	1.7%	1.5%	4.1%	2.5%
St.-Deviation of Growth	3.1%	2.7%	3.6%	4.2%	2.4%
Wage Growth	2.87%	0.84%	0.40%	3.55%	N/A
St.-Deviation of Growth	3.13%	2.94%	2.52%	3.19%	N/A
Annual Change in Real Housing Prices					
Mean Annual Inflation	0.71%	4.16%	0.98%	-0.32%	N/A
St.-Deviation of Inflation	4.05%	7.83%	6.29%	5.76%	N/A
Annual Change in the Single Family Housing Stock					
Single Family Stock	3.04%	0.88%	0.85%	2.33%	N/A
St.-Deviation in Growth	1.00%	0.71%	0.43%	2.18%	N/A

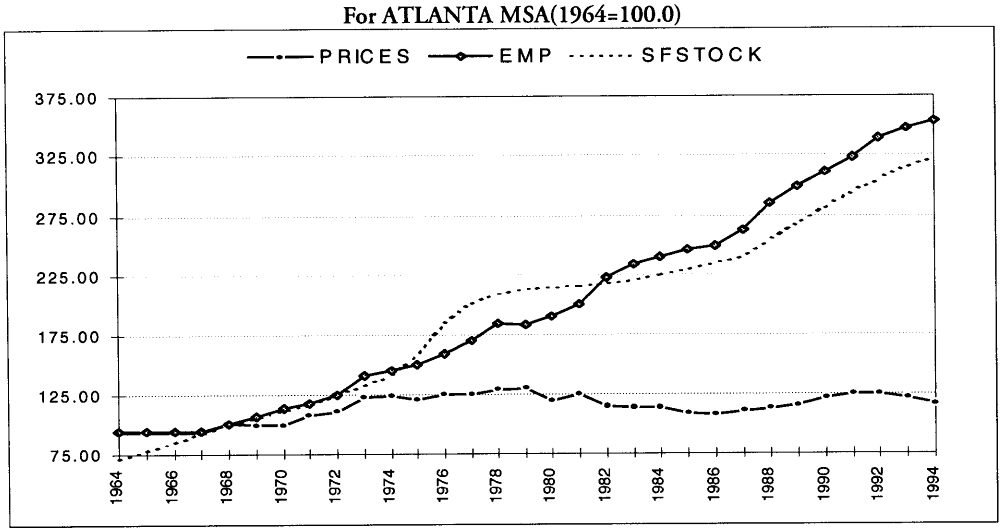
Table 3-2 highlights important trends in housing prices, employment and the stock that are worth noting. These trends are addressed by MSA and later by regional groupings. The classification system later becomes the fundamental criteria used to describe the results and findings of chapter five..

3.5. Trend Analysis

I. Atlanta

Figure 3-1 presents the observed changes in prices, single family housing stock and employment for the Atlanta MSA. Despite an impressive rate of employment growth, price inflation in Atlanta is flat. **Figure 3-1** shows the housing stock keeping pace with regional employment growth while house price inflation remain level. On average, Atlanta's real home prices rose 0.71 percent a year between 1964-1994, while employment boomed at 4.8 percent. The stock increased 3.8 percent annually during the same period. Generally, annual house price inflation in Atlanta varied slightly year to year, with a 4.05 percent standard deviation over the past 30 years (see **Table 3-2**).

Figure 3-1
Prices Employment and Single Family Stock
For ATLANTA MSA(1964=100.0)



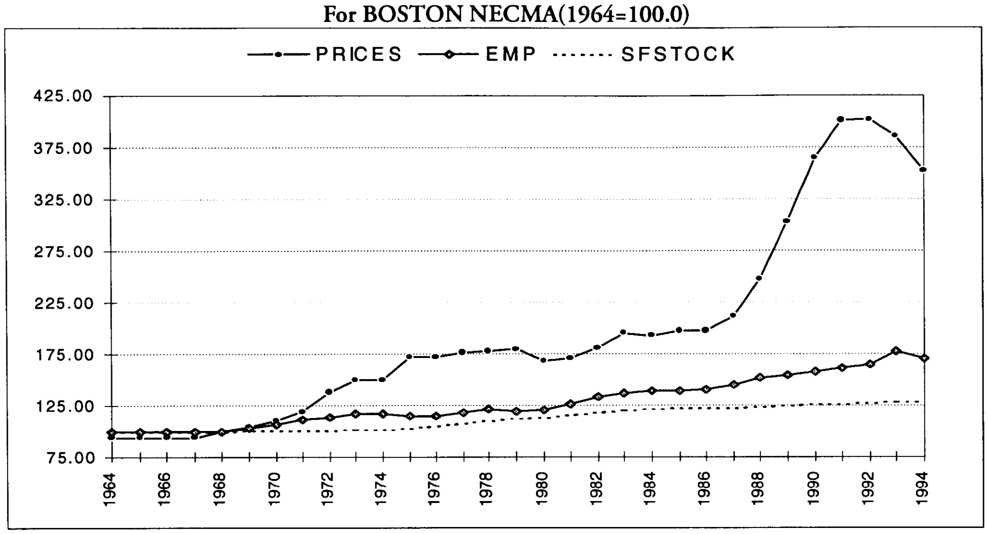
Atlanta's employment and housing trends suggest one of two effects. First, the region has a fairly elastic housing supply, where the market has short out of equilibrium adjustment periods. A second effect may be that Atlanta's building industry is rather robust despite modest fluctuations in price. This latter effect appears to be more plausible.

II. Boston

Figure 3-2 presents the observed changes in prices, single family housing and employment for Boston. Notably different from trends occurring in Atlanta, Boston employment and housing stock growth are flat. **Figure 3-1** also shows a high rate of price inflation despite meager economic and housing stock growth.

Home price inflation in Boston skyrocketed an average 4.16 percent annually between 1964-1994. The price increases occurred concurrently with a 0.28 percent growth in employment and 0.88 percent growth in stock (see **Table 3-2**).

Figure 3-2
Prices Employment and Single Family Stock
For BOSTON NECMA(1964=100.0)



Variations in these trends are interesting. Boston's high price inflation also showed a high year to year deviation of 7.83 percent. Conversely, employment growth in Boston, despite being below the national average at 1.7 percent annually, is stable varying by a 2.7 percent over the past 30 years (see **Table 3-2**).

What do these trends say about Boston or similar cities? Boston's housing and labor market is established and does not or cannot experience the rates of growth experienced by growing regions like Atlanta. Further, the housing stock in Boston is unable to rapidly increase in quantity given high land costs and its availability. Therefore, prices can rise rapidly with a meager response in the supply of housing

In terms of employment, the manufacturing base has experienced and continues to experience structural changes. With manufacturing jobs diminishing, and high tech and service sector jobs increasing the net effect is a modest rate of growth in Boston's employment level.

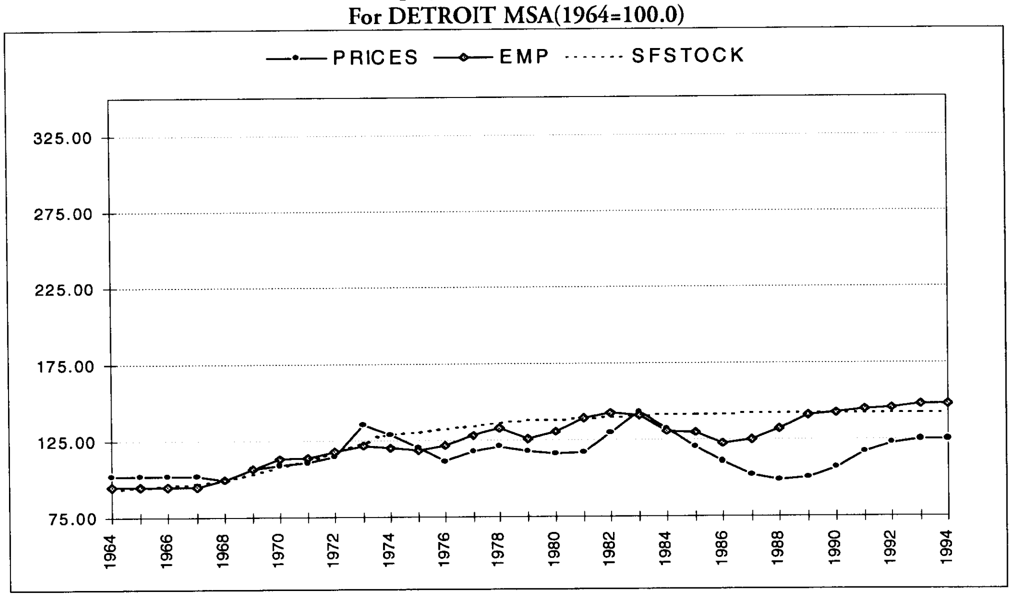
III. Detroit

Figure 3-3 presents the observed changes in prices, single family housing and employment for the Detroit MSA. Again, the trends in Detroit are quite different from those observed in Atlanta and

Boston. **Figure 3-3** shows a weak and slowly growing regional economy where in Detroit prices, employment and the housing stock growth are all horizontal.

Detroit's price inflation and employment growth appear to have a high degree of correlation with each other. The region experienced employment growth of 1.5 percent, way below the national average of 2.5 percent. Detroit's weak rate of employment growth still found house prices inflating 0.98 percent annually. Irrespective of weak growth in employment and housing, Detroit is similar to Boston where a fixed supply of land in an older city appears to push prices up. Moreover, these older established housing and labor markets like Detroit grow comparatively slower than newer regions like Atlanta.

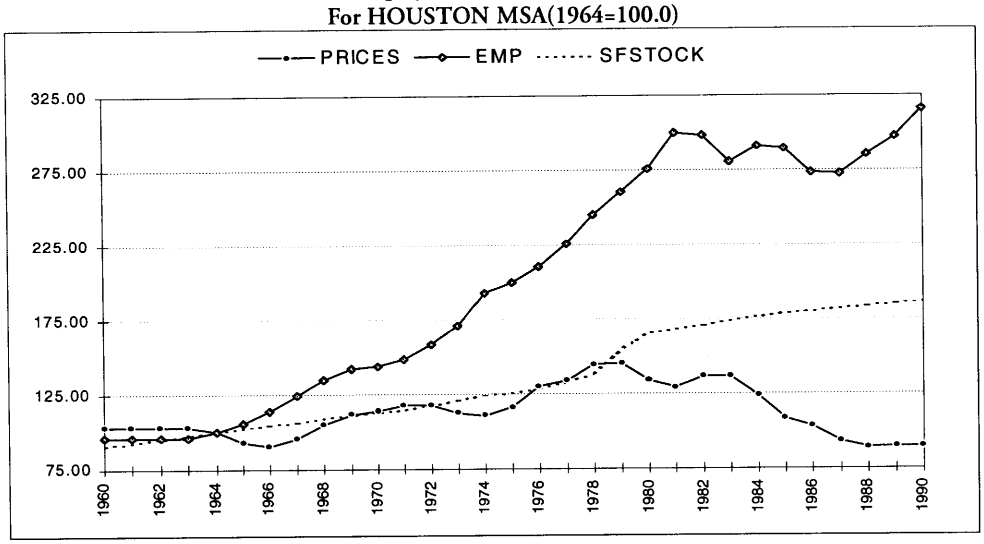
Figure 3-3
Prices Employment and Single Family Stock
For DETROIT MSA(1964=100.0)



IV. Houston

Figure 3-4 presents the observed changes in prices, single family housing and employment for the Houston MSA. Houston's pattern of growth is very similar to Atlanta. **Figure 3-4** finds a growing employment and housing stock while real prices declined. Most interesting is the upward tend of Houston's employment level until the late 70's when the oil industry crashed. Undoubtedly, the high concentration within the energy sector has contributed to the extreme variations in employment growth year to year (standard deviation of 1.6 percent) See **Table 3-2**.

Figure 3-4
Prices Employment and Single Family Stock
For HOUSTON MSA(1964=100.0)



Houston, like Atlanta has a housing stock that is correlated with movements in regional employment. Both employment and the housing stock grew over 2 percent per year over the past 30 years (2.89 percent and 2.33 percent respectively). However, real home prices depreciated an average of 0.32 percent a year between 1964-1994 (see **Table 3-2**). Such flat or negative movements in prices despite increase in employment and stock mimic the patterns existing in Atlanta. Further, as a growing region, Houston's movements are fundamentally different from those occurring in Boston and Detroit.

Observing the individual movements in employment, stock and price are worthwhile. Providing a context for why and how these movements occur is also important. For this reason, each MSA is categorized according to its intrinsic land and labor structure. These structures are important since regions with similar organizations have correlated responses in prices, stock, employment and wages. Most importantly, these descriptions are used to discuss the model results and findings and frame the discussion of conclusions in chapters five and six.

3.6. Regional Typologies

Although Atlanta and Houston have somewhat different responses to shocks, their movements are more similar with each other than with the responses of Boston or Detroit. Therefore, the analysis presented in chapter five uses a set of two more broadly defined categories to describe results. These categories are the growth region and the established region. The specific regional definitions are based on their physical and socioeconomic structures.

I. Growth Regions

Growth region include Atlanta and Houston and are characterized by an ample supply of land and a growing urban center. These regions tend to have an employment base that is largely service sector including a number of growing industries. Spatially, growth regions are more suburban in character and have a poly-nucleated central city.

Higher rates of employment growth and a rapidly increasing housing stock is a common characteristic of a growth region. This is particularly true in Atlanta and Houston where employment growth outpaced the national average and the housing stock grew at nearly 2 to 3 times the rate of older more established cities like Boston and Detroit.

A rapidly increasing population is another attribute of growing regions. Undoubtedly, as employment increases, household formation increases and thus a higher rate of population growth is observed. Both Atlanta and Houston saw their populations grow at nearly 3 percent a year, or nearly three times the rate of older more established regions.

Flat housing prices are another trait of a regions like Atlanta and Houston. As the level of the stock is rapidly increasing, prices remain flat. Notably, as the housing stock rose in both growth regions, Atlanta had meager house price inflation while Houston's real prices actually declined.

Movements in price, the stock, employment, population and wages of growth regions are quite different, and in most cases the inverse of older more established regions.

II. Established Regions

The other important regional type is the established region. Established or older regions include Boston and Detroit, and are generally characterized by a constrained supply of land and an older urban core. These regions have an employment base rooted in traditional manufacturing that is generally in transition toward more higher technologies and service sector employment. The outlying suburban areas of these older regions have garnered most of the regional growth observed in the data, largely at the expense of the central city.

Established regions have comparatively higher price inflation and inelastic housing supplies than growing regions. Boston had an incredibly high rate of annual price inflation, nearly 4 times the rate of the growing regions and three times the rate of Detroit. Although Detroit didn't exhibit as high inflation as Boston, its growth in prices still outpaced those of Atlanta and Houston.

Established regions have employment growth that is typically lower than the national average. Wage growth is flat with a work force concentrated in declining industries. Boston and Detroit showed meager annual employment growth, nearly one percentage point below the national average, with wages showing roughly one-half a percentage increase each year (with growth regions approximately three times higher). This point may be less significant given that growth regions may initially have had marginally lower wages.

Low population growth is another characteristic of older regions, that tend to lose employment and households to growing regions. Both Boston and Detroit saw less than an 0.3 percent increase in their populations. Regions that find employment and construction slowing as house prices rise are less attractive to migrating population and generally have a diminishing growth trend.

Table 3-3 summarizes the fundamental differences between growth regions and established regions. These differences are used to explain results and findings presented in chapters five and six.

Table 3-3
Summary of Differences between Growth and Established Regions

Regional Factors	Growth	Established
Prices	Flat/Stagnation	Rising/High Inflation
Employment	High Growth Stable Rate	Low Growth Stable Rate
Housing Stock	High Growth Rate Varies	Low Growth Stable Rate
Wages	Modest Growth	Low Growth
Population	High Growth	Modest Growth

The next chapter describes the methodology used to create a model which estimates dynamic movements in regional economic factors

4. The VAR Methodology

This chapter outlines the process of how a simple model is constructed to observe the regional economy and the innovations between the housing and labor markets. With just two sources of information useful in forecasting, historical data and knowledge about the system generating the data, the intent is to provide good estimates. Although there are many explanations for what causes real estate cycles, theories point to a variety of economic shocks including serial correlation in the data. Given that these correlations are thought to exist, the housing market is therefore modeled by using a restricted vector autoregressive (VAR) technique.

The VAR methodology uses times series data between 1960 to 1994 for four variables including price, housing stock, employment and wage, in four metropolitan regions; Atlanta, Boston, Detroit and Houston. This chapter provides; 1) a discussion and justification for the use of a VAR model and its apparent econometric shortcomings, 2) hypothesis testing and model specification and 3) methods of estimation and applied analysis.

4.1. Baseline Modeling Technique

The chosen form of a restricted VAR approach provides a simplified model of the regional economy. Why use a VAR? To answer this inquiry, a brief overview of the VAR approach, its premise and obvious shortcomings are described below.

I. Premise

A restricted or "structural" VAR approach creates a multivariate endogenous system whereby parameters are estimated. Applying this approach to the regional economy, the parameters of price, stock, employment and wage are estimated as levels through four simultaneous equations. The VAR methodology is based on the work of Sims(1980). Sims initial model has been augmented and refined over the last decade, especially in terms of the economic interpretations pulled from its results. Ooms(1994) finds that the basic estimation procedure of a VAR approach, the least square regression is well understood, easy to apply and known to be quite robust in terms of its ability to model the important characteristics of a time series[24]. However, the issue is whether this linear model provides a fair description of movements in regional housing and employment markets.

The general premise of a VAR model is that it provides a summary of all the variances and covariances of the variables and their lagged values, implying that these values are a good measure of the parameters being estimated. More simply, the VAR model is a system of internally determined variables highly dependent on the observations happening in prior periods (i.e. today's price is determined by yesterday's price, stock and employment)[25]. Therefore, each variable is written as a linear function of its own lagged values and the values of current and lagged variables in the system. The basic VAR model has the following form:

$$y_t = \sum_{s=1}^{L} B_s y_{t-s} + \varepsilon_t \qquad (1)$$

Where y is an (n)-vector of variables and B is an (n x n) matrix.

More simply, without an intuitive understanding of matrix algebra, a two variable unrestricted VAR system with (p) order of lags would be estimated by the two following set of simultaneous equations:

$$x_t = \alpha_{xt} + \beta_{x1} x_{t-1} \ldots + \beta_{xp} x_{t-p} + \beta_{y1} x_{t-1} \ldots + \beta_{yp} x_{t-p} + \varepsilon_{xt} \qquad (2)$$

$$y_t = \alpha_{yt} + \beta_{y1} x_{t-1} \ldots + \beta_{yp} x_{t-p} + \beta_{x1} x_{t-1} \ldots + \beta_{xp} x_{t-p} + \varepsilon_{yt} \qquad (3)$$

Note that y_t is dependent on past values of y_{t-1} through y_{t-p} and past values of x_{t-1} through x_{t-p}. Consequently, x_t is therefore dependent on the past values of itself as well as the past values of y_t. Given the structure of these two equations there are some inherent econometric shortcomings.

[24] The superiority of least squares is well established by Tjøstheim and Paulsen(1983), Hannan and McDougall(1988).

[25] The VAR process is often considered a Markov process since the observations at time t depend on observations at time t-1.

II. Econometric Shortcoming

Deciding which model is best for use in forecasting has generated considerable debate, especially under the heading of econometric issues[26]. Obviously, with four variables and a two period lag structure, an unrestricted VAR system would have 38 free coefficients, which presents a significant issue when there are only 30 years of data. Hence, a pure VAR approach yields estimation issues that need to be overcome.

A fundamental issue with the unrestricted VAR approach is the large number of parameters estimated when all independent and lagged dependent variables are placed on the right-hand side of each equation. Gilbert (1995) proposed that the number of parameters estimated in a VAR be reduced to retain the dynamic characteristics, yet in a smaller model. Further, "structural" VAR approaches were suggested by Bernanke (1986) and Sims (1986) as they used economic theory to determine what contemporaneous or current period structural restrictions should be imposed on the parameters, reducing the likelihood of obtaining insignificant results from reduced degrees of freedom and forecast errors.

From the suggested modifications to resolve issues of the unrestricted VAR, a possible solution to "overparameterization" is the restriction of "non-causal" variables through statistical tests that determine which variables and lags best estimate the system (i.e. Granger Causality Tests). These issues are carefully addressed through specification and hypothesis testing.

4.2. Model Specification and Hypothesis Testing

Estimation has inherent problems since its uses past and current information to generate probability distributions for future events. Compounding difficulties occur with the existence of limited data and measurement error. This section identifies the exact specification of the model by applying a series of hypothesis tests. In general, the intent of correctly specifying a model is not to create a system deemed real, but rather a model which corresponds well to observable data. The model specification process as noted by Kennedy (1991) is an innovative and imaginative process not capable of being taught. Further, he states that there is "no accepted best way of going about finding a correct specification."

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[26] Refer to McNees (1986)

Although a number of hypothesis tests abound, many are not applicable to testing the validity of a VAR[27]. The testing methodology used to specify the model is described within this section. These tests focus on issues of stationarity, linear transformation, causality and parameter lag structure.

I. Difference Stationary vs. Trend Stationary

Many scientific time series data are stationary, yet most economic time series data are trending (i.e. the mean changes overtime). Specifying an economic time series must first determine whether the data is stationary or should be made stationary through trend transformation or differencing.

Whether a set of variables in a VAR system should be stationary or non-stationary is the subject of much debate. Sims (1980) includes non-stationary variables while other researchers (Lupoletti and Webb, 1986) transform their variables by taking the rates of change[28]. Dua and Ray (1995) construct a model of income, employment and construction in levels with log transformations (i.e. applying a trend stationary process), with the exception of their unemployment variable[29].

Difference stationary refers to a model where there is infinite memory. Conversely, trend stationary refers to a model having a finite memory, with the impact of the error term restricted to the period in which it occurs. Hamilton (1994) finds that the trend-stationary process differs in the persistence of innovations, where the stochastic disturbance eventually wears off.

In general, stationary variables are preferred and Holden (1995) finds that the VAR should be estimated with stationary variables when they exist. However, in the presence of cointegration, the data series should remain non-stationary[30]. Holden also finds that it is incorrect to use differenced

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[27] It is important to note that in time series models standard t-tests are not good measures of specificity since the largest possible value for a coefficient on a lagged dependent variable is one. Consider that the OLS estimate of ß is Cov(Y,Yt-1)/Var(Yt). Of course, the covariance must, by Jensen's Inequality, be smaller than the variance, and thus ß has a maximum value of 1.

[28] The assumption that the nonstationarity is such that differencing (X_t - X_{t-1}) will create Stationarity. This concept is what is meant by the term integrated: a variable is said to be integrated of order d, written I(d) if it must be differenced d time to be made stationary (See Kennedy 1992 for a good discussion of unit roots and integrated variables).

[29] They based their approach on a model defined by Sims *et al.* (1990, p136)

[30] Cointegration states that there is a long run relationship among a group of time series variables

non-stationary variables in a VAR approach when cointegration is shown to exist[31]. Moreover, he states that in the presence of cointegration, using differenced variables will generally lead to poor forecasting results.

To test for cointegration and stationarity of the MSA level data, a Dicky Fuller test is applied. Results indicate that the null hypothesis for the existence of a unit root could not be rejected assuming a 90% confidence level[32]. Therefore, specification of the model assumes cointegration between variables of the system. Further, non-differenced or the levels of each variables are used for estimating housing price, single family stock, employment and wage.

Another necessary test on each series is the trend stationary hypothesis, where the process asks whether the data series is trend stationary and whether a linear transformation should be made. For example, assuming that housing units increase proportionally with total employment says that the total number of employees moving to a region is a constant fraction of the current number of units. Because such conditions are rare in economics (i.e. constant proportional growth[33]), economic relationships are generally assumed to grow in exponential form. Therefore taking the natural log of the exponential trend, yields a linear trend useable in a ordinary least squares (OLS) regression.

Kennedy(1991)[34] describes a method for testing an exponential trend. These tests found that the null hypothesis (i.e. no trending exists) could not be rejected. Therefore the series on price, stock, employment and wage are assumed to be exponential and are transformed to a linear form by taking the natural log of the trend. Hence, all four variables, price, stock, employment and have constant elasticity in a "log-linear" form.

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[31] The Granger Representation theorem (see Engle and Granger, 1987, p255) states that the cointegrated variables are related through an error correction model (ECM) which includes the differenced variables and also the levels of the cointegrated variables.

[32] See Appendix 4-4

[33] Refer to Hamilton (1994) pg. 435, and pages 438-44 for a more detailed explanation of trending economic variables

[34] Specifically this is $\log(y_t) = dt$ The tests for non-linearity was achieved by breaking the data into sub-groups based on the magnitude of the independent variable being tested for nonlinearity and then run separate regressions for each sub-group. Since these separate regressions were significantly different from one another, the functional form was believed to be non-linear (refer to Kennedy 1994 Pg. 105-106)

Now with the model specified as a log-linear system, what variables should be included to best estimate price, stock, employment and wage? More specifically, what "causes" adjustments in these variables to occur? First, economic theory is used to narrow the selection of variables used to estimate regional economic movements. Following the application of economic theory, statistical tests are used to determine causal relationships. These relationships are defined through Granger Causality tests, which attempt to determine what parameters best estimate future values of each dependent variable.

II. Causality and Variable Selection

The basic methodology of using Granger Causality tests in variable selection is quite simple. Granger (1969) proposed a concept of "causality" based on the prediction error, where x is said to Granger-cause y if y can be forecast better using past y and past x rather than just past y alone. Doan(1992) states that "cause" is a loaded term, and many articles are written about whether this concept is a proper definition of causality.

Causality test conducted on each city determines whether the independent variable is exogenous in a bivariate relationship with the dependent variable. The Granger Causality test is described by the following procedure where the VAR has a lag length p and x is tested for Granger Causality of y:

Again, the VAR system with (p) order of lags is estimated by the two following set of simultaneous equations:

$$x_t = \alpha_{xt} + \beta_{x1}x_{t-1}...+\beta_{xp}x_{t-p} + \beta_{y1}x_{t-1}...+\beta_{yp}x_{t-p} + \varepsilon_{xt} \quad (2)$$

$$y_t = \alpha_{yt} + \beta_{y1}x_{t-1}...+\beta_{yp}x_{t-p} + \beta_{x1}x_{t-1}...+\beta_{xp}x_{t-p} + \varepsilon_{yt} \quad (3)$$

In equation 1, the group of variables represented by y is block exogenous in the time series sense with respect to x, if the coefficients on y variables are of cumulatively no greater help in improving a forecast of x (i.e. $\beta_{yt} = 0$), than only using the coefficients of lagged values of x (i.e. the dependent variable or β_{xt}).[35]

[35] Hamilton (1994)

Application of the test above used a critical value of 10% for the F distribution. Therefore, if a F-value of greater than .10 is found, the null hypothesis of Granger Causality is rejected. The matrix of causal results is presented in Table 4-1. All dependent variables are listed vertically in the left column. Independent variables are shaded when the null hypothesis is rejected at 90% confidence. Essentially, the horizontally listed variables Granger Cause vertically listed variable where α=0.10. The number in parenthesis is the F-test for the null hypothesis that the coefficient on the independent variable is zero (i.e. no causality). The matrices presented in Table 4-1 assume a two period lag structure.

Table 4-1
Granger Causality Tests of Exogeneity by MSA level Series

ATLANTA

Dependent	Price	TStock	SFStock	Employ	Wages	SFPer
Price	•	YES (.033)	YES (.049)	• (.39(	• (.369)	•
Single-Family Stock	•	•	•	•	YES (.001)	•
Employment	•	•	•	•	YES (.0095)	•
Wages (income per worker)	YES (.10)	•	•	• (.54)	•	•

BOSTON

Dependent	Price	TStock	SFStock	Employ	Wages	SFPer
Price	•	YES (.035)	YES (.007)	YES (.005)	• (.43)	• (.23)
Single-Family Stock	• (.77)	YES (.02)	•	• (.66)	• (.20)	YES (.050)
Employment	• (.31)	• (.087)	YES (.037)	•	YES (.049)	• (.059)
Wages (income per worker)	• (.26)	YES (.10)	YES (.07)	YES (.002)	•	• (.57)

DETROIT

Dependent	Price	TStock	SFStock	Employ	Wages	SFPer
Price	•	• (.109)	YES (.09)	• (.17)	YES (.08)	• (.29)
Single-Family Stock	• (.95)	• (.25)	•	• (.19)	• (.19)	YES (.000)
Employment	YES (.006)	YES (.049)	YES (.061)	•	YES (.055)	YES (.046
Wages (income per worker)	• (.24)	• (.13)	• (.11)	• (.17)	•	• (.69)

HOUSTON

Dependent	Price	TStock	SFStock	Employ	Wages	SFPer
Price	•	YES (.035)	• (.23)	YES (.018)	• (.070)	YES (.036)
Single-Family Stock	YES (.009)	YES (.10)	•	YES (.020)	• (.110)	YES (.000)
Employment	• (.89)	YES (.08)	• (.11)	•	• (.35)	• (.90)
Wages (income per worker)	• (.80)	YES (.001)	YES (.008)	YES (.001)	•	• (.66)

From the two period lag "causality" test shown in **Table 4-1**, a number of strong relationships are observed. Notably, in all four market areas either wages or employment, or both Granger cause price. This implies that prices in the current period are correlated with wages and employment levels of prior periods.

Another strong relationship exists between some form of the stock series (i.e. total stock, single family stock or permits) and the series on price. The TStock series, which includes both the multi-family and single family units, and the series SFPer (i.e. Single Family Construction) have causality the highest causality on the estimation of the single family stock series. This result strongly suggests that single family stock is block exogenous or determined by its own innovations occurring in prior periods.

The causality of employment is less certain. Employment is Granger caused by different variable in each market, yet, wage has the greatest frequency of causality on employment, appearing in 3 out 4 MSAs. Detroit is the exception. Therefore, by observing the results in **Table 4-1** the best estimator of employment in time period t, appears to be first, employment in t-1 then wages in t-1 and t-2.

With innovations in employment tied to wages and prices, the causality of wage is yet undefined. Inspection of **Table 4-4** show price and employment levels with the highest causality on wage in most markets, again Detroit is the exception. Wages in Detroit seem to have no other variable providing a better estimate of future wages than prior wage levels themselves. Therefore, past wage levels appear to be the best estimator of future wages with employment levels in time t-1 and t-2 having stronger causality in other MSAs. These results suggest that wage's characteristics are strongly exogenous..

The results of the Granger Causality test are consistent with the a priori economic theory. Given the causal relationships described above between price, stock, employment and wage, a testing strategy is employed to specify the VAR model.

III. Testing Strategy

Given that typical testing measures of OLS estimation (i.e. T-tests, R^2) are not applicable to VAR models, the testing methodology used to specify the model is far more intuitive, aside from the test of stationarity and causality previously described. The testing procedure defined a good result when a coefficients exhibited an expected sign. A correct sign, is a sign that is consistent with economic theory. The hypothesized movements are assumed to have the following relationships (see **Table 4-2**):

Table 4-2
Expected OLS Variable Signs on Coefficients

Independent Variable	Housing Demand (PRICE)	Housing Supply (STOCK)	Labor Demand (EMP)	Labor Supply (WAGE)
PRICE	+	+	N/A.	+
STOCK	-	+	N/A.	N/A.
EMPLOYMENT	+	N/A.	+	+
WAGE	+	N/A.	-	+

Application of the criteria shown in **Table 4-2** provided for the final specification of the VAR model. The only exception to the criteria is made in labor supply where movements appear to be sufficiently justifiable since a proxy is used for wage[36].

IV. Specified Model

The tests conducted in previous sections provided for the specification of four simultaneous equations used to estimate movements in price, stock, employment and wage at the regional level. This regional level VAR model is defined by the following:

$$LNprice_t = \alpha_{pt} + \beta_{p0} LNprice_{t-1} + \beta_{p1} LNstock_t + \beta_{p2} LNwage_t + \beta_{p3} LNemp_t + \varepsilon_{pt} \quad (4)$$

$$LNstock_t = \alpha_{st} + \beta_{s0,1,2} LNstock_{(t-1,t-2,t-3)} + \beta_{s3,4} LNprice_{(t-2,t-3)} + \varepsilon_{st} \quad (5)$$

$$LNemp_t = \alpha_{et} + \beta_{e0} LNemp_{(t-1)} + \beta_{e1,2} LNwage_{(t-1,t-2)} + \varepsilon_{et} \quad (6)$$

[36] Refer to section 3.1.3 on the data description

$$LNwage_t = \alpha_{wt} + \beta_{w0} LNwage_{(t-1)} + \beta_{w1} LNemp_{(t-1)} + \beta_{w2,3} LNprice_{(t-1,t-2)} + \varepsilon_{wt} \qquad (7)$$

Using these equations, future innovations in the regional economy and housing market are estimated. Methods used to derive the results and analysis presented within chapter 5 are described below.

4.3. Estimation Method

Previous sections of this chapter specified a VAR model with four equations and four variables all estimated in log levels. This section presents the approach used to analyze the data, including estimation, variance decomposition and impulses responses. Given the econometric structure of a VAR approach to forecasting, these techniques are the most appropriate tools in evaluating the results of this time series model.

Generally, VAR estimations produce a "memory," whereby each value is correlated with all preceding values. Therefore, an innovation or shock to the system has a diminishing effect on all subsequent time periods. Simply stated, the objective of a VAR model is to identify disturbances accounting for a significant amount of the observed variances in each parameter. Therefore, the primary tools used to estimate and analyze a VAR system are the impulse response function and forecast error variance decomposition[37]. Although the mathematical manipulations and calculations necessary to estimate the results of an impulse responses and a variance decomposition are complex,[38] a general description of the technique and the interpretation of results is provided below.

I. Impulse Responses

Impulse responses are computations of changes in system variables to a particular initial shock in one variable. Since the VAR is a complete dynamic system of equations with no exogenous variables, the easiest way of determining the dynamic multiplier of this system is through simulation. Simply stated the impulse response function plots the reaction of a given variable in time the to an exogenous shock in another variable, allowing all other variables in the system to adjust and take into account the impact of the adjustment. The system plots the row i, column j element of the coefficient's matrix as a function of a period s, with the following form:

[37] Judge e al. (1988) refers to the use of these analysis tools as innovation accounting.
[38] For a detailed description of the exact methodology used see Hamilton (1994) pgs. 383-390

$$\frac{\Delta Y_{t+s}}{\Delta \varepsilon_{jt}}$$

This form describes the response of y_{it+s} to a one-time impulse in y_{jt} with all other variables dated t or earlier held constant for the first period. In successive periods all other variables are permitted to change (i.e. "innovate") after which they adjust to new levels that are determined by their relationship to other variables in the system. The observed magnitude is response describes the effect of an innovation in the jth variable on future values of the variable in the system. This innovation is considered to be a linear combination of all structural disturbances[39].

Results from an impulse response measure the adjustments of a variable to a one standard error shock. These responses are measured in percentage terms as changes from the original level of each variable, including the variable being shocked.

Although each variable and its innovations are graphed, not all variable responses are relevant to the analysis. Therefore, determining the amount of disturbance attributable to each variable is critically important in assessing the significance of each impulse response result. The disturbances are closely examined by decomposing the variances (i.e. analyzing the forecast errors).

II. Forecast Errors

The variance decomposition of an impulse response presents the effects of independent variables on the innovation of dependent variables. In general, the forecast error variance is measured in percentage terms and represents the total forecast error variance attributable to the observed variable. The decomposition of forecast errors considers how each of the disturbances contribute to the Mean Squared Error (MSE). By observing the results, the contribution of each variable innovation to the MSE of the forecast period is calculated. Again, the VAR system with (p) order of lags has the following form:

$$x_t = \alpha_{xt} + \beta_{x1}x_{t-1} \ldots + \beta_{xp}x_{t-p} + \beta_{y1}x_{t-1} \ldots + \beta_{yp}x_{t-p} + \varepsilon_{xt} \qquad (2)$$

$$y_t = \alpha_{yt} + \beta_{y1}x_{t-1} \ldots + \beta_{yp}x_{t-p} + \beta_{x1}x_{t-1} \ldots + \beta_{xp}x_{t-p} + \varepsilon_{yt} \qquad (3)$$

[39] Refer to Hamilton (1994) pgs. 327-330

Using equation 3 of the VAR, the variance decomposition is the total percentage of the variance in y resulting from the disturbance in x. Therefore, when $\beta_{x0}...\beta_{xp}$. are large, it is said to have a greater affect on y and thus a higher significance in terms of its responses to a given shock.

The variance decomposition is a useful analysis tool when analyzing the impulse responses of each variable to a given shock. Most importantly, when a strange or illogical innovations is observed in the responses, a cursory look at the decomposition reveal the insignificance of the variable's shock path.

Again, each decomposition is measured in terms of a percentage, whereas the summation of all period one disturbances accounting for innovations in y equal 100 percent. Further these percentages increase and decrease in successive periods, which says that the innovations in y due to x are not static for each period.

Summarizing the events of this chapter, a framework for looking at housing and labor market responses at the metropolitan level is established. Specifically, use of a was VAR justified, the model was tested and specified and the process of estimation and analysis described. The next chapter presents the results and findings from application of the aforementioned methodology.

5. Results and Findings

This chapter builds on the previous chapters by providing housing and employment estimates for each metropolitan area modeled by the VAR approach specified in chapter four. **Appendix 5-1** presents the regression estimates and RATS[40] output for each MSA.

Generally, the results and findings estimate and describe the effects of different shocks on housing and employment within a metropolitan area. This chapter divides the results and findings into two sections -The first section reports the VAR results and the impacts of economic change. Each VAR result is presented as the coefficient are examined and analyzed for their fit. Most importantly, the specific movements of each variable to other economic factors are identified and comparatively analyzed by region.

The other half of this chapter is devoted to assessing the impacts of economic change on the regional economy. This is achieved by estimating the impulse response functions to four different economic shocks, including unexpected price inflation, a construction boom, an adverse employment shock and a jump in the wage level. This chapter concludes with a series of findings based on the analysis of: 1) model estimation performance, 2) the importance of providing a dynamic link between the economy and housing; and 3) the impacts of economic change on the residential market.

5.1. VAR Results

I. Price

Estimates for the relationship between price adjustments and regional variations in economic growth are presented here through the use of a VAR modeling approach described in chapters 3 and four. Looking at **Table 5-1,** each coefficient achieved the desired sign and relationship with one exception in the wage series for Detroit. The signs for estimating price found prices inflating when the stock is falling, when wages are rising and when employment is growing. Despite the relatively low degrees

[40] Regression Analysis of a Time Series - is a statistical application produced by Estima (1994) Evanston, IL.

of freedom depicted in **Table 5-1**, the model appears to provide a decent fit for regional house price data.

Table 5-1
Price Coefficients and VAR Regression Results

	Atlanta	Boston	Detroit	Houston
Constant	11.173	-3.957	9.465	8.182
LPRICE{1}	0.581	0.518	0.790	0.828
LSSTOCK	-1.165	-0.430	-1.226	-0.769
LYPW	0.520	0.609	-0.014	0.079
LEMP	0.512	1.139	1.144	0.361
R2	0.75	0.97	0.83	0.94
R2bar	0.70	0.97	0.80	0.92
DW-tests	1.89	0.74	1.88	1.41
Degrees Freedom	24	24	24	24

The VAR estimates (i.e. the coefficients) provided in **Table 5-1** are not easy to interpret. Therefore, viewing the adjustments in price resulting from changes in other regional economic variables is far more revealing. The adjustments to price or its elasticity with respect to a change in the level of stock, employment and wage are shown in **Table 5-2**.

Table 5-2
Price Elasticity with 1% change in:

	Atlanta	Boston	Detroit	Houston
Stock	-1.17	-0.43	-1.23	-0.77
Wage	0.52	0.61	-0.01	0.08
Employment	0.51	1.14	1.14	0.36

Observing the results of **Table 5-2** finds higher price elasticity with respect to the stock in Atlanta and Detroit and lower elasticities in Boston and Houston. The elasticities measure how much one variable moves with a 1 percent change in another variable. This says that a 1 percent increase in the housing stock finds prices falling by over 1 percent in Atlanta and Detroit (See **Table 5-2**). Such results are expected since both Atlanta and Detroit had the highest ratio of changes in price relative to change in their stock between 1964-1994 (see to chapter three).

Price elasticity to changes in wage are most sensitivity in Boston and Atlanta and least sensitive in Detroit and Houston However, an incorrect sign is found in Detroit's wage coefficient for price, thus questioning the effectiveness of the model in determining labor supply (wage), particularly in Detroit. Despite a relatively good model fit for the other three MSAs, the performance in Detroit is likely the result of substantial structural changes occurring in the labor force or the use of a proxy for wages, or both.

Another price elasticity namely to changes in employment are greater in established regions like Boston and Detroit, where a 1 percent change in employment finds prices rising by more than 1 percent. The higher price elasticity of employment within established regions is a likely result from the sluggish rate of employment growth, such that larger increases in employment are not expected and any increase generates substantial optimism, hence, generating higher price inflation. This also implies that growth regions are less affected by changes in employment in terms of their housing price. These finding concur with observation made in chapter four.

In general, the estimates find higher price elasticities with respect to the stock in growing regions and higher price elasticities with respect to employment in established regions.

II. Stock

The stock estimates of how regional variations in economic growth are related to housing supply are presented within **Table 5-3**. These estimates find the expected sign and relationship for every coefficient. Again, disregarding the relatively low degrees of freedom, the model appears to provide a decent fit for the estimation of housing supply within the metropolitan region[41].

[41] This statement temporarily ignores the fact that the model as specified in levels has no controlling mechanism for when prices continue to decline and the stock responds negatively in each period (i.e. it stock is dropping successively)..

Table 5-3
Housing Stock Coefficients and VAR Regression Results

	Atlanta	Boston	Detroit	Houston
Constant	-0.031	0.449	0.207	0.046
LSSTOCK{1}	2.065	1.767	1.657	1.547
LSSTOCK{2}	-1.628	-0.889	-0.885	-0.657
LSSTOCK{3}	0.564	0.088	0.212	0.103
LPRICE{2}	0.024	-0.003	0.019	0.105
LPRICE{3}	-0.019	0.008	-0.014	-0.093
R^2	0.999	0.998	0.998	0.996
R^{2bar}	0.999	0.997	0.997	0.995
DW-tests	1.82	2.01	1.95	2.01
Degrees Freedom	23	23	23	23

Looking closely at the estimates provided in **Table 5-3** find varying movements of current stock on past or lagged stock values. Given that these figures are not easy to interpret a more revealing description is derived from analyzing the adjustment in stock relative to changes in price, employment and wage (i.e. supply elasticities). These elasticities are presented in Table 5-4.

The supply (stock) elasticity with respect to price is highest in Houston. In Houston, a 1 percent increase in prices finds the stock increasing by over 1 percent, while Atlanta, Boston and Detroit have lower elasticities, yet, similar with respect to each other. (See **Table 5-4**)

Table 5-4
Housing Stock Elasticity with 1% change in:

	Atlanta	Boston	Detroit	Houston
Price (long-term - 3yrs x1000)	0.52	0.51	0.56	1.15
Wage (Short term)	1.19	1.20	1.35	1.12
Employment (Short term)	1.04	1.03	1.12	1.34

Other supply elasticities, like wage are highest in established regions like Boston and Detroit. Conversely, the housing stock of growth regions is relatively less elastic to wage changes. These finding are consistent with prior findings given that the housing supply is less elastic in established regions, where consumption wages must increase with prices to spawn new construction.

The remaining supply elasticity discussed is the stock's adjustment to changes in employment. These elasticities are nearly equal across regions, with Houston and Detroit having slightly higher elasticities. Explaining this variation in regions finds the level of diversification in the regional economy defining supply elasticity of employment. Since Detroit and Houston traditionally have had higher specialization in their economies, changes in employment have a dynamic effect in the region and undoubtedly impact the overall economy and, thus, the rate of construction.

Generally, the estimates for stock find greater supply elasticities with respect to employment and wage in both growing and established regions. Further, specialized economies have higher supply elasticities with respect to employment changes, where as diverse regions have higher supply elasticities with respect to changes in the wage level.

III. Employment

Estimates for employment are presented in **Table 5-5**. These estimates find strong relationships between employment and the regional economy. The estimation results provide a good model fit as each coefficient achieved the desired sign and relationship. Generally, these relationships find employment slowly rising as wages fall.

Table 5-5
Employment Coefficients and VAR Regression Results

	Atlanta	Boston	Detroit	Houston
Constant	0.260	0.392	0.992	1.540
LEMP{1}	0.962	0.968	0.885	0.885
LYPW{1}	0.434	0.269	0.004	0.657
LYPW{2}	-0.426	-0.296	-0.005	-0.791
R2	0.996	0.973	0.909	0.990
R2bar	0.995	0.970	0.898	0.989
DW-tests	1.76	1.27	1.11	1.58
Degrees Freedom	26	26	26	26

These estimates shown in **Table 5-5** find larger coefficients on wage in growing regions like Atlanta and Houston with smaller coefficients in established regions, like Boston and Detroit. However, adjustments in employment changes occurring with movements in price, stock and wage are more revealing. These employment elasticities are presented in **Table 5-6**.

Table 5-6
Employment Elasticity with 1% change in:

	Atlanta	Boston	Detroit	Houston
Wage (short term)	0.434	0.269	0.004	0.657
Wage (long term)	0.008	-0.027	-0.001	-0.134
Price (long-term - 2yrs)	2.163	0.513	1.274	1.504
Stock	0.964	0.970	0.894	0.747

Higher employment elasticity with respect to wage are found in Houston and Atlanta in the short-term and to a lesser extent in the long term[42]. This says that a 1 percent increase in wages finds employment increasing approximately one half of a percent in Houston and Atlanta, while both Boston and Detroit have marginal effects, 0.27 and 0.004 respectively (See **Table 5-6**).

Growth regions appear to have higher employment elasticities with respect to price, where a 1 percent positive change in price finds employment increasing by over 2 percent in Atlanta and over 1.5 percent in Houston. Conversely, established regions like Boston and Detroit have weaker employment elasticities when prices change (0.5 and 1.3 respectively). Again, the relatively higher price inflation of established regions enhances the plausibility of these findings.

Aside from changes in housing demand, employment elasticities with respect to the stock provide very similar results, with Houston and Detroit showing slightly a little less elasticity. Again, similar to estimates in stock, the level of diversification in the regional economy appears to define the degree of employment elasticity with respect to the stock in each region. Since Detroit and Houston have fairly specialized economies, changes in the stock find greater changes in employment.

Reviewing the employment estimates, the model finds higher employment elasticities with respect to price rather than wage. This result confers suspicions regarding the linkage between the housing market and the regional economy, albeit mildly. Further, specialized regional economies have employment levels that are more sensitive to price changes while diverse regions have a higher employment elasticities with respect to stock. Justification for these results is similar to those for the stock series, where specialized economies are more affected by employment innovations, which undoubtedly affect their rate of construction and thus, housing stock growth.

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[42] The time of these effects is determined by the order of lags on the wage variable where long term is a two year period and short term is equal to one year.

IV. Wage

Estimates for regional wage are presented in **Table 5-7**. These estimates indicate how adjustments to wages relate to the regional economy. The estimated results vary from expectations in terms of variable signs and relationships.. Although these relationships are justifiable through the existing structural and economic nature of the regions, the results are troublesome and question the effectiveness of the model's ability to estimate labor supply (i.e. wage). The expected coefficients in a labor supply equation would find wages rising as both employment and prices rise. The estimates in **Table 5-7** are therefore inconsistent with expectations.

Table 5-7
Wage Coefficients and VAR Regression Results

	Atlanta	Boston	Detroit	Houston
Constant	11.173	-3.957	9.465	8.182
Constant	0.622	1.086	1.416	-0.257
LYPW{1}	0.977	0.790	0.725	0.690
LEMP{1}	0.036	-0.011	-0.025	0.278
LPRICE{1}	-0.066	0.157	-0.027	0.024
LPRICE{2}	-0.10	-0.12	0.06	-0.10
R2	0.984	0.857	0.556	0.996
R2bar	0.982	0.833	0.481	0.995
DW-tests	1.35	1.59	1.44	1.59
Degrees Freedom	24	24	24	24

Although the results appear to contradict economic theory, there is consistency between growth and established regions. Both Atlanta and Houston correctly find employment increasing as wage supply increases, while Detroit and Boston are slightly negative, or employment decreases with rising wages. The coefficients for price have similar sign problems where rising wages in Atlanta and Houston find house prices falling. Yet, in Boston and Detroit the signs for price are positive (i.e. they move with wages). Despite these inverted results for prices and wages in Boston and Detroit they appear to be consistent with the findings of other researchers where the dynamic response of wages varies by state and by region[43].

[43] Blanchard and Katz (1992) found that the traditional heavy manufacturing states exhibit the smallest response of wages and personal income to employment. They describe these composition effects as reverse seniority at work or other structural changes occurring within the work force.

Wage adjustments resulting from changes in regional economic and housing market variables are presented in **Table 5-7**, wage elasticities.

Table 5-7
Wage Elasticity with 1% change in:

	Atlanta	Boston	Detroit	Houston
Employment (short term)	0.04	-0.01	-0.02	0.28
Price (long-term - 2yrs)	-0.17	0.03	0.03	-0.07
Stock	0.84	0.84	0.74	0.89

These wage elasticities are important analysis tool in that they describe how much wages adjusts to a 1 percent change in employment, price and the housing stock.

Growth regions of Atlanta and Houston have higher wage elasticity with respect to changes in employment as Boston and Detroit have falling wage elasticity with respect to regional employment. Essentially a 1 percent increase in employment finds wages increasing 0.28 percent in Houston and only 0.04 percent in Atlanta, while in Boston and Detroit wages fall -0.01 in Boston and -0.02 in Detroit (Refer to **Table 5-7**) Again, the results for Boston and Detroit violate the assumptions made in labor supply where both prices and employment are expected to rise with increases in labor supply. However, regional labor structure aside, there may be serious limitations in using the model as an estimate for labor supply.

Other wage elasticities including those relative to price are higher in established regions, where a 1 percent positive change in price finds wages increasing by 0.03 percent in Boston and Detroit. Conversely, growth regions have smaller wage elasticities with respect to price, where a 1 percent increase in prices finds wages dropping 0.17 percent in Atlanta and 0.07 percent in Houston.

The last wage elasticity discussed is in relation to changes in stock. Atlanta, Boston and Houston are all fairly similar exhibiting higher wage elasticities than Detroit (see **Table 5-7**). Again, prior research finds the effects of wage in heavy manufacturing regions, like Detroit to be less responsive to changes in other regional variables[44]. Once more, the results for wage are suspect and should be taken lightly.

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[44] Blanchard and Katz (1992) - Regional Evolutions, pg. 45

As an overview of the wage estimates, the model results for wage contradict a priori theory, yet the consistent movements between growth regions and establish regions indicate that the model is struggling with dynamic effects occurring with the labor market of each region. Moreover, the empirical work of other researchers find labor demand unresponsive to current wages and wages relatively weak in spurring job creation and job-migration[45]. Such results imply that the estimates for wage are questionable.

5.2. Impacts of Economic Change

As each estimation result is described in the prior section, this section addresses the various impacts of economic change on all regional variables modeled in regional economy. The objectives of this dynamic analysis are to:

1. Observe the behavior of price, stock, employment and wage across metropolitan areas;
2. Construct observable shocks and trace effects on price, stock, employment and wage by observing differences in timing and level changes;
3. Determine cumulative house prices changes following a labor and housing market shocks;
4. Identify the trends and relationships between variables and regions; and
5. Evaluate the estimation ability of the proposed model assuming that: 1) housing markets are best understood at the regional level; 2) a strong connection exists between the housing and labor market, and 3) the effects of a first period shock are predictable.

To best achieve these objectives, the results and findings are explained through four plausible economic shocks. Framing the analysis according to realistic scenarios provides an easy test for the reasonableness of the model. Testing the reasonableness, each shock first affect the variable being shocked and then dynamically all other variables in successive periods. The employed methodology uses impulse response functions and variance decompositions, as described in chapter four. The shocks used to account for the innovations in each variable are 1)unexpected price inflation, 2) a construction boom, 3) adverse employment demand and 4) a sudden wage hike. These shocks are described below.

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[45] Blanchard and Katz (1992)

Economic change resulting from unanticipated price inflation, finds house prices rising when there is an increased demand for housing within the region. This may include extreme reductions in ownership costs, increases in construction cost or a the persistence of a tight supply of desirable units.

Another economic change or observed shock in the regional system is a construction boom. This shock sees the addition of a sizable number of housing units placed into the regional economy. Such a shock may occur from development speculation, a drop in construction costs, the completion of several large developments, or the sudden release of units (e.g. military housing from a base closure).

Another shock with notably significant impacts on a region is an adverse shock in employment demand. An adverse employment shock would result from plant closings, or a decrease in the demand for a region's goods and services. Noteworthy examples point to Boeing in Seattle, the American auto industry in Detroit, petroleum in Houston and Aerospace in Southern California. Obviously when these regional goods and services are shocked there are strong effects on the regional housing and labor markets.

The last shock observed within the regional economy is a sudden wage hike. Such a shock occurs with a sudden loss of workers. This loss may result from increases in the cost of living or the comparatively low desirability of a region as a place to live and work. Each of the four shock described above intends to unravel the cross-sectional responses and sensitivities of the labor and housing market.

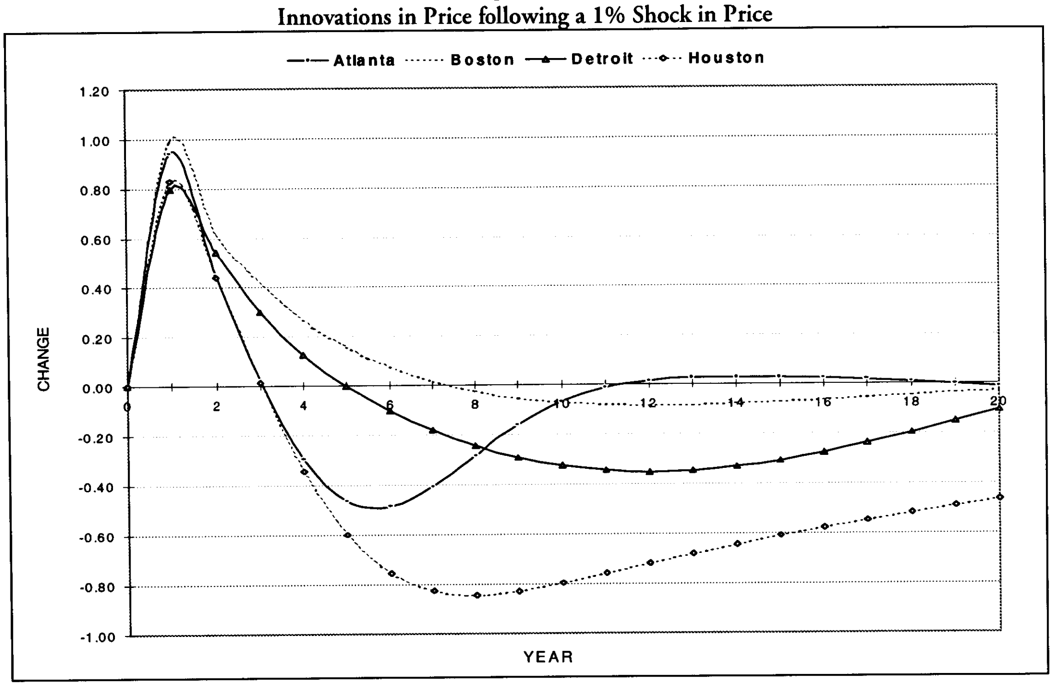
I. Unexpected Price Inflation

An inflationary price shock assumes that there is an external force increases housing demand and thus housing price. A shock in prices affects successive levels of housing price, stock, employment and wage. This section specifically addresses the impacts of economic change resulting from a shock in regional housing demand.

a) Price Adjustments

As regional housing prices abruptly rise, their pattern in successive periods finds them dropping down below their initial state then finishing practically unchanged.. This result is fairly consistent across MSAs except in Houston where prices remain permanently lower. The result is consistent with previous findings given that real price inflation in Houston is flat and has actually declined. **Figure 5-1** depicts the innovations in price resulting from a first period shock of unexpected price inflation.

Figure 5-1
Innovations in Price following a 1% Shock in Price



Generally, as prices in each MSA finish at or near their starting position the cumulative effect on prices find regional differences between growth and established regions. **Table 5-8** provides estimates of the annualized returns for different holding periods.

Table 5-8
Estimated Annualize Real Returns of Holding a Single Family House Following a 2% Positive Shock in Housing Prices

Annualize Holding Period Returns	Atlanta	Boston	Detroit	Houston	Avg.
Yr. Prices Trough - after 1% Shock in Price	6	13	13	8	10
1-5yr Real Annual Return	-8.1%	1.3%	-1.7%	-12.6%	-5.3%
1-20yr Real Annual Return	-1.7%	-0.8%	-1.0%	-1.7%	-1.3%
5-10yr Real Annual Return	3.8%	-5.6%	-7.5%	-7.5%	-4.2%
5-15yr Real Annual Return	2.9%	-3.1%	-3.9%	-2.4%	-1.6%
5-20yr Real Annual Return	-0.6%	-2.2%	-1.7%	-0.4%	-1.2%

Table 5-8 finds unexpected price inflation generates higher negative returns in growing regions for the first five years following a shock, where price inflation is traditionally flat. Obviously since real prices have remained fairly flat in Atlanta and Houston, buying an asset in the peak of prices tends to generate weak and often negative annualized returns as prices tend to come down much quicker.

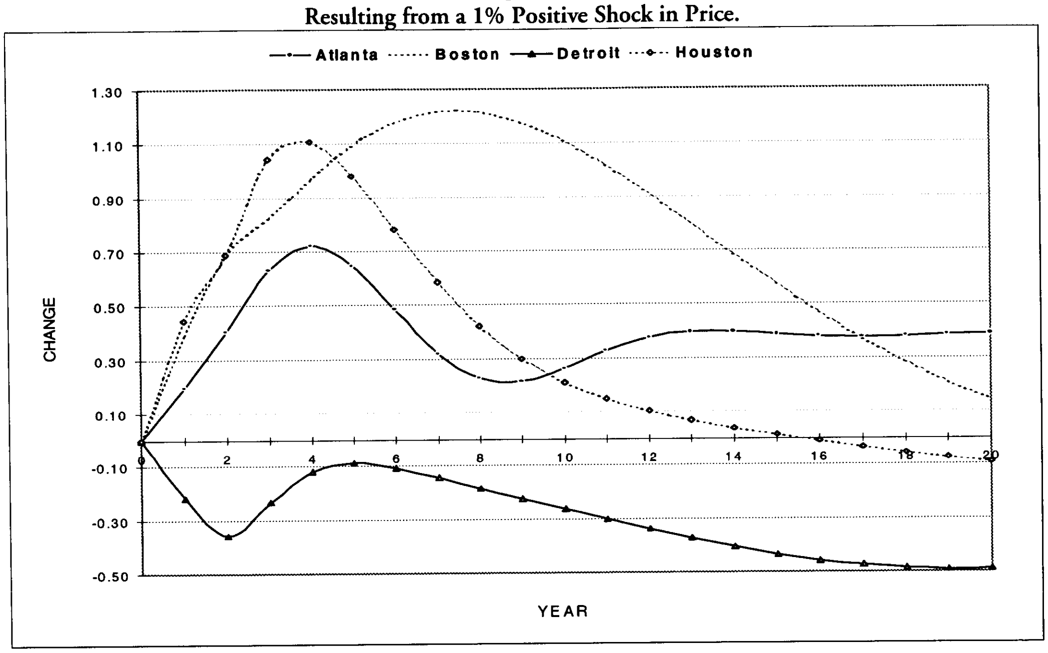
In general, growing regions seem to have housing markets in frequent disequilibrium where construction overshoots demand. These adjustments create wider cycles and longer correction periods. Although Atlanta has similar movements to a shock in price compared with the other regions, its adjustment period is substantially shorter. This shorter adjustment period confirms higher price elasticity with respect to stock in Atlanta, as the price nearly recovers to its initial level within seven years.

From these observations, the innovations resulting from a shock in price appear to be comparable across regions. Most importantly, growing markets or regions with traditionally low price inflation and fairly elastic housing supplies have higher and longer stock impulses to price shocks. This is to say that a price shock has a permanent effect on the housing stock in growing markets, and the magnitude of the effect depends on the difference between their price and supply elasticities.

b) Stock Responses

Housing price responses to price inflation are one reaction resulting from an economic shock. Most importantly, these innovations do not occur in isolation as they tend to influence succeeding levels of price, stock, employment and wage. This intern effect each other dynamically as time continues. **Figure 5-2** depicts the sequential movements in the housing stock following a jump in price inflation.

Figure 5-2
Innovations in the Single Family Housing Stock
Resulting from a 1% Positive Shock in Price.



A fairly large stock response for Boston and Houston are depicted in **Figure 5-2**. The plot finds both stock series rising after the initial shock, with Boston peaking considerably later than the two growth regions of Atlanta and Houston.

The long term supply elasticities for Boston may justify the tall and flat stock response shown in **Figure 5-1**. However, the results for Detroit are inconsistent with expectations. Detroit's stock declines in the first two periods nearing its original level in the 5th year, only to fall again staying permanently lower. With the model specified in levels for the stock series, there are no mechanisms controlling the response of stock under rapid declines. Realistically, the housing stock cannot rapidly decline within a region given the permanence and stability of residential structure and its immobility as compared to workers. There are obvious difficulties in modeling the stock series when estimated results depict rapid declines in the housing stock. This is particularly true for the estimates on Detroit.

Modeling issues aside, the geographic definition and sub-urbanization pattern of the past 20 years may also contribute to the puzzling results for Detroit. First, with a 1983 MSA definition used for

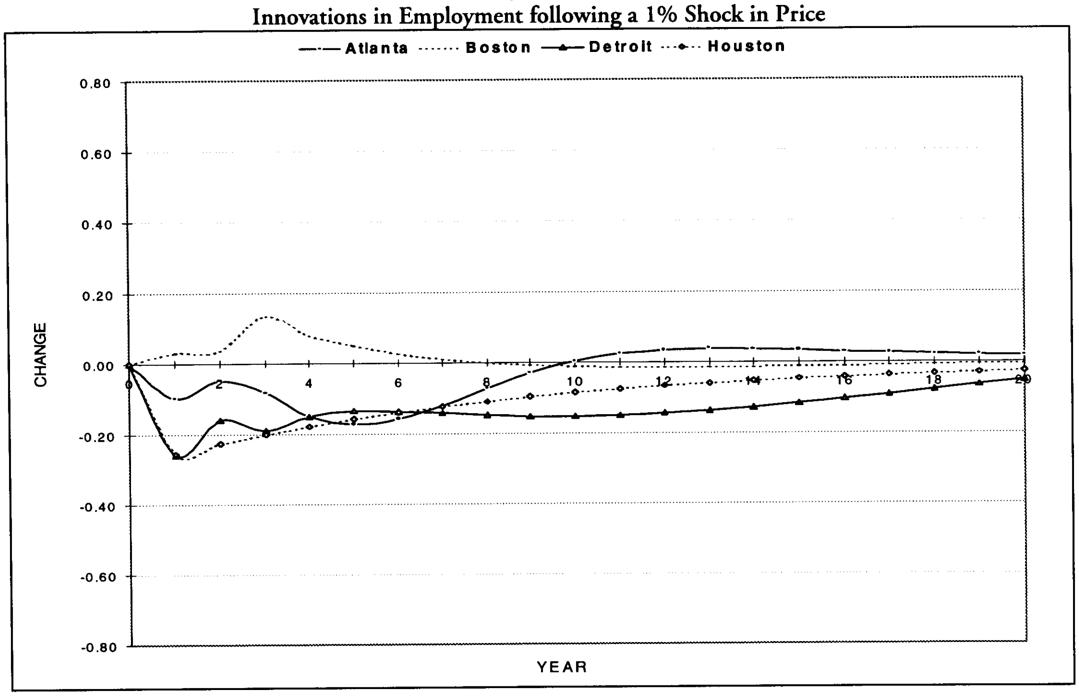
Detroit (see **Appendix 3-1**) estimation issues may be exacerbated when increases in a suburbanizing stock are not captured but the definition used. For example, if the two counties omitted from the 1983 definition yet included in the 1990 definition account for a substantial amount of stock growth, using the older definition would under estimate regional stock growth. This is to say that while prices increase, housing in the central city is declining. Hypothetically, the newer unaccounted suburbs receive the increase in stock expected from changes in price. Lastly, the presence of bad price data may also contribute to poor model fit.

In general, the stock impulses in Atlanta, Boston and Houston, illustrate how regions with greater supply elasticities with respect to price find stock returning to its initial level sooner. Further, modeling stock and providing future estimates may be particularly troubling when a region is in decline.

c) Employment Responses

As regional housing prices abruptly rise, living costs increases. These increases tend to weaken employment demand. **Figure 5-3** depicts the adjustments to regional employment under first period price shock.

Figure 5-3
Innovations in Employment following a 1% Shock in Price



The magnitude of change observed in **Figure 5-3** emphasizes the relatively small responses of employment from a price shock. Although these responses are fairly weak, the variance decomposition find nearly 40% of the disturbances in price explained by employment in Detroit, 10% in Boston, and roughly 5% in Atlanta and Houston.. Therefore, housing prices in growing markets appear to be less determined by adjustments in employment while established regions more so. This result is consistent with those made previously, where establish regions are shown to exhibit greater price sensitivities with changes in employment.

d) Wage Responses

Adjustments in wage resulting from a price shock are weak at best and vary widely between markets. Further, by decomposing the forecast variance of price, Atlanta has the largest percentage of its price variation, described by wage (12% in the first period). **Table 5-9** presents the first five periods of the price decomposition for each MSA.

Table 5-9
Variance Decomposition Errors for Forecasts in Price
Is the % Variation Explaining Changes in Price for each Period

Atlanta	Std Error	PRICE	STOCK	EMP	WAGE
1	0.03	83.75	1.75	2.16	12.33
2	0.04	56.74	8.12	2.27	32.87
3	0.05	36.09	17.69	2.00	44.23
4	0.06	27.65	24.16	1.69	46.49
5	0.07	26.48	26.37	1.50	45.65

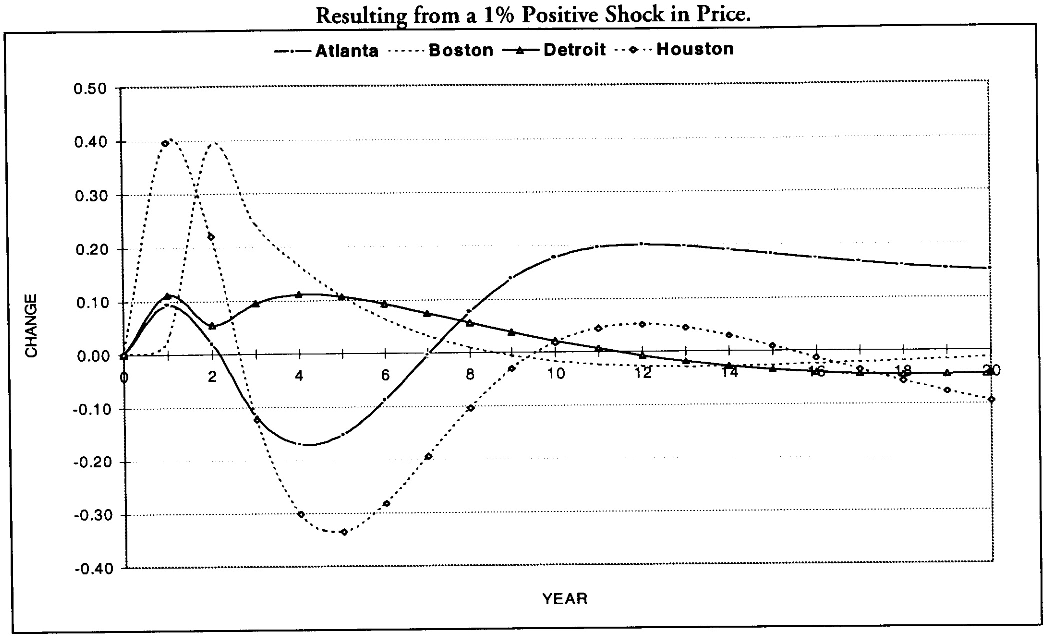
Boston	Std Error	PRICE	STOCK	EMP	WAGE
1	0.07	88.50	0.18	8.09	3.22
2	0.08	75.45	0.40	14.91	9.25
3	0.10	62.35	0.89	23.10	13.66
4	0.11	51.01	1.65	31.60	15.73
5	0.12	41.94	2.58	39.58	15.90

Detroit	Std Error	PRICE	STOCK	EMP	WAGE
1	0.04	53.92	2.70	43.38	0.01
2	0.06	31.22	6.64	56.36	5.78
3	0.08	19.47	7.02	65.49	8.01
4	0.10	13.44	5.99	73.35	7.22
5	0.12	10.06	4.75	79.52	5.66

Houston	Std Error	PRICE	STOCK	EMP	WAGE
1	0.04	88.61	3.21	8.07	0.11
2	0.05	63.07	13.24	23.63	0.06
3	0.06	38.23	25.22	36.43	0.12
4	0.08	26.62	32.55	40.61	0.23
5	0.10	23.81	35.84	40.03	0.33

Variance decomposition for price presented in **Table 5-3** provide some basic observations. First, consistent with the Granger causality tests described in chapter four, the stock series appears to have a stronger effect on price in the later periods of growth regions. Further employment explain most of the future variation in the price of established regions. Moreover, wages appear to be a fairly important price determinant in Atlanta and to a lesser extent in Boston, with insignificant percentages in the other MSAs. These decompositions lend some credibility to the response of wage within Atlanta and Boston and to a lesser extent in Houston and Detroit. **Figure 5-4** plots the impulse responses of wage to a shock in price.

Figure 5-4
Innovations in Wages
Resulting from a 1% Positive Shock in Price.



Looking at **Figure 5-4**, the responses in the first eight periods appear to vary widely. What is most interesting is how the innovations in Atlanta and Houston appear quite similar except in their levels. Further, the responses of Detroit and Boston are more similar to each other than those observed for growth regions. Again, upon review of the decomposition, these responses are not entirely credible, yet the plotted innovations do not appear wildly inconsistent with the previously described results.

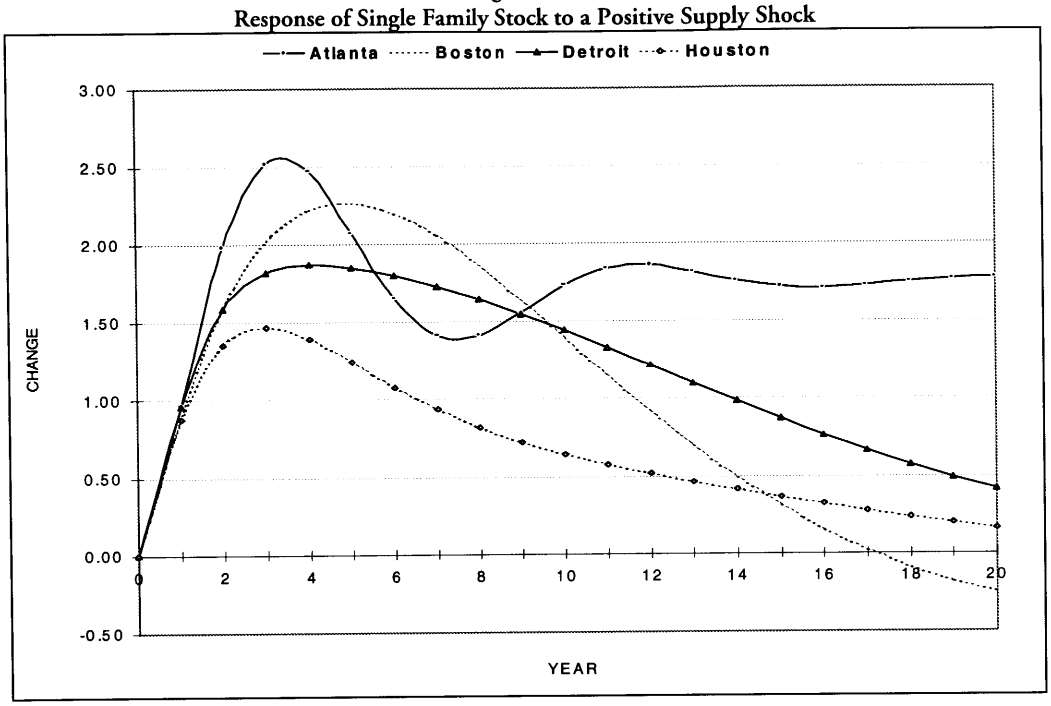
II. Construction Boom

Shocking housing supply produces similar adjustments in stock as those observed for a shock in price. With a boom in the housing supply, stock influences price, and as prices fall, the stock tends to overshoot price by rising and falling in successive periods with a lag as theorized in chapter two. Moreover, supply shocks produce an echoing effect lasting between 3 to 4 years. In general, stock adjustments to first period shocks are a function of the price and supply elasticities observed in each region. This section specifically addresses the impacts of economic change resulting from a shock in regional housing supply.

a) Stock Responses

As a boom in regional construction occurs, the stock generally responds positively in the first few periods, then levels out following sharp price declines. This result is consistent across most regions, yet the finishing stock level are lower in three of the four regions. **Figure** 5-1 depicts the innovations in price resulting from a first period increase in the supply of housing.

Figure 5-6
Response of Single Family Stock to a Positive Supply Shock



The finishing level of the stock in Atlanta is permanently effected at a much higher level than other MSAs. Most other regions find the stock gradually declining and converging with housing prices in future periods. Again, the lack of a controlling mechanism in the VAR model for stock produces irrational declines in the supply of housing.

b) Price Adjustments

When the supply of housing increases, prices tend to fall.. This result is fairly consistent across regions except in Detroit where prices rise in the first three periods only to drop and remain permanently lower. **Figure** 5-7 depicts the innovations in price resulting from a construction boom.

Figure 5-7
Response of Housing Price to a Positive Supply Shock

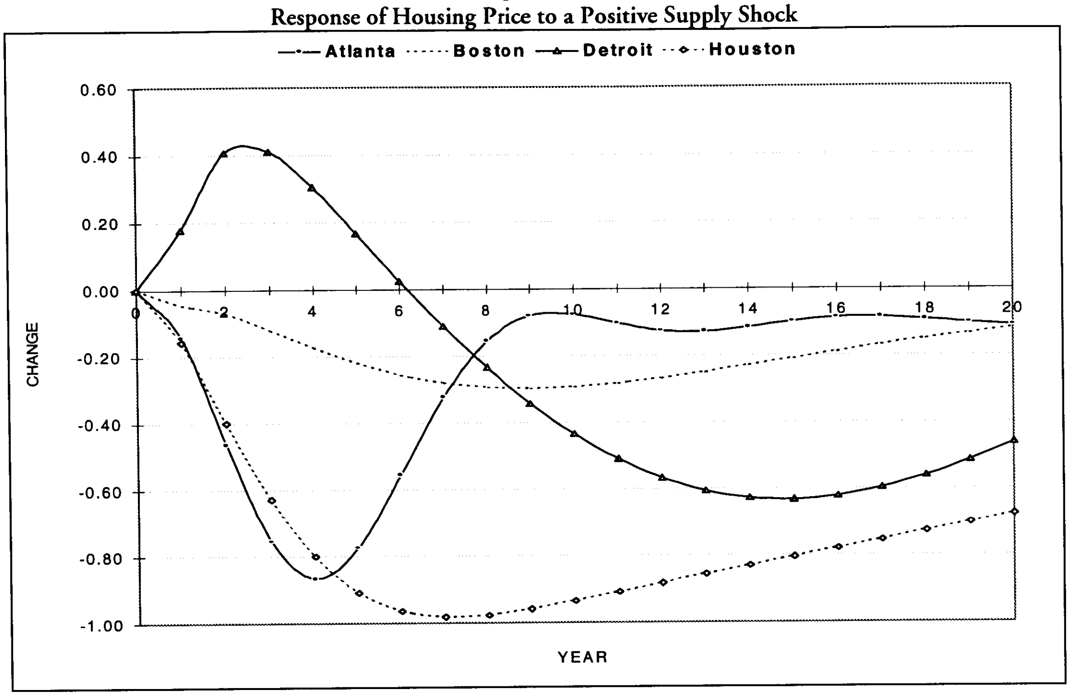


Figure 5-7 find prices jumping lower except in Detroit where the response is similar to those observed for a price shock and therefore the same justification[46] is submitted.

A shock to the housing stock finds the price of housing arriving at different levels for the housing consumer and investor. **Table** 5-4 places these price responses in a time table and provides a glimpse of the annualized returns for varying holding periods given a 1 percent positive shock in the supply of housing.

[46] Recall that in the prior section the geographical definition of the Detroit MSA may create measurement problems when stock and price data are compared.

Table 5-4
Estimated Annualize Real Returns of Holding a Single Family House Following a 1% Positive Shock in Single Family Stock

Annualize Holding Period Returns	Atlanta	Boston	Detroit	Houston	Avg.
Yr. Prices Trough - after 1% Shock in Stock	4.0	9.0	N/A	9.0	7.3
1-5yr Real Annual Return	-9.3%	-4.3%	0.4%	-16.1%	-7.3%
1-20yr Real Annual Return	-1.2%	-0.2%	0.0%	-0.9%	-0.6%
5-10yr Real Annual Return	13.1%	-2.0%	-12.3%	-2.3%	-0.9%
5-15yr Real Annual Return	7.0%	-0.3%	-8.5%	0.0%	-0.5%
5-20yr Real Annual Return	2.7%	0.6%	-1.4%	2.7%	1.2%

Table 5-4 illustrates how there is virtually little permanent effect on price for the homeowner (1-20 year returns) following a construction boom[47]. Further those who buyer their house at the onset of a construction boom seem to suffer losses only if they plan to sell their asset within 5-10 years. Further, the purchase of a home in the 5th year following a boom, will generally yield positive annualized returns for the investor and housing consumer.

c) Employment and Wage Innovations

How does a building boom impact other aspects of the regional economy? At first glance, illogical adjustments in employment and wage appear to result from a supply shock. However, viewing the variance decomposition of the stock series clarifies these issues regarding the innovations of employment and wages (See **Table 5-10**).

Table 5-10
Variance Decomposition Errors for Forecasts in Stock Is the % Variation Explaining Changes in Stock in each Period

Atlanta	Std Error	PRICE	STOCK	EMP	WAGE
1	0.01	3.96	96.04	0.00	0.00
2	0.01	3.96	96.04	0.00	0.00
3	0.02	5.06	94.92	0.00	0.02
4	0.03	6.03	93.84	0.01	0.12
5	0.03	6.55	93.05	0.02	0.38

[47] This assumes 1) that the homeowner purchases the home in the year of the shock, and 2) that there are no other subsequent shocks.

Boston	Std Error	PRICE	STOCK	EMP	WAGE
1	0.00	15.64	84.36	0.00	0.00
2	0.01	15.64	84.36	0.00	0.00
3	0.01	14.87	85.13	0.00	0.00
4	0.02	15.26	84.74	0.00	0.00
5	0.02	16.32	83.67	0.00	0.00

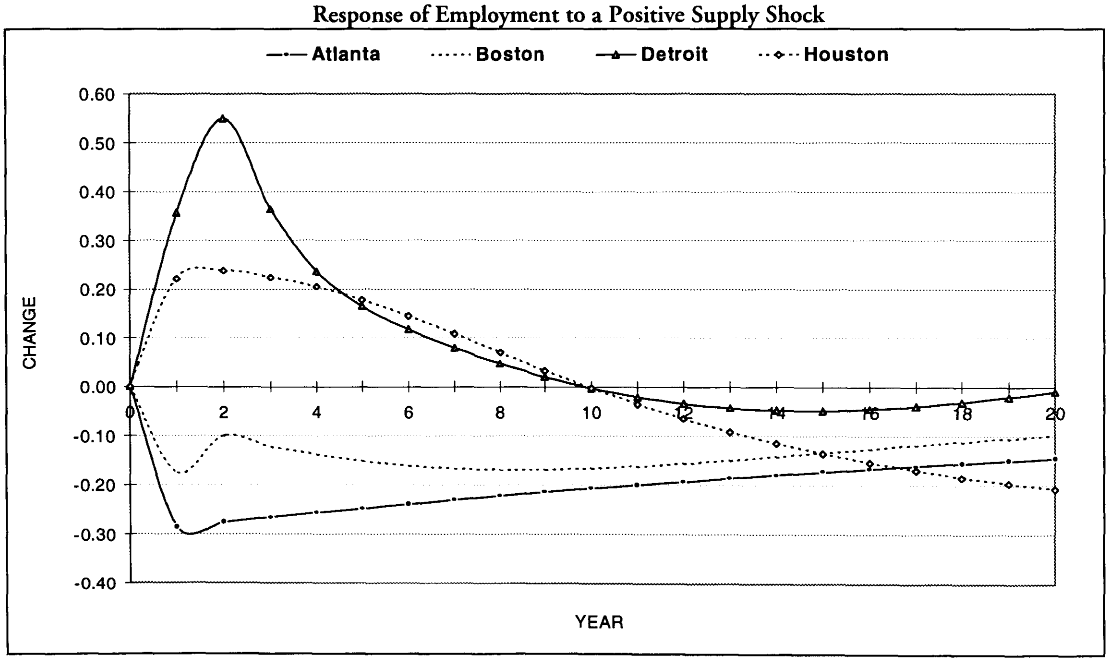
Detroit	Std Error	PRICE	STOCK	EMP	WAGE
1	0.00	4.85	95.15	0.00	0.00
2	0.01	4.85	95.15	0.00	0.00
3	0.01	3.28	96.39	0.33	0.00
4	0.01	2.29	96.12	1.52	0.07
5	0.01	1.73	94.36	3.61	0.29

Houston	Std Error	PRICE	STOCK	EMP	WAGE
1	0.01	20.56	79.44	0.00	0.00
2	0.03	20.56	79.44	0.00	0.00
3	0.04	26.97	65.58	0.00	0.00
4	0.04	30.91	66.17	0.01	0.01
5	0.05	32.92	64.77	0.50	0.01

The decompositions in **Table 5-10** strongly suggest that there is virtually no stock variance attributable to the innovations in employment and wage. Therefore, as previously noted in the discussion of VAR results, employment and wage are not swayed by any modest shock in supply. **Figure 5-9** and **Figure 5-10** plots the impulse responses of employment and wage to a sudden burst in construction activity.

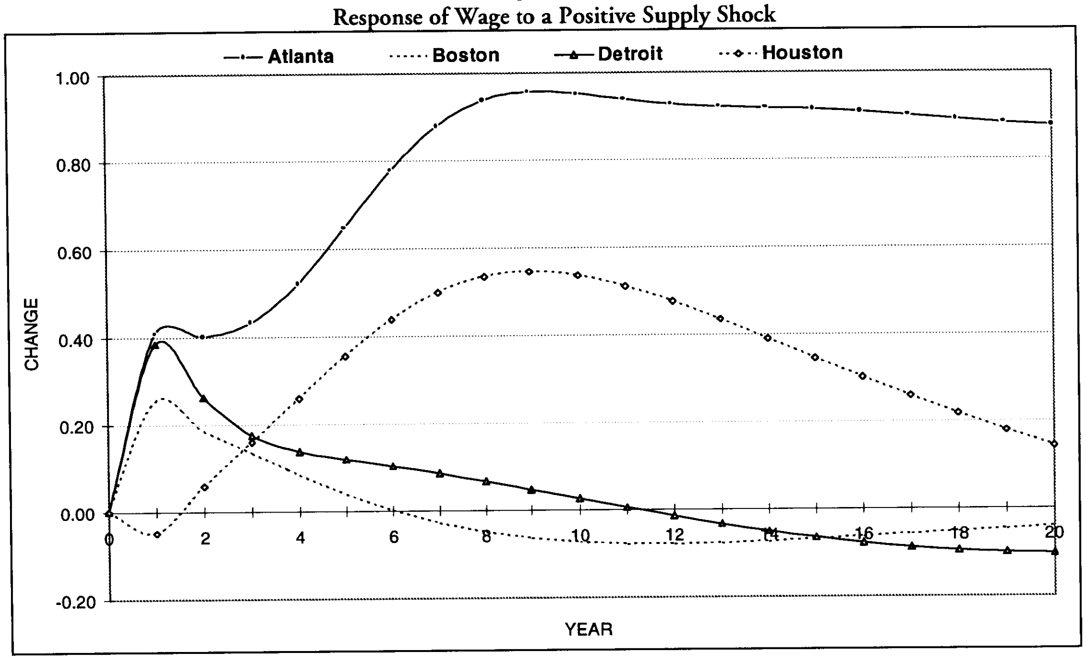
Figure 5-9

Response of Employment to a Positive Supply Shock



Following a construction boom, **Figure** 5-9 shows employment rising in Detroit and Houston while employment in Atlanta and Boston fall All four markets find employment ending permanently lower following a positive shock in the stock. Again with employment accounting for virtually none of the disturbances in stock for the first 5 periods, this impulse response is not entirely useful in estimating future employment given a boom in regional construction.

Figure 5-10
Response of Wage to a Positive Supply Shock



Following a construction boom, **Figure 5-10** shows wages rapidly rising in Atlanta and Houston while wages rise then fall in Boston and Detroit. Both growth regions find wages ending higher while the established regions end lower. Again with wages accounting for virtually none of the disturbances in stock for the first 5 periods, this impulse response is not particularly useful in estimating future wages under a surge in housing supply.

There are relatively benign effects of a construction boom on price, stock, employment and wage. Again these responses confirm the results of the causality test conducted in chapter four. Further the effects of a supply shock are seem more significant in growing markets, where changes in the stock have a large effect on prices. In general there is little permanent effect on price and employment and a questionable effect on stock and wage following a sudden surge in the supply of housing.

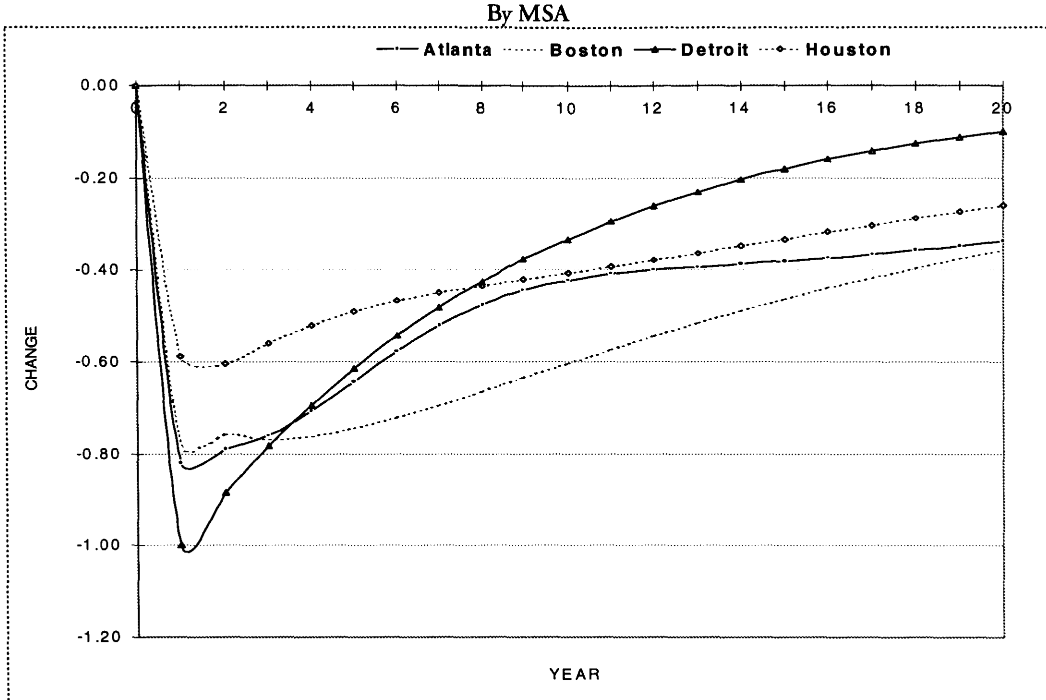
III. Adverse Employment Shock

An adverse shock in employment assumes labor demand is reduced and employment opportunities dwindle from a decrease in demand for a region's good and services (i.e. plant closings). This section specifically addresses the impacts of economic change resulting from a shock in regional labor demand.

a) Employment Innovations

The important question here asks how an employment shock affects the housing market and are the effects permanent? The estimated innovations in employment from the regional model confirm the findings of Blanchard and Katz, where following a shock to employment, the employment level is permanently affected. **Figure 5-8** illustrates the estimated innovations in employment following a negative shock.

Figure 5-8
Response of Employment to an Adverse Employment Shock
By MSA



This figure shows employment gradually rising after the adverse shock, yet finishing much lower than pre-shock levels. Although their theories are not tested here, Blanchard and Katz find these permanent effects resulting from slight wage adjustments and the out-migration of labor (i.e. convergence[48]). Restated, wages fall with the decrease in employment demand, but not so much as to attract new firms to the region, which would increase the level of employment. Instead, what happens is that the unemployment rate returns to its mean value through a process of out-migration occurring regionally.

As most employment responses end at fairly different levels, each seems to coincide with the expected movements described by previous authors. This is to say that when a region experiences a significant employment shock (i.e. -2% change), employment always ends lower, never quite recovering to its original state[49].

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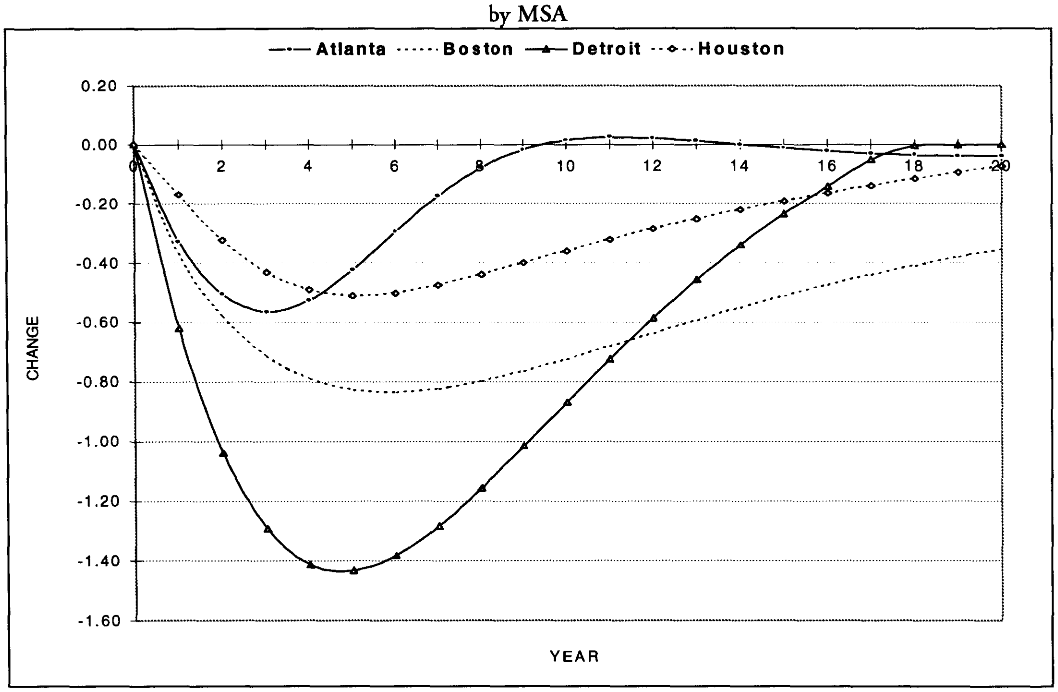
[48] These findings are described in chapter two

[49] Blanchard and Katz show that this is so since a region slowly evolves through a decline in wages and an out-migration of labor. Few firms are attracted to the small, quick decline in wages, which isn't enough for firms to relocate to the region.

b) Price Adjustments

Similar to employment, the estimated price movement appear to coincide with the work of Bartnik, Poterba and Blanchard and Katz. Prices move in a hump shape pattern to an adverse shock with some markets having permanent effects and others ending back near their initial state. **Figure 5-9** depicts the permanent effects in Boston and Houston as both markets end lower (-.18% and -.36% from pre-shock price level), while Atlanta and Detroit prices recover to their initial pre-shock state.

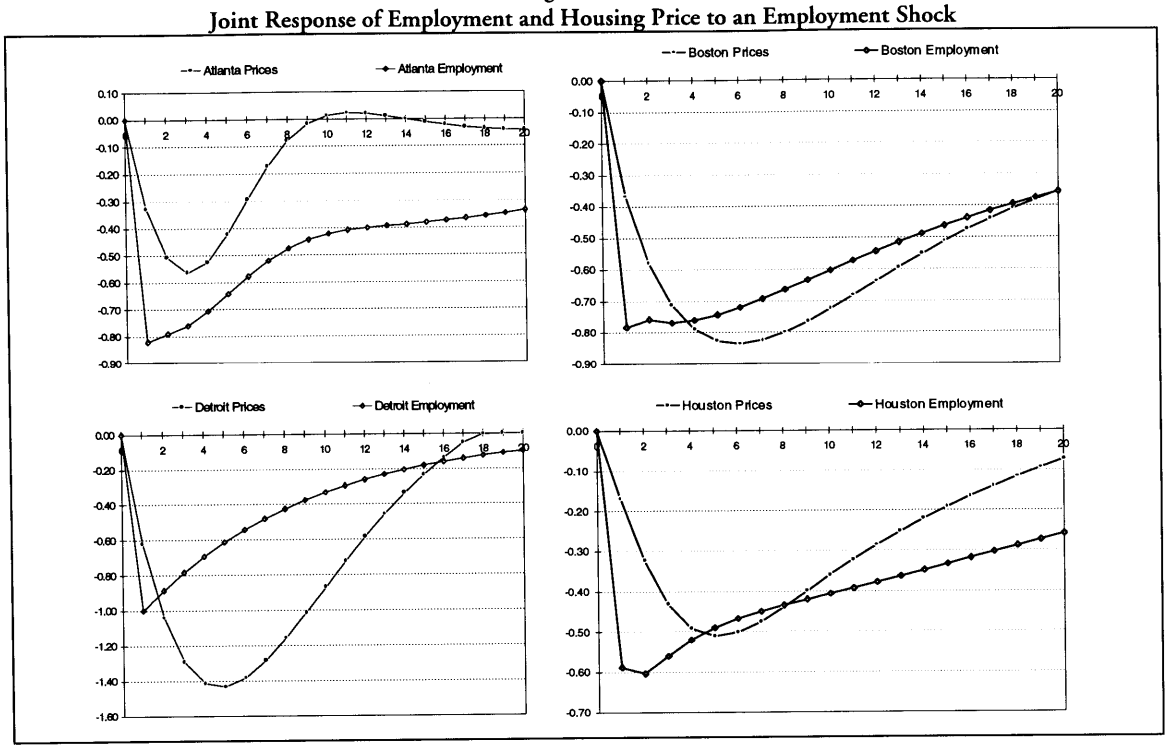
Figure 5-9
Response of Housing Price to an Adverse Employment Shock
by MSA



Most interestingly, is how Atlanta reaches its price trough in just three years following the shock then quickly recovers back to its initial state in another four to five years. Other regions are not as resilient as they tend to have longer lasting effect on price. **Figure 5-9** shows the depth and length of the responses following the initial shock. These responses find older established regions with deeper price troughs, nearly -0.8% to -1.2% from their initial levels, while growth regions have smaller declines between 0.5 and 2 percent under an adverse shock in employment.

These disparities between regions may exists from prior shock experience or hysterics. More specifically, older regions, that suffer from adverse shocks may be overly pessimistic about actual economic impacts to the region. **Figure 5-10** provides a detailed view of the joint responses of employment and price to an adverse shock in employment.

Figure 5-10
Joint Response of Employment and Housing Price to an Employment Shock



The pattern of price depicted in **Figure 5-10** strongly suggests that there is some predictability of returns in the housing market. Do these patterns provide opportunities for investors? Clearly, as prices overshoot the shock in employment, and rebound few years later, market inefficiencies appear[50]. Further, by closely looking at the cumulative price adjustments in each successive year following the shock, an estimated annualized return for a particular holding period is estimated. These estimates are presented in **Table 5-11**

[50] These findings are quite similar to Blanchard and Katz, where they estimated an employment shock of 2 percent would find house prices decline at roughly 1 percent per year for the next three years, and then recover at a rate of approximately 0.4 percent per year of the following five years.

Table 5-11
Estimated Annualize Real Returns of Holding a Single Family House Following a 2% Adverse Shock in Regional Employment

Asset Holding Period Returns	Atlanta	Boston	Detroit	Houston	AVG.
Yr. Prices Trough-after 2% Employment Shock	3.0	6.0	5.0	5.0	4.8
Years 1-5 Real Annual Return	-4.9%	-13.9%	-23.0%	-8.4%	-12.6%
Years 1-20 Real Annual Return	-0.2%	-0.5%	-1.0%	-0.4%	-0.6%
Years 5-10 Real Annual Return	9.0%	1.1%	9.1%	2.2%	5.3%
Years 5-15 Real Annual Return	4.7%	2.5%	10.7%	2.7%	5.2%
Years 5-20 Real Annual Return	2.2%	3.1%	5.5%	1.8%	3.2%

The estimated annualized returns presented in **Table 5-11** provide some insights for the consumer and investor of housing. First, housing consumers who purchase before the shock and weather the 20 year storm following an adverse shock realize an estimated annualized real return of -0.6%. A speculative investor purchasing in the 5th year following the shock and holding the asset for five years achieves a real return of 5.3% Further, in markets where price is highly sensitive to changes in stock rather than employment[51], the speculative returns are much higher (9.0% in Atlanta and 9.1% in Detroit). These returns are not illogical given 1) the cyclically and disequilibrium present in the housing market; and 2) the need for unemployed workers to sell their house given high transaction costs[52]. Obviously these returns assume no other shocks (i.e. positive or negative) impact the region within the observed time frame.

c) Stock Adjustments

Looking at the estimated stock adjustments the results appear illogical given a knowledge about the permanence and stability of the housing stock. **Figure 5-11** plots the innovations in stock to an adverse demand in regional employment. Obviously, with a negative shock in regional employment, the expected response of the stock would find a slowing or drastic decrease in additions to the stock level. Again with the model specified in levels and no controlling mechanisms for rapid declines in stock, **Figure 5-11** appears highly irrational.

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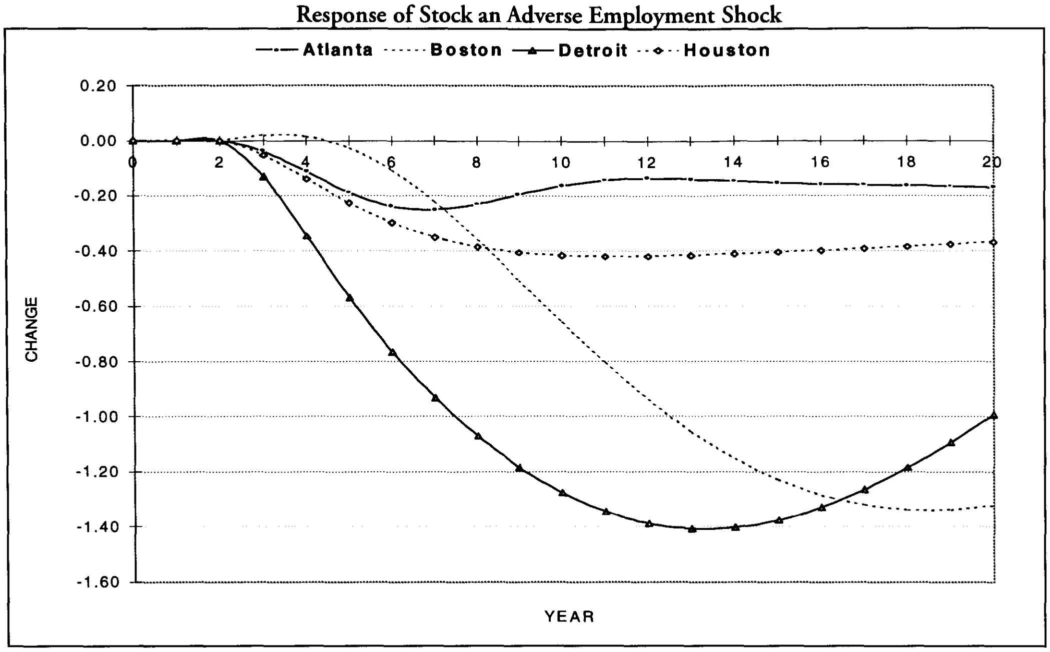
[51] Recall that both Atlanta and Detroit have highly elastic prices with respect to supply (-1.17 and -1.23 respectively)
[52] Blanchard and Katz (1992)

Figure 5-11
Response of Stock an Adverse Employment Shock



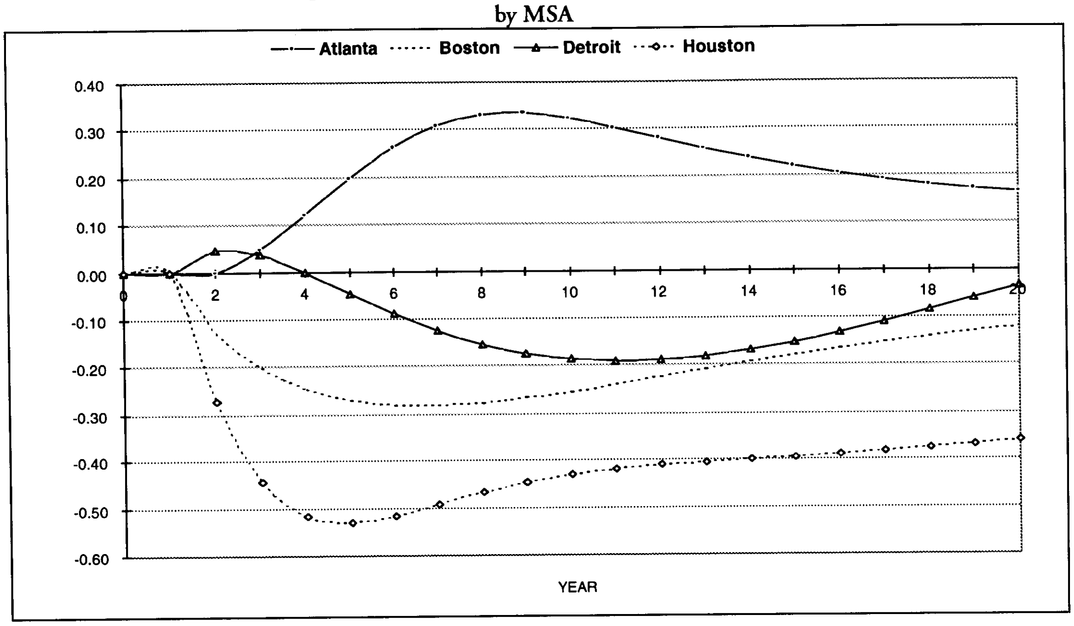
Despite the falling stock responses depicted in **Figure 5-11**, the relationships show the stock in Boston and Detroit having a larger affect with an adverse shock in employment. This finding is consistent with observations made in the first section of this chapter, VAR estimation results.

d) Wage Innovations

Next, the impact of an employment shock on wages finds wages slowly declining until employment stabilizes with convergence occurring several year later between wages and employment. Again these results are consistent with the work of other researchers[53]. **Figure 5-12** depicts the innovations in wage following an adverse shock in employment.

[53] See Blanchard and Katz (1992)

Figure 5-12
Response of Wages to an Adverse Employment Shock
by MSA



The response of Detroit wages is not logical. However, issues with the model's ability to provide good wage estimates particularly in Detroit is further underscored by the plotted impulse response shown in **Figure 5-12**.

In general, an adverse employment shock has the greatest impact on established regions. Further, there appears to be predictable returns in the price of single family housing following an adverse employment shock. Despite the models effectiveness in estimating movements in price, employment and to a lesser extend wage, the VAR appears to be limited it is ability to estimate the stock series.

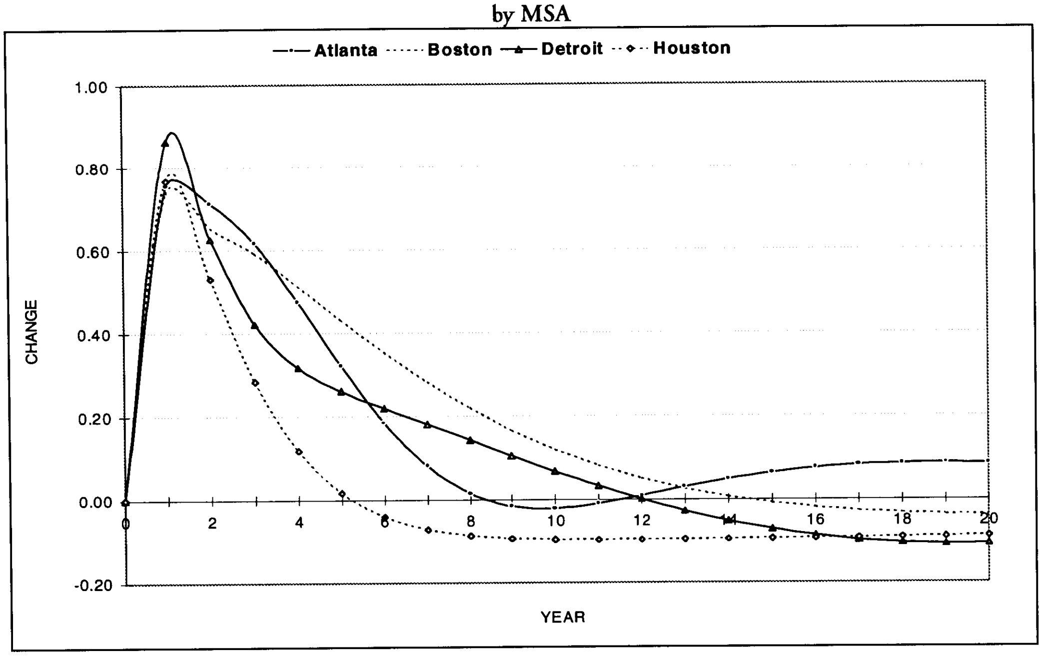
IV. Wage Jumps

The last impact on the regional economy to be considered is a sudden jump in wages. This assumes that a condition whereby the amount of wage supplied rises from regional economic factors. From a positive shock in wage and its future innovations, adjustments in price, stock and employment are analyzed. This section addresses the impacts of economic change resulting from a shock in regional labor supply.

a) Wage Innovations

Adjustments to the wage series following a first period shock are graphed in **Figure 5-12.** The estimated adjustments from a wage hike find most wages returning to their pre-shock levels in seven to-twelve years with each regions having no real permanent effect. **Figure 5-13** illustrates the estimated innovations in wage (i.e. labor supply) following a sudden jump in wage.

Figure 5-13
Innovations in Wage to a Positive Wage Shock
by MSA

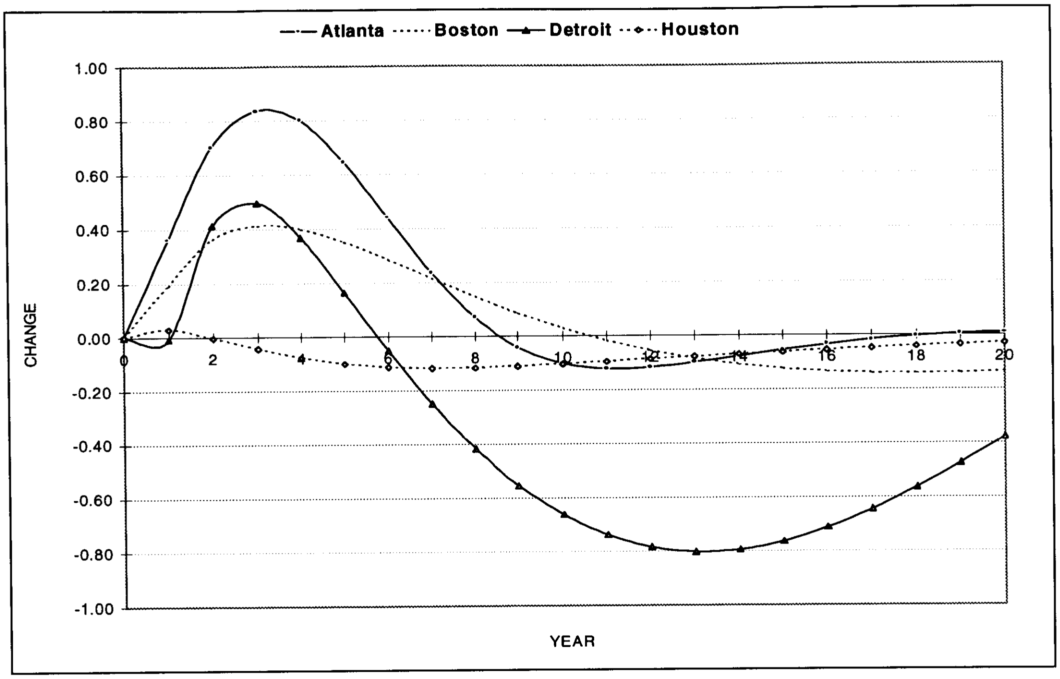


The responses depicted in **Figure 5-13** are generally expected, whereby a shock in wage finds an increase in labor supply until demand is fulfilled, drooping and ending near its initial level. Small differences exists between regions. Notably, wages in growth regions return sooner to pre-shock levels than wages in established regions, approximately four to six years in Atlanta and Houston.

b) Price Adjustments

Adjustments to regional housing prices following a shock in wage are depicted in **Figure 5-14.** The estimated adjustments from a wage hike find most prices rising in the first couple periods then dropping below their pre-shock state.

Figure 5-14
Response of Housing Price to a Positive Wage Shock
by MSA

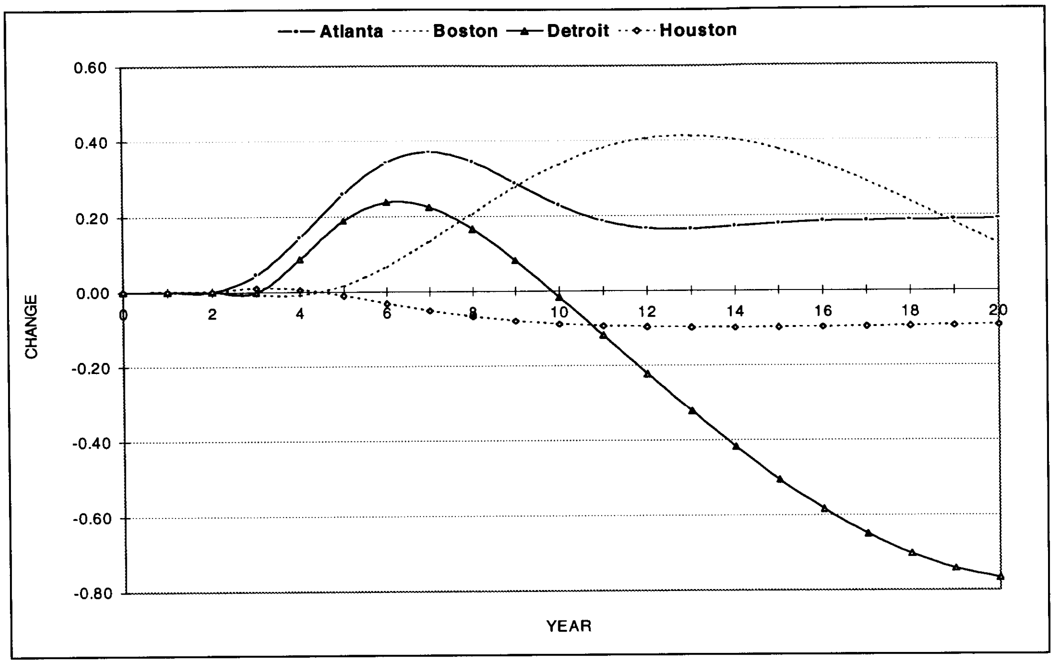


The responses depicted in **Figure 5-14** are generally expected, whereby a shock in wage finds an housing prices initially climbing then drooping down to their pre-shock levels. Most regions find prices ending slightly lower, except Detroit, where prices are substantially lower. Issues with the Detroit and the models estimation ability for wages in Detroit are reproduce in this impulse response depicted in **Figure 5-14**.

c) Stock Adjustments

Stock adjustments following a first period shock in wage are depicted in **Figure 5-15**. The estimated adjustments from the sudden wage increase find the stock rising in the first few periods remaining higher in Atlanta and Boston and slightly lower in Houston.

Figure 5-15
Response of Housing Stock to a Positive Wage Shock
by MSA



Again, the plot of Detroit estimates in **Figure 5-15** for innovations in stock from a shock in wage is troublesome. Poor data and model fit are likely the blame. Looking at the variance decompositions in **Table 5-12** for the wage series find stock to be fairly insignificant in describing variances in wage. Further, these results are similar to the pattern of causality discovered in the Granger causality test used in chapter four.

Table 5-12
Variance Decomposition Errors for Forecasts in Wage
Is the % Variation Explaining Changes in Stock in each Period

ATLANTA	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.03	0.90	17.30	22.52	59.29
2	0.04	0.49	17.94	22.41	59.16
3	0.05	0.89	19.80	23.05	56.26
4	0.05	1.58	23.40	23.81	51.20
5	0.06	1.89	28.83	24.26	45.02

BOSTON	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.03	0.06	6.60	36.96	56.38
2	0.03	8.84	5.71	28.83	56.63
3	0.04	9.58	5.27	24.96	60.20
4	0.04	9.49	4.89	22.37	63.25
5	0.04	9.22	4.58	20.73	65.47

DETROIT	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.02	16.25	0.25	22.50	61.00
2	0.02	15.68	0.44	17.52	66.36
3	0.03	12.86	1.81	29.93	55.41
4	0.03	12.74	3.99	43.89	39.39
5	0.04	12.56	6.60	52.31	28.54

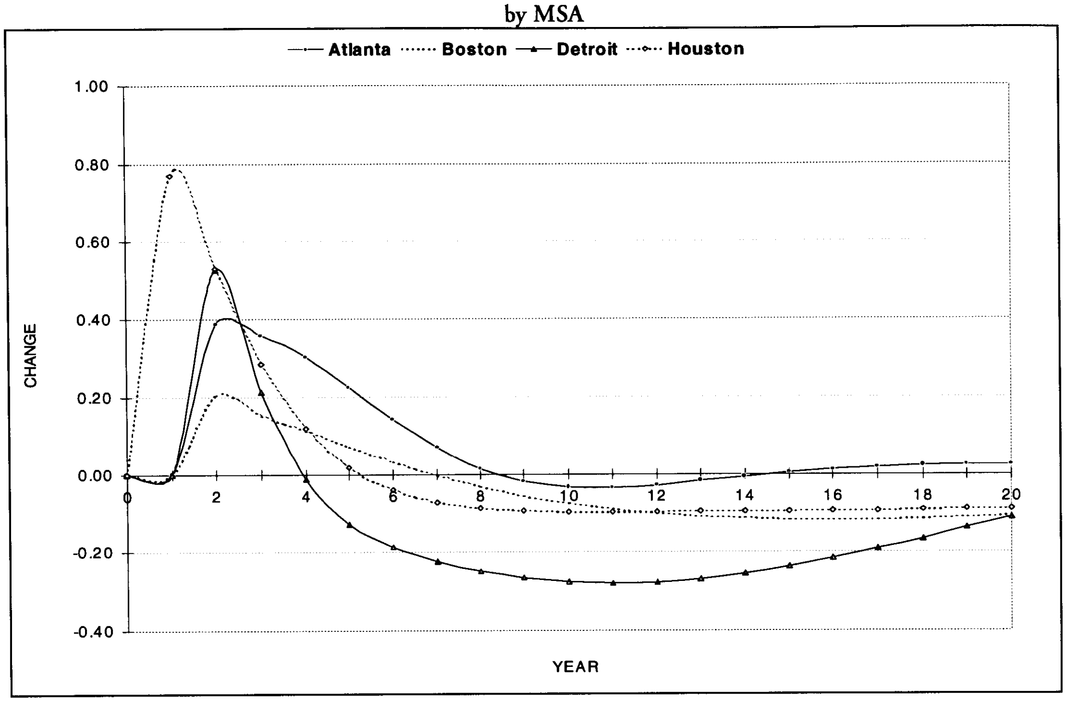
HOUSTON	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.02	1.29	15.29	6.13	77.29
2	0.03	1.04	14.58	7.56	76.82
3	0.03	1.44	14.28	8.01	76.27
4	0.03	1.98	14.21	7.84	75.97
5	0.03	2.47	14.22	7.54	75.77

Other points to be made from **Table 5-12** see stock as a larger contributor of wage innovations in growing regions, approximately 15-20 percent in Atlanta and Houston. These results seem to indicate a linkage between the construction or building industry and wages of growing regions, further emphasizing the linkage between the housing market and regional economy.

d) Movements in Employment

Employment adjustments following a first period shock in wage are depicted in **Figure 5-16** The estimated adjustments from a wage hike find employment rising in the first couple periods then barely dropping below their pre-shock state. Given the scale of **Figure 5-16** each region nearly finishes unchanged from a wage jump.

Figure 5-16
Response of Employment to a Positive Wage Shock
by MSA



By looking at the variance decompositions in **Table 5-12**, employment describes a significant amount of the variations occurring in wage. Further, established regions find their wages more affected by employment levels than do growth regions. This finding is consistent with those made previously in the discussion of VAR results and the Granger causality tests in chapter four.

5.3. Findings

This section summarizes the important findings of the results and analysis section. The following presents a brief summary of this chapter by 1) describing the estimation performance of the model, 2) evaluating the importance of a linkage between the regional economy and its housing market and 3) summarize the impact of economic shocks on the housing market.

I. Estimation Performance

The model performed as expected in generating estimates for regional house prices, employment levels and to a lesser extent stock and wages. The regression results for price are significant and provide good insight as to regional differences in the movement of price with respect to other economic variables (i.e. stock, employment and wages). Further, the estimation of regional employment differences distinguish the regions in to another categorization, diverse and specialized economies, where the results are concur with past trends.

The ability of the model to estimate wages and the housing stock is a bit more precarious. The constraining factor to wage estimation appears to be the data used. With significant structural changes occurring in the Detroit labor market, the model seem to be a poor estimator of labor supply or wage, particularly in the established regions.

Another issue of estimation concerns the symmetrical structure used to describe the stock series. Because housing stock is unlike other modeled variables, where the level is not likely to decrease given the permanence of a housing unit, the stock equation should contain some constraining parameter or asymmetrical specification to prevent it from plunging when prices continue to fall. Therefore, the model does not accurately reflect the degree of innovation occurring between variables however the relationship among other variables holds with a priori theory.

II. Economy and Housing Market Linkage

Despite a few peculiarities in model estimates, strong linkages are present between variables in the regional economy and the housing market. Again, to better analyze regional movements, the definitions for growth and established regions are used. An additional distinction to each region is made in the level of diversity present within the economy. Atlanta and Boston are labeled diverse, while Houston and Detroit are specialized. This categorization doesn't say Atlanta and Boston don't exhibit any specializations in their economic structure, but that they are far more diverse than the cities of Detroit and Houston.

From these definitions, the findings for regional linkage between the regional economy and housing market appear. The first example finds housing prices having a high degree of their variation explained by both wages and the employment (i.e. regional economic variables). Wages are stronger in diverse regions, while employment accounts for a higher percentage of the variation in specialized economies. These findings emphasize the importance of regional economic variables as housing market determinants.

Looking at the housing markets effect on the regional economy is the crux of this discussion. The importance modeling housing market feedback into the regional economy is made through the observed price and stock effects on employment. The changes in these variables are shown as having a higher degree of influence on employment than wage (i.e. labor supply). These results strongly suggest the importance of providing housing market feedback into the regional economy.

Another possible linkage is revealed in the wage series. Wage adjustments are roughly 15-20 percent described by movements in the housing stock of growth regions. Although this result is not overwhelmingly significant, it does conferring the importance providing a housing and labor market linkages[54]. Generally, with the persistence of poor estimates in labor supply, the connection between the housing market and wages is inconclusive.

III. Impacts of Economic Change

The impacts of economic change are summarized by the two regional categories. These include growth regions and established regions. The first economic change involves unexpected house price inflation, found the housing markets of growth regions are more affected by changes in the housing stock than changes in employment or wage. Conversely, established regions have more of their price determined by changes in employment than any other variable.

The next economic change observed on the regional system is the construction boom. Prices under a construction boom always appear to end lower with the cumulative prices in growing regions effected more than established, which seems to result from an ample supply land and structure. Further, the housing stock is not affected by changes in employment or wage.

An adverse employment shock is the economic change of most interest to regional inhabitants. These shocks find employment levels permanently lower as wages rise and exhibit convergence years out. Adverse shocks in employment have the greatest effect on established regions. Most

[54] This result is consistent with the VAR regression results where both Atlanta and Houston have larger movements in wage accounting for every movement in their housing stock.

importantly, a negative shock in employment demand finds fairly predictable returns in asset prices as they tend to drop from the adverse shock only to rise 3 to 5 years following the shock.

Finally, a wage jump is the fourth economic change considered. From the shock, wage, prices and employment finish relatively unchanged while the stock is higher in growing regions and lower in established regions. Aside from estimation issues, these results find a positive wage shock as having little or no permanent effects on the labor or housing market of a region.

6. Conclusion

The objective of this research is to understand the effectiveness of modeling at the regional level and observe the movement of variables affecting the market for single family housing. With this purpose, a modern time series approach is applied to understand the linkage between the regional economy and its housing market. Further, by using a structural vector autoregressive (VAR) model, the impact of regional economic change is observed on the market for owner occupied housing, both as consumer and as investor. Specifically, this research strives to:

1. Provide a better understanding of the housing market by using metropolitan level data;
2. Uncover the linkage between the regional economy and its residential property market; and
3. Estimate the impact of economic change on the housing market.

With these in mind, a model estimating the dynamic responses between regional housing and employment is constructed. The research, methodology, results and findings are described within six chapters. This first chapter is the introduction, which establishes the research objectives and framework for the work.

Chapter two provides a foundational overview of empirical and theoretical work in housing market research and regional economics. This literary overview focuses on past research objectives and the inherent strengths and weaknesses found within their reduce form models, structural dynamic models and current times series models. Using these observations as a base, the proposed model addresses the apparent shortcoming of prior work. In avoidance of past pitfalls, the proposed model shall 1) estimate the housing market using regional level data, 2) provide a more direct link between the regional economy and the housing market, 3) include estimates for the housing stock, 4) identify the impacts of economic change on regional economic factors.

From this brief model overview, chapter three addresses the need for good data. Within this chapter, data sources are identified, discussed and thoroughly critiqued as far as their ability to represent specific model inputs. Atlanta, Boston, Detroit and Houston are the four regions selected for estimation. Chapter three examines each data series by plotting past trends and patterns. This analysis produces a classification system whereby each region is grouped according to its growth characteristics. The two basic typologies are 1) established regions (i.e. Boston and Detroit) and 2) growth regions (i.e. Atlanta and Houston).

Chapter four describes the specifics of the restricted vector autoregressive (VAR) model. The basic premise of a VAR and methodology used to specify parameters and test assumptions are presented. This chapter then describes and details the exact variable selection, lag structure and linear form used in estimation. The chapter concludes by identifying the two primary methodologies used to evaluate the impact of an economic shock. These two estimation techniques are the impulse response function and the forecast error decomposition.

Upon application of the previously described methodology, estimates for housing price, housing supply, regional employment and wages are presented within chapter five. The impacts of four different economic shocks are then discussed. These include: 1) unanticipated house price inflation, 2) a construction boom, 3) adverse employment and 4) a wage hike. Generally, the analyses finds correlated responses in regions having similar growth patterns. Further, given these correlations under different economic shocks, housing prices appear to be predictable.

The conclusions in chapter six offer evidence to support the hypothesized dynamic linkage between regional economies and residential property markets. Although it is well established that regional economic factors affect housing, the model shows that the reverse is also true; housing significantly affects general economic conditions.

Aside from the evidence supporting regional economic dependencies, the model appears to be a good estimator for movements in housing price and regional employment. Although the model does not provide good estimates for the supply of labor and housing, it does seem to provide a reasonable description of the inherent dynamics of regional economic relationships.

6.1. Implications

The implications of this work find metropolitan level analysis to be quite descriptive in terms of a housing markets affect on the regional economy. Although the linkage from the regional economy to the housing market is fairly well established, the model provides enough evidence to suggest that a the reverse is also true, and that the two way linkage should be considered elemental when forecasting housing market movements.

6.2. Areas for Further Research

The implications of each conclusion establish areas for further research. Obviously, by estimating four metropolitan areas the analysis suffers from small sample biases. Conducting a similar study with a much larger sample size may provide results which are more fruitful.

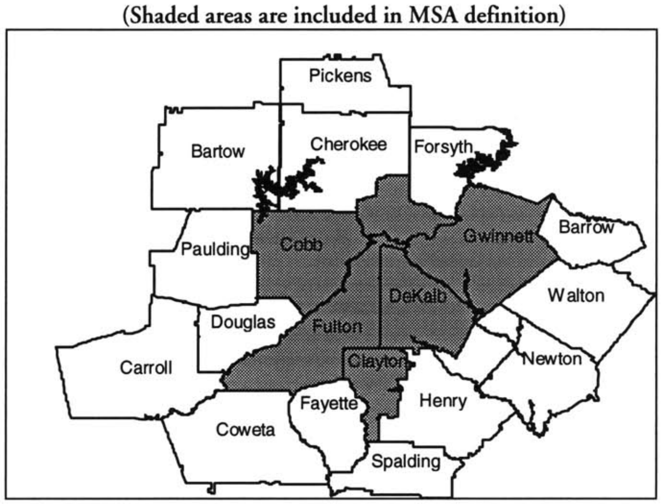
Additional areas of research should also be focused on providing a better estimate for wage and a controlling device in the structure of the stock model. These improvements could greatly enhance the performance of the restricted VAR in modeling the regional effects.

Further research could also utilize the same approach, except it to the market for rental housing. Moreover, a study of other property types within the regional economy would prove interesting if data were available.

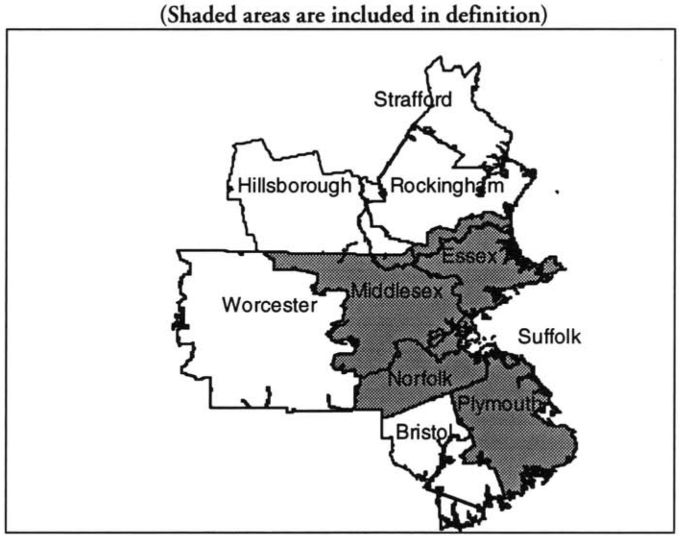
7. Appendices

7.1. Appendix 3-1 Geographic Definitions

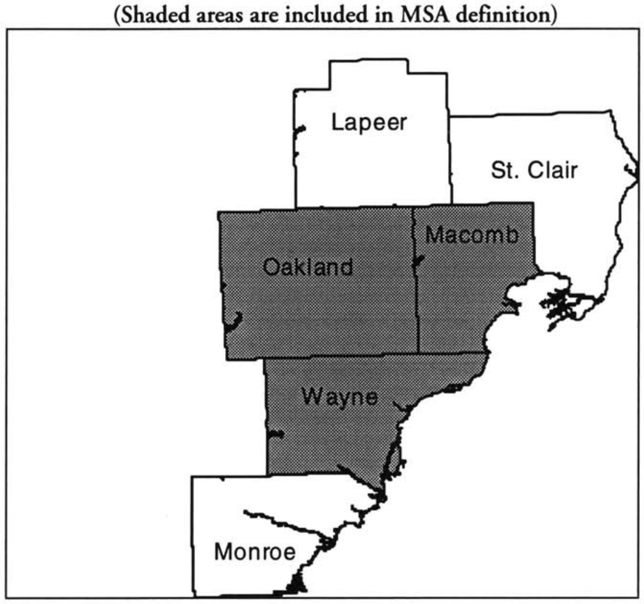
ATLANTA MSA
(Shaded areas are included in MSA definition)



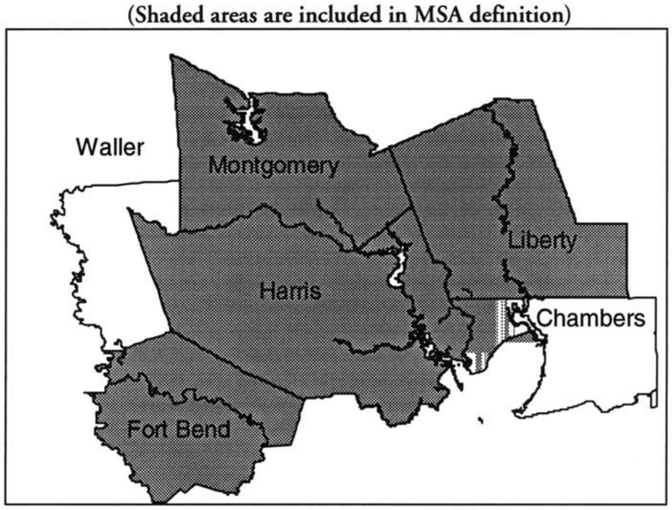
BOSTON NECMA
(Shaded areas are included in definition)



DETROIT MSA
(Shaded areas are included in MSA definition)



HOUSTON MSA
(Shaded areas are included in MSA definition)



7.2. Appendix 3-2 Data Series

Atlanta Data

YEAR	PRICE	RENT	MFPER	SFPER	TTPER	EMP	POP	YPIR	SFSTOCK	MFSTOCK	TSTOCK
1960									227,319	81,351	308,670
1961									231,756	89,224	320,980
1962									238,030	97,314	335,345
1963	67.3	147.1	12,806	10,541	23,347	429	1,432	12.7	244,332	106,036	350,368
1964	72.2	145.2	9,244	10,639	19,883	453	1,488	13.6	251,117	114,700	365,818
1965	71.9	144.1	9,546	10,898	20,444	483	1,558	14.0	257,965	120,955	378,920
1966	71.9	141.7	9,046	7,668	16,714	516	1,605	15.1	264,980	127,414	392,394
1967	77.4	140.1	13,325	9,461	22,786	533	1,652	15.9	269,916	133,534	403,450
1968	80.1	137.9	14,274	10,102	24,376	564	1,709	16.9	276,006	142,550	418,556
1969	88.2	134.6	14,530	8,879	23,409	639	1,742	18.2	282,508	152,207	434,716
1970	89.0	132.7	20,349	10,139	30,488	657	1,773	18.8	288,224	162,038	450,262
1971	87.0	131.6	33,924	14,721	48,645	679	1,832	19.8	297,658	180,777	478,436
1972	89.9	131.1	20,678	16,691	37,369	720	1,893	21.9	311,357	212,017	523,374
1973	89.8	126.8	10,770	13,699	24,469	771	1,960	23.4	326,888	231,059	557,947
1974	92.7	118.9	5,217	7,820	13,037	837	2,012	23.3	339,636	240,977	580,612
1975	93.5	112.3	931	7,441	8,372	830	2,029	22.8	346,912	245,781	592,694
1976	86.3	108.1	1,120	8,728	9,848	862	2,053	24.0	353,837	246,639	600,476
1977	90.0	104.6	3,015	10,707	13,722	911	2,093	25.4	361,958	247,670	609,628
1978	82.6	100.6	2,823	11,284	14,107	1,011	2,133	27.0	371,922	250,446	622,368
1979	82.1	98.2	5,931	12,727	18,658	1,060	2,192	27.5	382,422	253,046	635,468
1980	82.0	95.6	5,338	11,947	17,284	1,087	2,248	27.6	394,265	258,508	652,773
1981	78.4	97.0	5,319	9,370	14,689	1,116	2,299	28.3	403,060	263,944	667,003
1982	77.8	97.0	6,217	13,246	19,464	1,129	2,344	28.8	415,493	269,360	684,853
1983	79.5	100.7	14,360	22,617	36,977	1,188	2,403	31.2	436,722	275,692	712,414
1984	81.5	102.0	16,153	23,093	39,245	1,290	2,476	34.6	458,397	290,316	748,713
1985	83.3	106.7	15,011	22,992	38,003	1,353	2,566	37.6	479,978	306,765	786,743
1986	88.0	112.0	15,014	22,591	37,606	1,411	2,663	40.9	501,182	322,052	823,234
1987	89.8	114.6	10,930	19,168	30,098	1,464	2,754	43.0	519,174	337,342	856,516
1988	90.2	113.4	12,643	17,141	29,784	1,541	2,834	45.1	535,262	348,473	883,736
1989	88.1	109.8	8,518	12,710	21,228	1,575	2,907	45.7	547,192	361,349	908,541
1990	83.9	105.5	5,138	11,938	17,076	1,604	2,979	46.6	558,397	370,023	928,421
1991	81.7	102.2	1,216	12,624	13,841	1,574	3,058	46.7	570,247	375,256	945,503
1992	81.6	100.7	334	15,916	16,250	1,624	3,143	48.9	585,186	376,495	961,680
1993	81.7	100.3	2,312	17,952	20,264	1,711	3,238	51.3	602,036	376,835	978,871
1994	81.7	100.8	7,208	17,033	24,241	1,798	3,347	54.1	618,024	379,190	997,214

Boston Data

Year	PRICE	RENT	MFPER	SFPER	TOTPER	EMP	POP	YPW	SFSTOCK	MFSTOCK	TSTOCK
1960			2552	4054	6,606				553,758	517,492	1,071,250
1961			5928	4688	10,616				554,779	520,978	1,075,757
1962			7587	4576	12,163				555,959	529,077	1,085,036
1963	21.26	115.69	8,080	4,462	12,542	1093.2	4596.4	186.95	557,111	539,442	1,096,553
1964	22.70	116.45	9,846	4,761	14,607	1100.4	4599.3	194.03	558,235	550,480	1,108,715
1965	23.55	116.83	5,123	7,969	13,092	1127.7	4639.8	191.98	559,433	563,932	1,123,365
1966	25.01	116.67	4,982	6,530	11,512	1173.8	4668.5	195.12	561,439	570,931	1,132,370
1967	27.17	114.37	7,983	6,086	14,069	1216.3	4709.2	200.53	563,083	577,737	1,140,820
1968	31.22	112.93	13,203	6,240	19,443	1247	4728.2	205.17	564,615	588,643	1,153,259
1969	33.87	113.35	9,605	4,967	14,572	1281.5	4758.3	207.62	566,186	606,681	1,172,867
1970	34.00	113.66	14,703	4,091	18,794	1283.6	4802.7	212.65	567,436	619,804	1,187,240
1971	38.83	115.80	14,952	6,315	21,267	1265.6	4832.9	220.81	576,219	633,043	1,209,262
1972	38.90	118.18	13,292	6,381	19,672	1266.3	4851.9	231.53	589,779	646,505	1,236,284
1973	39.98	117.34	13,272	6,040	19,312	1296.8	4855.4	231.36	603,478	658,473	1,261,952
1974	40.26	110.75	7,258	3,683	10,941	1343.2	4833.3	216.67	616,447	670,423	1,286,870
1975	40.92	106.32	4,931	4,412	9,343	1316.9	4813.4	214.26	624,355	676,958	1,301,313
1976	38.08	105.27	3,094	5,034	8,129	1320.6	4803.4	218.09	633,828	681,398	1,315,225
1977	38.81	104.79	4,672	5,549	10,222	1382.4	4797.5	212.70	644,637	684,184	1,328,821
1978	41.15	102.15	5,757	6,113	11,869	1470.7	4794.1	206.11	656,552	688,391	1,344,943
1979	44.23	96.42	4,719	4,964	9,683	1505.9	4793	201.58	669,676	693,575	1,363,251
1980	43.61	92.23	3,986	4,140	8,126	1523.5	4788.2	197.78	680,334	697,824	1,378,158
1981	44.88	93.62	4,106	4,108	8,214	1535.3	4808.4	199.07	682,709	704,976	1,387,686
1982	44.63	97.20	3,686	4,158	7,844	1541.1	4811.6	202.19	685,067	712,342	1,397,409
1983	48.04	100.60	4,000	6,660	10,660	1588.2	4835.3	207.71	687,453	718,956	1,406,409
1984	55.99	102.02	4,727	7,833	12,561	1671.2	4867.7	213.71	691,275	726,132	1,417,407
1985	68.66	106.41	7,931	9,213	17,144	1697.5	4899	220.84	695,770	734,614	1,430,384
1986	82.67	112.23	9,073	9,255	18,327	1734.1	4921.9	231.82	701,057	748,843	1,449,900
1987	90.84	116.02	8,004	8,395	16,399	1777.3	4940.5	236.04	706,368	765,120	1,471,487
1988	91.30	118.17	4,862	6,318	11,180	1813.7	4973.3	246.26	711,185	779,479	1,490,664
1989	87.43	120.97	2,622	4,711	7,333	1946.4	5000.3	230.47	714,811	788,202	1,503,012
1990	79.95	118.36	1,503	4,124	5,626	1875.6	5000.5	233.01	717,514	792,906	1,510,420
1991	72.91	114.24	679	4,587	5,266	1762.9	4980.3	240.91	719,880	795,602	1,515,482
1992	70.56	110.98	695	7,112	7,807	1759.3	4979.8	235.71	722,513	796,820	1,519,333
1993	69.48	108.44	1,124	6,602	7,726	1786.6	4992	236.82	726,594	798,068	1,524,662
1994	69.15	106.48	777	5,451	6,228	1836.8	5011.5	238.95	730,383	800,084	1,530,466

Detroit Data

Year	PRICE	RENT	MFPER	SFPER	TOTPER	EMP	POP	YPIR	SFSTOCK	MFSTOCK	TSTOCK
1960.00			1548.00	6674.00	8222.00				869,941	283,302	1,153,243
1961.00			1611.00	2914.00	4525.00				873,560	285,134	1,158,694
1962.00			4854.00	6417.00	11271.00				875,140	287,041	1,162,181
1963.00	80.77	137.58	6143.00	9951.00	16094.00	1257.90	4176.30	42.44	878,620	292,785	1,171,405
1964.00	79.02	136.45	8846.00	13301.00	22147.00	1320.90	4238.00	44.75	884,016	300,054	1,184,071
1965.00	84.48	135.87	12469.00	18396.00	30865.00	1408.10	4317.10	46.65	891,229	310,523	1,201,752
1966.00	86.55	135.19	9884.00	14132.00	24016.00	1490.20	4378.40	49.40	901,205	325,279	1,226,484
1967.00	87.61	135.63	13562.24	16465.65	30027.89	1509.10	4441.10	49.79	908,868	336,975	1,245,844
1968.00	90.70	134.20	15405.32	13203.24	28608.57	1560.80	4459.10	52.66	917,797	353,025	1,270,822
1969.00	106.82	132.15	15257.20	10300.57	25557.77	1606.70	4476.50	54.19	924,957	371,255	1,296,213
1970.00	102.23	130.15	10107.52	11612.60	21720.12	1586.90	4499.60	52.54	930,543	389,311	1,319,854
1971.00	95.24	130.12	17108.11	18489.50	35597.61	1565.40	4520.10	54.24	943,017	392,947	1,335,964
1972.00	88.42	130.14	15813.48	13035.31	28848.79	1611.60	4513.00	58.22	962,879	399,101	1,361,979
1973.00	93.45	126.58	17976.36	13299.31	31275.67	1693.30	4490.50	61.49	976,881	404,789	1,381,670
1974.00	95.62	119.07	10020.12	8131.86	18151.98	1754.20	4473.00	58.69	991,167	411,255	1,402,422
1975.00	93.16	114.31	4473.53	7519.16	11992.69	1665.90	4444.30	55.58	999,902	414,859	1,414,761
1976.00	91.98	112.48	5406.90	10188.03	15594.93	1727.70	4408.80	59.34	1,007,979	416,468	1,424,448
1977.00	92.59	112.54	7172.11	14256.21	21428.32	1838.40	4397.20	62.96	1,018,923	418,413	1,437,336
1978.00	102.87	112.88	8167.95	13136.09	21304.04	1887.20	4398.30	65.21	1,034,237	420,993	1,455,230
1979.00	113.10	110.06	6439.61	9565.12	16004.73	1866.10	4394.50	63.94	1,048,348	423,931	1,472,279
1980.00	104.56	106.55	3624.28	3917.26	7541.54	1730.80	4378.20	59.51	1,058,622	426,248	1,484,870
1981.00	95.28	102.64	2595.31	1971.39	4566.70	1715.90	4334.70	56.87	1,062,348	426,406	1,488,754
1982.00	87.40	100.52	2542.80	1413.24	3956.05	1623.50	4277.00	54.14	1,064,223	426,520	1,490,743
1983.00	80.72	100.00	2696.65	4076.36	6773.01	1651.00	4235.40	55.40	1,065,568	426,631	1,492,198
1984.00	78.26	99.52	4378.16	5258.72	9636.88	1741.40	4230.40	58.94	1,069,445	426,749	1,496,193
1985.00	79.27	101.77	8892.48	8081.26	16973.74	1859.30	4240.10	62.20	1,074,447	426,940	1,501,387
1986.00	84.39	107.30	10646.63	9257.32	19903.95	1886.70	4254.10	65.35	1,082,133	427,329	1,509,462
1987.00	92.43	108.27	5513.41	6765.94	12279.36	1913.00	4270.50	65.31	1,090,939	427,794	1,518,733
1988.00	96.80	107.27	10132.32	5720.65	15852.97	1924.20	4258.20	66.76	1,097,374	428,035	1,525,409
1989.00	98.76	105.56	6455.29	9106.17	15561.46	1952.10	4258.70	67.78	1,102,815	428,478	1,531,293
1990.00	99.11	104.44	3982.82	7943.70	11926.52	1960.50	4269.30	66.91	1,111,477	428,760	1,540,237
1991.00	99.29	101.91	3311.32	6747.26	10058.58	1897.00	4288.60	65.19	1,119,032	428,934	1,547,967
1992.00	100.24	99.36	3071.56	8224.77	11296.33	1903.40	4307.60	66.92	1,125,450	429,079	1,554,529
1993.00	100.34	98.82	2954.46	8563.57	11518.03	1920.70	4322.60	69.00	1,133,273	429,213	1,562,487
1994.00	103.21	98.18	3755.30	8749.53	12504.83	1975.50	4347.70	71.84	1,141,419	429,343	1,570,761

Houston Data

YEAR	PRICE	RENT	MFPER	SFPER	TOTPER	EMP	POP	YPIR	SFSTOCK	MFSTOCK	TSTOCK
1960			10,931	6,255					397,561	66,534	464,095
1961			12,037	6,056					407,328	76,488	483,816
1962			12,727	5,799					416,783	87,449	504,232
1963	95.30	141.18	14,626	7,458	22,084	510.40	1536.10	14.04	425,838	99,038	524,876
1964	92.50	139.68	10,888	6,085	16,973	533.20	1585.50	14.82	437,483	112,357	549,840
1965	85.96	136.83	6,223	6,797	13,020	563.70	1639.50	14.93	446,984	122,272	569,256
1966	83.21	134.57	6,463	6,043	12,506	604.90	1676.80	15.92	457,597	127,939	585,536
1967	87.66	132.34	9,050	5,828	14,878	661.10	1737.30	17.24	467,033	133,824	600,857
1968	97.21	129.60	15,435	5,976	21,411	718.80	1825.20	18.68	476,133	142,065	618,198
1969	102.65	125.34	20,882	4,459	25,341	755.90	1872.10	19.91	485,464	156,120	641,584
1970	104.98	121.65	18,249	3,746	21,995	767.50	1913.90	20.93	492,426	175,136	667,562
1971	109.12	119.75	27,974	5,768	33,742	789.60	1975.40	21.99	501,338	198,735	700,074
1972	108.66	117.22	24,384	6,518	30,902	842.90	2028.60	23.68	515,061	234,911	749,972
1973	103.81	111.71	14,361	4,858	19,219	910.00	2093.40	25.41	530,568	266,444	797,012
1974	102.24	104.06	6,003	3,557	9,561	1026.70	2165.30	27.28	542,126	285,015	827,141
1975	107.50	102.79	8,514	5,010	13,524	1066.00	2263.80	29.26	550,589	292,778	843,368
1976	119.94	108.79	17,577	7,786	25,363	1124.20	2359.90	31.98	562,509	303,788	866,297
1977	124.00	113.53	24,196	9,157	33,352	1205.90	2452.20	34.61	581,033	326,518	907,551
1978	133.40	110.43	29,029	29,839	58,868	1306.40	2555.20	38.32	602,818	357,807	960,626
1979	133.92	104.68	28,109	22,023	50,133	1388.70	2659.50	40.49	673,809	395,347	1,069,157
1980	123.51	97.94	17,441	19,247	36,688	1469.80	2786.90	42.09	726,206	431,698	1,157,904
1981	119.45	96.59	21,127	23,296	44,423	1597.50	2918.40	45.72	735,718	451,846	1,187,564
1982	125.73	102.28	41,924	27,131	69,054	1592.30	3107.60	47.53	747,232	476,253	1,223,484
1983	126.00	102.11	31,292	26,953	58,245	1498.50	3199.90	45.97	760,640	524,684	1,285,324
1984	113.92	95.86	16,729	15,472	32,201	1550.50	3223.00	47.13	773,960	560,834	1,334,794
1985	100.23	90.52	7,813	15,792	23,605	1545.70	3232.20	47.63	781,607	580,160	1,361,767
1986	95.68	88.41	1,666	13,943	15,610	1455.80	3275.50	45.80	789,411	589,186	1,378,597
1987	86.09	82.66	546	13,942	14,487	1452.00	3242.60	44.84	796,302	591,111	1,387,413
1988	82.40	77.94	3,000	15,331	18,331	1523.20	3260.90	46.57	803,192	591,741	1,394,933
1989	83.17	76.85	5,466	18,637	24,103	1587.70	3287.30	48.23	810,769	595,207	1,405,976
1990	82.64	78.50	5,402	20,271	25,674	1684.40	3343.00	50.49	819,979	601,522	1,421,501
1991	81.99	82.09	8,967	21,964	30,932	1692.00	3437.40	52.37	829,998	607,763	1,437,761
1992	83.04	84.53	8,373	24,160	32,533	1689.50	3530.40	54.70	840,853	618,122	1,458,975
1993	82.73	84.71	8,523	25,081	33,603	1715.90	3595.70	55.67	852,793	627,795	1,480,588
1994	82.05	85.02	14,954	25,587	40,541	1743.30	3704.60	57.83	865,189	637,640	1,502,829

7.3. Appendix 5-1 RATS Output - Model Results

I. Atlanta Regression Results

Dependent Variable LPRICE - Estimation by Least Squares
Annual Data From 1966:01 To 1994:01
Usable Observations 29 Degrees of Freedom 24
Centered R**2 0.746430 R Bar **2 0.704168
Uncentered R**2 0.999952 T x R**2 28.999
Mean of Dependent Variable 4.4346
Std Error of Dependent Variable 0.0623
Standard Error of Estimate 0.0339
Sum of Squared Residuals 0.0275644172
Durbin-Watson Statistic 1.894274

Variable	Coeff	StdError	T-Stat	Signif
1. Constant	11.17282803	5.01543390	2.22769	0.03553402
2. LPRICE{1}	0.58108035	0.13508294	4.30166	0.00024527
3. LSSTOCK	-1.16535115	0.58034826	-2.00802	0.05602433
4. LYPW	0.52042275	0.23117284	2.25123	0.03379999
5. LEMP	0.51247699	0.29123469	1.75967	0.09120661

Dependent Variable LSSTOCK - Estimation by Least Squares
Usable Observations 29 Degrees of Freedom 23
Centered R**2 0.999466 R Bar **2 0.999350
Uncentered R**2 1.000000 T x R**2 29.000
Mean of Dependent Variable 12.9064
Std Error of Dependent Variable 0.2706
Standard Error of Estimate 6.8986e-03
Sum of Squared Residuals 0.0010945811
Durbin-Watson Statistic 1.823826

Variable	Coeff	StdError	T-Stat	Signif
1. Constant	-0.030808445	0.092193885	-0.33417	0.74127909
2. LSSTOCK{1}	2.064980719	0.179770264	11.48678	0.00000000
3. LSSTOCK{2}	-1.627535258	0.336247843	-4.84028	0.00006934
4. LSSTOCK{3}	0.564313896	0.186415331	3.02719	0.00599472
5. LPRICE{2}	0.024495188	0.037798912	0.64804	0.52337666
6. LPRICE{3}	-0.019302118	0.034574237	-0.55828	0.58204751

Dependent Variable LEMP - Estimation by Least Squares
Usable Observations 29 Degrees of Freedom 25
Centered R**2 0.995899 R Bar **2 0.995406
Uncentered R**2 0.999988 T x R**2 29.000
Mean of Dependent Variable 6.9403218300
Std Error of Dependent Variable 0.3829596198
Standard Error of Estimate 0.0259552498
Sum of Squared Residuals 0.0168418748
Durbin-Watson Statistic 1.762077

Variable	Coeff	StdError	T-Stat	Signif
1. Constant	0.286129703	0.152660722	1.87429	0.07262344
2. LEMP{1}	0.964982006	0.028122843	34.31310	0.00000000
3. YPW{1}	0.007018108	0.002598192	2.70115	0.01222563
4. YPW{2}	-0.007209451	0.002787152	-2.58667	0.01590093

Dependent Variable LYPW - Estimation by Least Squares
Usable Observations 29 Degrees of Freedom 24
Centered R**2 0.984304 R Bar** 2 0.981688
Uncentered R**2 0.999954 T x R**2 28.999
Mean of Dependent Variable 4.171875032
Std Error of Dependent Variable 0.229959346
StandardError of Estimate 0.031118517
Sum of Squared Residuals 0.0232406904
Durbin-Watson Statistic 1.346744

Variable	Coeff	StdError	T-Stat	Signif
1. Constant	0.622277220	0.383959341	1.62069	0.11815144
2. LYPW{1}	0.977404751	0.069197047	14.12495	0.00000000
3. LEMP{1}	0.035713755	0.040244117	0.88743	0.38365575
4. LPRICE{1}	-0.066348141	0.165629627	-0.40058	0.69227207
5. LPRICE{2}	-0.102437706	0.159462089	-0.64240	0.52670603

II. Boston Regression Results

*Dependent Variable LPRICE - Estimation by Least Squares
Annual Data From 1966:01 To 1994:01
Usable Observations 29 Degrees of Freedom 24
Centered R**2 0.972805 R Bar **2 0.968273
Uncentered R**2 0.999758 T x R**2 28.993
Mean of Dependent Variable 3.8983
Std Error of Dependent Variable 0.3761
Standard Error of Estimate 0.0670
Sum of Squared Residuals 0.1077082445
Durbin-Watson Statistic 0.740357

Variable	Coeff	StdError	T-Stat	Signif
1. Constant	-3.957080895	6.266478594	-0.63147	0.53370339
2. LPRICE{1}	0.518263546	0.174744787	2.96583	0.00672958
3. LSSTOCK	-0.430380089	0.462060553	-0.93144	0.36090351
4. LYPW	0.609149753	0.422664654	1.44121	0.16244574
5. LEMP	1.139227572	0.402356776	2.83139	0.00922980

Dependent Variable LSSTOCK - Estimation by Least Squares
Usable Observations 29 Degrees of Freedom 23
Centered R**2 0.997802 R Bar **2 0.997324
Uncentered R**2 1.000000 T x R**2 29.000
Mean of Dependent Variable 13.391482818
Std Error of Dependent Variable 0.092312338
Standard Error of Estimate 0.004774971
Sum of Squared Residuals 0.0005244081
Durbin-Watson Statistic 2.011164

Variable	Coeff	StdError	T-Stat	Signif
1. Constant	0.448982817	0.286745733	1.56579	0.13105463
2. LSSTOCK{1}	1.766534135	0.206139045	8.56962	0.00000001
3. LSSTOCK{2}	-0.889399835	0.375363878	-2.36943	0.02658737
4. LSSTOCK{3}	0.088072109	0.198454638	0.44379	0.66134173
5. LPRICE{2}	-0.003279862	0.012664026	-0.25899	0.79794646
6. LPRICE{3}	0.008412909	0.012553168	0.67018	0.50941529

Dependent Variable LEMP - Estimation by Least Squares
Usable Observations 29 Degrees of Freedom 25
Centered R**2 0.972990 R Bar **2 0.969748
Uncentered R**2 0.999988 T x R**2 29.000
Mean of Dependent Variable 7.3180
Std Error of Dependent Variable 0.1554
Standard Error of Estimate 0.0270
Sum of Squared Residuals 0.0182678526
Durbin-Watson Statistic 1.282773

Variable	Coeff	StdError	T-Stat	Signif
1. Constant	0.392178419	0.395688181	0.99113	0.33111870
2. LEMP{1}	0.968350005	0.041465706	23.35303	0.00000000
3. LYPW{1}	0.269231914	0.176591968	1.52460	0.13991098
4. LYPW{2}	-0.296435721	0.176131906	-1.68303	0.10481791

Dependent Variable LYPW - Estimation by Least Squares
Usable Observations 29 Degrees of Freedom 24
Centered R**2 0.856899 R Bar **2 0.833049
Uncentered R**2 0.999977 T x R**2 28.999
Mean of Dependent Variable 5.3859
Std Error of Dependent Variable 0.0691
Standard Error of Estimate 0.0282
Sum of Squared Residuals 0.0191145048
Durbin-Watson Statistic 1.592600

Variable	Coeff	Std Error	T-Stat	Signif
1. Constant	1.086126136	2.033956284	0.53400	0.59825566
2. LYPW{1}	0.790084397	0.209887109	3.76433	0.00095367
3. LEMP{1}	-0.011300644	0.192941620	-0.05857	0.95377934
4. LPRICE{1}	0.156829212	0.090130264	1.74003	0.09466409
5. LPRICE{2}	-0.123636356	0.085668147	-1.44320	0.16189027

III. Detroit Regression Results

Dependent Variable LPRICE - Estimation by Least Squares
Annual Data From 1966:01 To 1994:01
Usable Observations 29 Degrees of Freedom 24
Centered R**2 0.830088 R Bar **2 0.801769
Uncentered R**2 0.999936 T x R**2 28.998
Mean of Dependent Variable 4.5447
Std Error of Dependent Variable 0.0896
Standard Error of Estimate 0.0399
Sum of Squared Residuals 0.0381593112
Durbin-Watson Statistic 1.878914

Variable	Coeff	Std Error	T-Stat	Signif
1. Constant	9.464853894	2.834962887	3.33862	0.00274065
2. LPRICE{1}	0.790461324	0.092370915	8.55747	0.00000001
3. LSSTOCK	-1.226194086	0.254506402	-4.81793	0.00006598
4. LYPW	-0.014315793	0.242559808	-0.05902	0.95342515
5. LEMP	1.143957646	0.203928637	5.60960	0.00000896

Dependent Variable LSSTOCK - Estimation by Least Squares
Usable Observations 29 Degrees of Freedom 23
Centered R**2 0.997794 R Bar **2 0.997315
Uncentered R**2 1.000000 T x R**2 29.000
Mean of Dependent Variable 13.8474775053
Std Error of Dependent Variable 0.0716857881
Standard Error of Estimate 0.0037147621
Sum of Squared Residuals 0.0003173875
Durbin-Watson Statistic 1.953726

Variable	Coeff	Std Error	T-Stat	Signif
1. Constant	0.207136539	0.146570846	1.41322	0.17098305
2. LSSTOCK{1}	1.656745767	0.205005385	8.08147	0.00000004
3. LSSTOCK{2}	-0.885373538	0.352060757	-2.51483	0.01934990
4. LSSTOCK{3}	0.212144607	0.194707625	1.08955	0.28719387
5. LPRICE{2}	0.019437645	0.012307469	1.57934	0.12791449
6. LPRICE{3}	-0.013854615	0.012229434	-1.13289	0.26893222

Dependent Variable LEMP - Estimation by Least Squares
Usable Observations 29 Degrees of Freedom 25
Centered R**2 0.908881 R Bar **2 0.897946
Uncentered R**2 0.999988 T x R**2 29.000
Mean of Dependent Variable 7.4691
Std Error of Dependent Variable 0.0867
Standard Error of Estimate 0.0277
Sum of Squared Residuals 0.0191687526
Durbin-Watson Statistic 1.125143

Variable	Coeff	Std Error	T-Stat	Signif
1. Constant	1.539824443	0.883121074	1.74362	0.09351303
2. LEMP{1}	0.885018431	0.056726714	15.60144	0.00000000
3. LYPW{1}	0.656923579	0.215105881	3.05395	0.00530206
4. LYPW{2}	-0.791387890	0.217414310	-3.64000	0.00124087

Dependent Variable LYPW - Estimation by Least Squares
Usable Observations 29 Degrees of Freedom 24
Centered R**2 0.555504 R Bar **2 0.481421
Uncentered R**2 0.999977 T x R**2 28.999
Mean of Dependent Variable 5.0072
Std Error of Dependent Variable 0.0364
Standard Error of Estimate 0.0262
Sum of Squared Residuals 0.0164469488
Durbin-Watson Statistic 1.436180

Variable	Coeff	Std Error	T-Stat	Signif
1. Constant	1.416002742	0.822399089	1.72180	0.09797295
2. LYPW{1}	0.724664629	0.153778063	4.71241	0.00008628
3. LEMP{1}	-0.024949853	0.057442593	-0.43434	0.66791862
4. LPRICE{1}	-0.027057143	0.092598252	-0.29220	0.77264532
5. LPRICE{2}	0.060492337	0.081930009	0.73834	0.46746606

IV. Houston Regression Results

Dependent Variable LPRICE - Estimation by Least Squares
Usable Observations 29 Degrees of Freedom 24
Centered R**2 0.935288 R Bar **2 0.924502
Uncentered R**2 0.999917 T x R**2 28.998
Mean of Dependent Variable 4.62095
Std Error of Dependent Variable 0.16875
Standard Error of Estimate 0.04637
Sum of Squared Residuals 0.0515967247
Durbin-Watson Statistic 1.406346

Variable	Coeff	Std Error	T-Stat	Signif
1. Constant	8.182408038	2.868125211	2.85288	0.00877816
2. LPRICE{1}	0.828240365	0.067260417	12.31393	0.00000000
3. LSSTOCK	-0.768772234	0.280872841	-2.73708	0.01148489
4. LYPW	0.078529772	0.190643510	0.41192	0.68405433
5. LEMP	0.361090078	0.134019935	2.69430	0.01267110

Dependent Variable LSSTOCK - Estimation by Least Squares
Annual Data From 1966:01 To 1994:01
Usable Observations 29 Degrees of Freedom 23
Centered R**2 0.996083 R Bar **2 0.995232
Uncentered R**2 0.999999 T x R**2 29.000
Mean of Dependent Variable 13.391344831
Std Error of Dependent Variable 0.222899717
Standard Error of Estimate 0.015391976
Sum of Squared Residuals 0.0054489972
Durbin-Watson Statistic 2.008152

Variable	Coeff	Std Error	T-Stat	Signif
1. Constant	0.046057092	0.198472358	0.23206	0.81854533
2. LSSTOCK{1}	1.547486817	0.204044383	7.58407	0.00000011
3. LSSTOCK{2}	-0.657351485	0.354330413	-1.85519	0.07643121
4. LSSTOCK{3}	0.103408988	0.208070322	0.49699	0.62391313
5. LPRICE{2}	0.104676473	0.057455225	1.82188	0.08150450
6. LPRICE{3}	-0.093221163	0.055319198	-1.68515	0.10548194

DependentVariable LEMPEstimation by Least Squares
Usable Observations 29 Degrees of Freedom 25
Centered R**2 0.989721 R Bar **2 0.988487
Uncentered R**2 0.999978 T x R**2 28.999
Mean of Dependent Variable 7.100648843
Std Error of Dependent Variable 0.335599438
Standard Error of Estimate 0.036008937
Sum of Squared Residuals 0.0324160883
Durbin-Watson Statistic 1.565330

Variable	Coeff	Std Error T-	Stat	Signif
1. Constant	0.301178731	0.209982097	1.43431	0.16387605
2. LEMP{1}	1.026892569	0.077807671	13.19783	0.00000000
3. LYPW{1}	-0.356973352	0.260662754	-1.36948	0.18302542
4. LYPW{2}	0.253919008	0.223880345	1.13417	0.26748076

Dependent Variable LYPW - Estimation by Least Squares
Usable Observations 29 Degrees of Freedom 24
Centered R**2 0.995696 R Bar **2 0.994978
Uncentered R**2 0.999978 T x R**2 28.999
Mean of Dependent Variable 4.34071
Std Error of Dependent Variable 0.31895
Standard Error of Estimate 0.02260
Sum of Squared Residuals 0.0122606153
Durbin-Watson Statistic 1.585727

Variable	Coeff	Std Error	T-Stat	Signif
1. Constant	-0.256681494	0.144859751	-1.77193	0.08910353
2. LYPW{1}	0.690148423	0.070111996	9.84351	0.00000000
3. LEMP{1}	0.277513993	0.062507252	4.43971	0.00017266
4. LPRICE{1}	0.023749452	0.083844413	0.28326	0.77940940
5. LPRICE{2}	-0.095775946	0.079029763	-1.21190	0.23734850

7.4. Appendix 5-2 Impulse Responses and Variance Decomposition

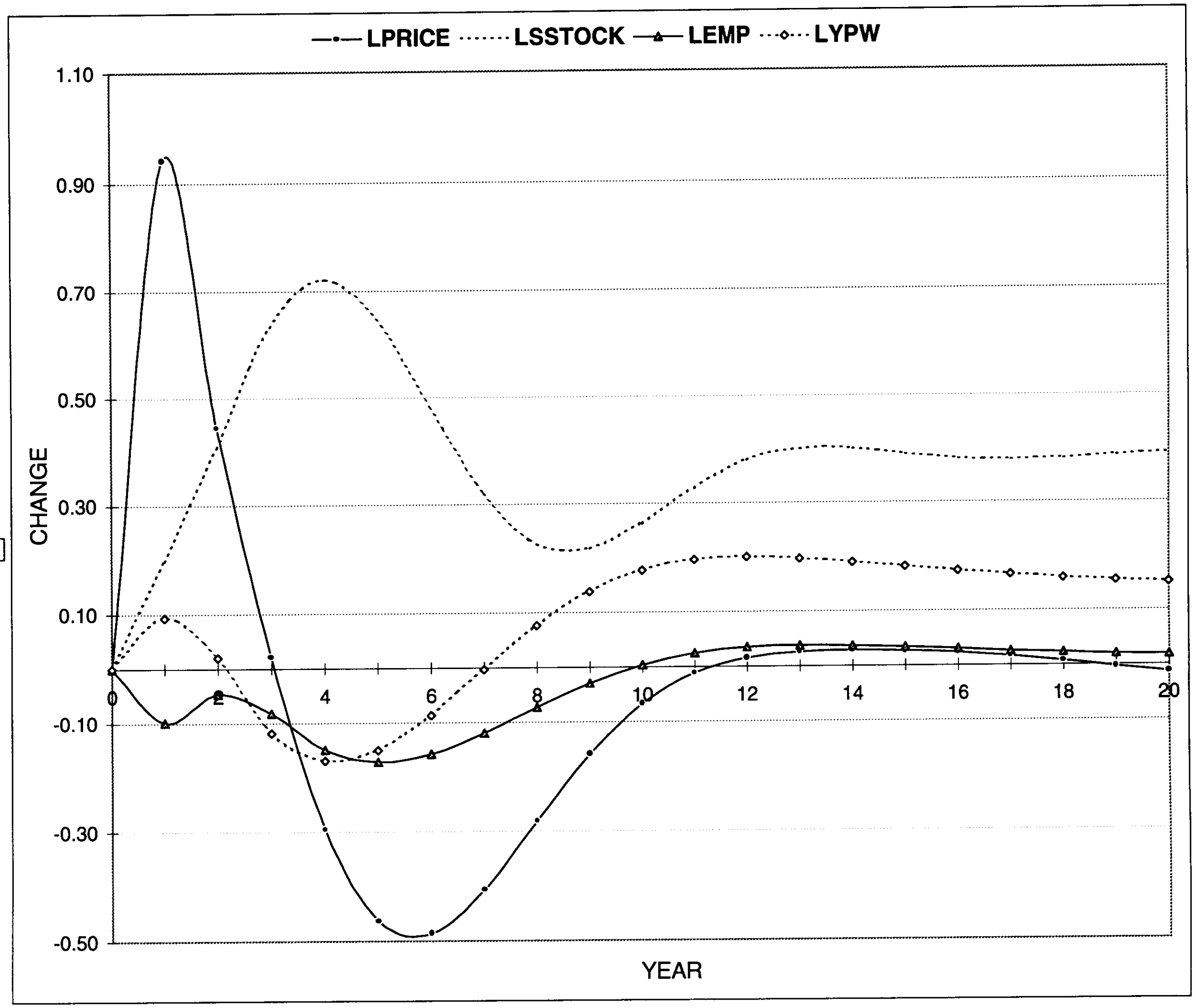
Atlanta MSA

Innovations in Price, Stock , Wage and Employment from Positive Shock in Single Family Demand (PRICE)

Year	LPRICE	LSSTOCK	LEMP	LYPW
0	0.00	0.00	0.00	0.00
1	0.94	0.20	-0.10	0.09
2	0.44	0.40	-0.05	0.02
3	0.02	0.63	-0.08	-0.12
4	-0.30	0.72	-0.15	-0.17
5	-0.46	0.65	-0.17	-0.15
6	-0.49	0.48	-0.16	-0.09
7	-0.41	0.32	-0.12	0.00
8	-0.28	0.23	-0.07	0.08
9	-0.16	0.22	-0.03	0.14
10	-0.07	0.26	0.00	0.18
11	-0.01	0.33	0.02	0.20
12	0.02	0.38	0.04	0.20
13	0.03	0.40	0.04	0.20
14	0.03	0.40	0.04	0.19
15	0.03	0.39	0.03	0.18
16	0.02	0.38	0.03	0.17
17	0.02	0.38	0.03	0.17
18	0.01	0.38	0.02	0.16
19	0.00	0.38	0.02	0.15
20	-0.01	0.39	0.02	0.15

Decomposition of Variance for Series LPRICE

Entry	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.03	83.75	1.75	2.16	12.33
2	0.04	56.74	8.12	2.27	32.87
3	0.05	36.09	17.69	2.00	44.23
4	0.06	27.65	24.16	1.69	46.49
5	0.07	26.48	26.37	1.50	45.65
6	0.08	27.94	26.11	1.43	44.53
7	0.08	29.56	25.32	1.42	43.70
8	0.08	30.42	25.00	1.43	43.15
9	0.08	30.62	25.06	1.45	42.87
10	0.08	30.55	25.13	1.48	42.84
11	0.08	30.46	25.08	1.51	42.94
12	0.08	30.38	25.02	1.54	43.05
13	0.08	30.32	25.00	1.58	43.10
14	0.08	30.27	25.02	1.61	43.10
15	0.08	30.23	25.04	1.64	43.08
16	0.08	30.21	25.08	1.67	43.05
17	0.08	30.18	25.11	1.70	43.01
18	0.08	30.15	25.16	1.73	42.96
19	0.08	30.11	25.22	1.76	42.91
20	0.08	30.07	25.29	1.78	42.85



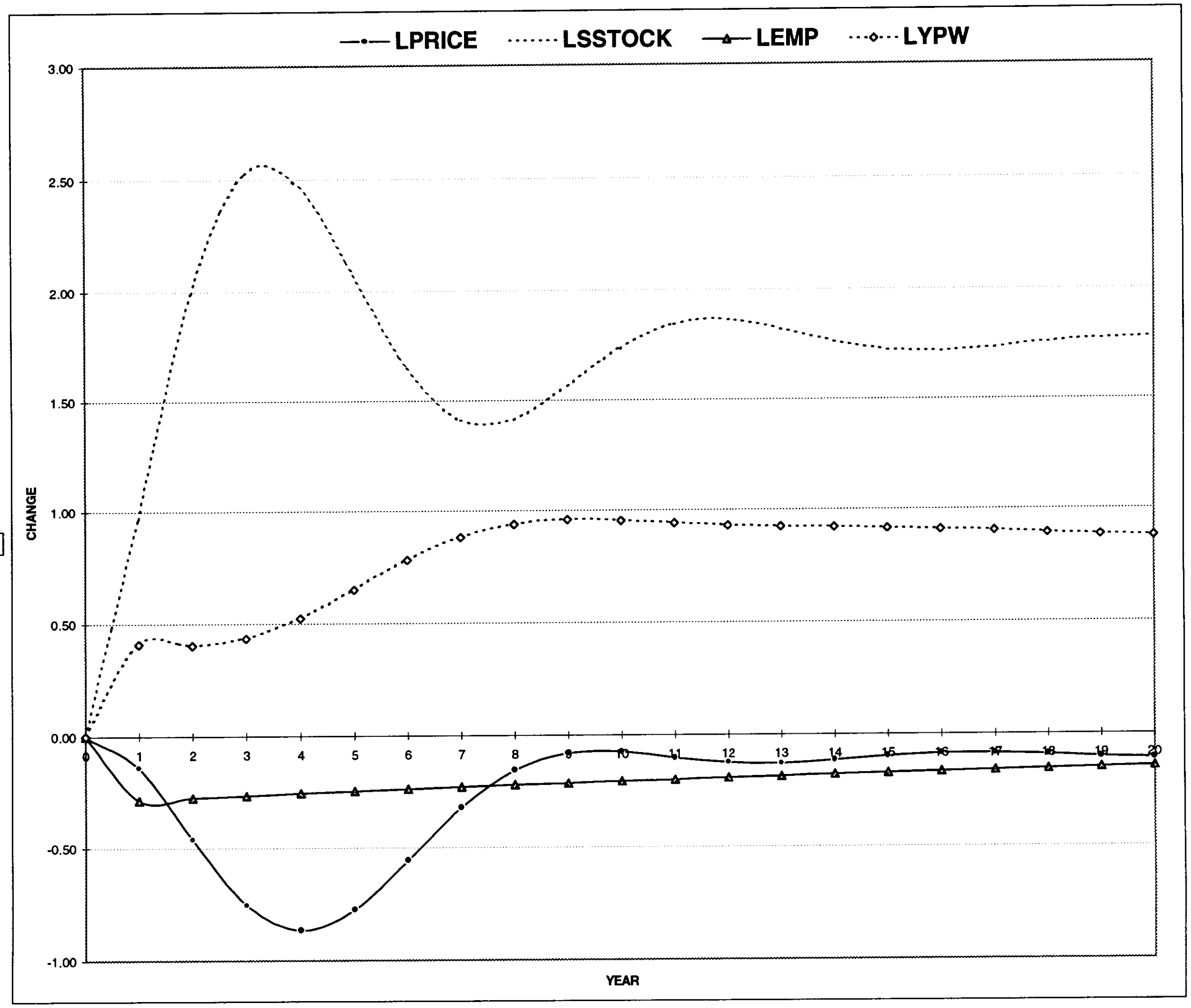
Atlanta MSA

Innovations in Price, Stock, Employment and Wage from a Positive Shock SF Supply (SFSTOCK)

Year	LPRICE	LSSTOCK	LEMP	LYPW
0	0.0000	0.0000	0.0000	0.0000
1	-0.1424	0.9630	-0.2863	0.4087
2	-0.4629	1.9885	-0.2762	0.4011
3	-0.7538	2.5215	-0.2666	0.4330
4	-0.8651	2.4707	-0.2572	0.5213
5	-0.7731	2.0726	-0.2482	0.6483
6	-0.5553	1.6481	-0.2395	0.7785
7	-0.3224	1.4133	-0.2311	0.8801
8	-0.1557	1.4122	-0.2231	0.9384
9	-0.0808	1.5602	-0.2152	0.9577
10	-0.0768	1.7330	-0.2077	0.9528
11	-0.1031	1.8414	-0.2004	0.9395
12	-0.1255	1.8608	-0.1934	0.9283
13	-0.1289	1.8182	-0.1866	0.9220
14	-0.1162	1.7598	-0.1801	0.9189
15	-0.0990	1.7212	-0.1738	0.9154
16	-0.0877	1.7142	-0.1677	0.9096
17	-0.0866	1.7308	-0.1618	0.9014
18	-0.0936	1.7541	-0.1562	0.8922
19	-0.1033	1.7706	-0.1507	0.8837
20	-0.1110	1.7749	-0.1454	0.8771

Decomposition of Variance for Series LSTOCK

Entry	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.01	3.96	96.04	0.00	0.00
2	0.01	3.96	96.04	0.00	0.00
3	0.02	5.06	94.92	0.00	0.02
4	0.03	6.03	93.84	0.01	0.12
5	0.03	6.55	93.05	0.02	0.38
6	0.03	6.62	92.57	0.03	0.77
7	0.03	6.42	92.36	0.04	1.18
8	0.04	6.09	92.40	0.05	1.46
9	0.04	5.72	92.65	0.05	1.58
10	0.04	5.38	93.00	0.05	1.57
11	0.04	5.12	93.32	0.05	1.51
12	0.04	4.97	93.54	0.05	1.43
13	0.04	4.90	93.67	0.06	1.37
14	0.05	4.85	93.76	0.06	1.33
15	0.05	4.81	93.82	0.06	1.31
16	0.05	4.76	93.88	0.07	1.29
17	0.05	4.72	93.94	0.07	1.27
18	0.05	4.68	94.00	0.08	1.25
19	0.05	4.64	94.05	0.08	1.23
20	0.05	4.61	94.09	0.08	1.22



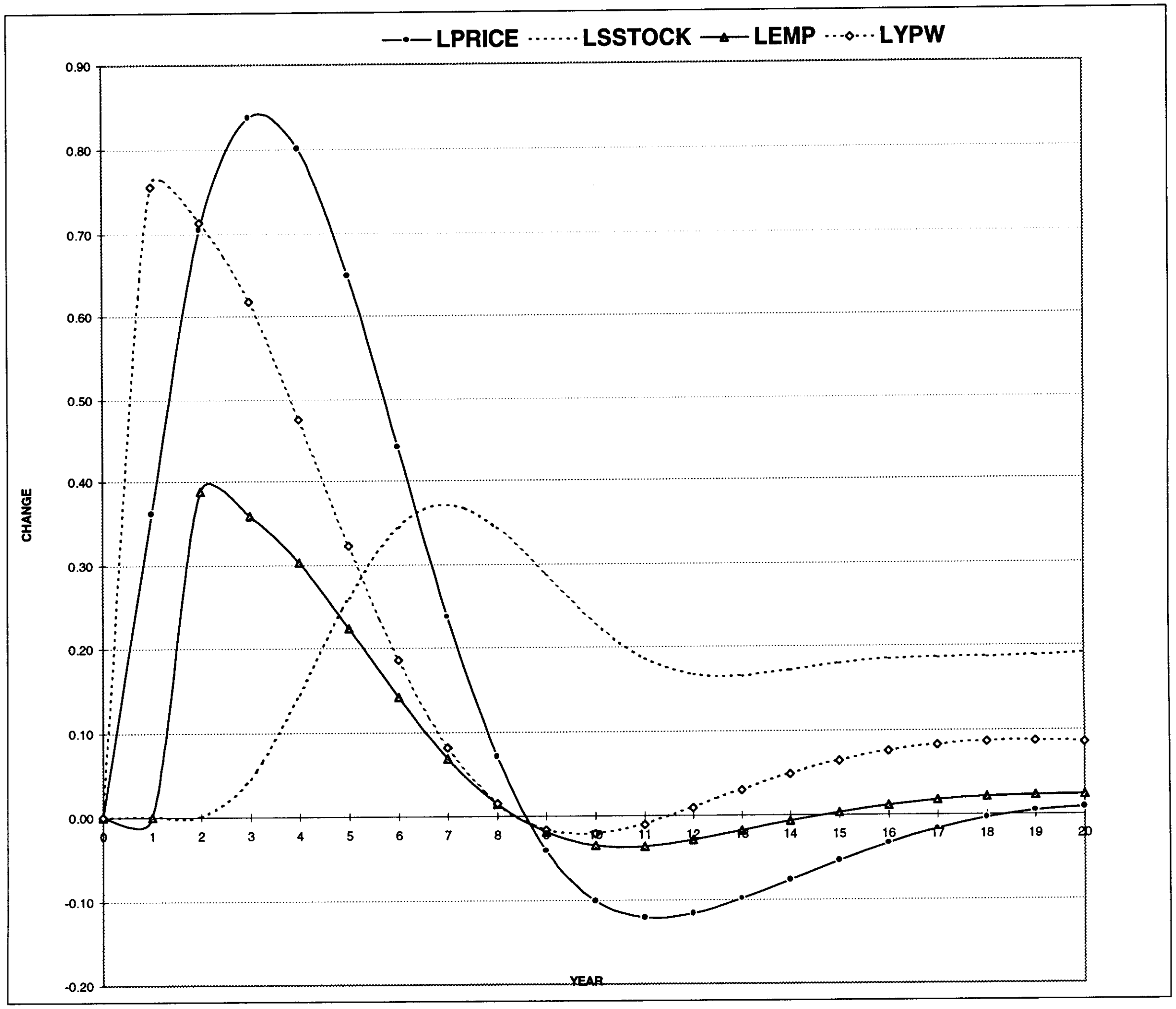
Atlanta MSA

Innovations in Price, Stock, Employment and Wage from a Positive Shock in Labor Supply (LYPW)

Year	LPRICE	LSSTOCK	LEMP	LYPW
0	0.0000	0.0000	0.0000	0.0000
1	0.3615	0.0000	0.0000	0.7566
2	0.7056	0.0000	0.3882	0.7134
3	0.8376	0.0444	0.3585	0.6177
4	0.8010	0.1435	0.3025	0.4753
5	0.6486	0.2586	0.2238	0.3224
6	0.4423	0.3428	0.1414	0.1856
7	0.2374	0.3702	0.0689	0.0814
8	0.0711	0.3440	0.0145	0.0151
9	-0.0410	0.2876	-0.0192	-0.0164
10	-0.1010	0.2287	-0.0346	-0.0216
11	-0.1212	0.1863	-0.0361	-0.0103
12	-0.1164	0.1665	-0.0291	0.0089
13	-0.0989	0.1644	-0.0183	0.0298
14	-0.0766	0.1711	-0.0068	0.0487
15	-0.0542	0.1789	0.0034	0.0639
16	-0.0337	0.1838	0.0116	0.0751
17	-0.0165	0.1857	0.0174	0.0822
18	-0.0034	0.1864	0.0211	0.0858
19	0.0049	0.1877	0.0230	0.0866
20	0.0088	0.1901	0.0233	0.0854

Decomposition of Variance for Series LYPW

Entry	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.03	0.90	17.30	22.52	59.29
2	0.04	0.49	17.94	22.41	59.16
3	0.05	0.89	19.80	23.05	56.26
4	0.05	1.58	23.40	23.81	51.20
5	0.06	1.89	28.83	24.26	45.02
6	0.06	1.76	35.38	24.13	38.73
7	0.07	1.50	41.80	23.53	33.17
8	0.07	1.39	47.16	22.73	28.72
9	0.08	1.49	51.20	21.97	25.34
10	0.08	1.73	54.13	21.34	22.80
11	0.09	2.02	56.28	20.84	20.86
12	0.09	2.30	57.96	20.43	19.31
13	0.09	2.53	59.36	20.05	18.05
14	0.09	2.71	60.61	19.69	16.99
15	0.10	2.85	61.74	19.33	16.07
16	0.10	2.95	62.80	18.97	15.28
17	0.10	3.03	63.79	18.60	14.58
18	0.11	3.08	64.72	18.24	13.96
19	0.11	3.11	65.59	17.89	13.41
20	0.11	3.14	66.43	17.54	12.90



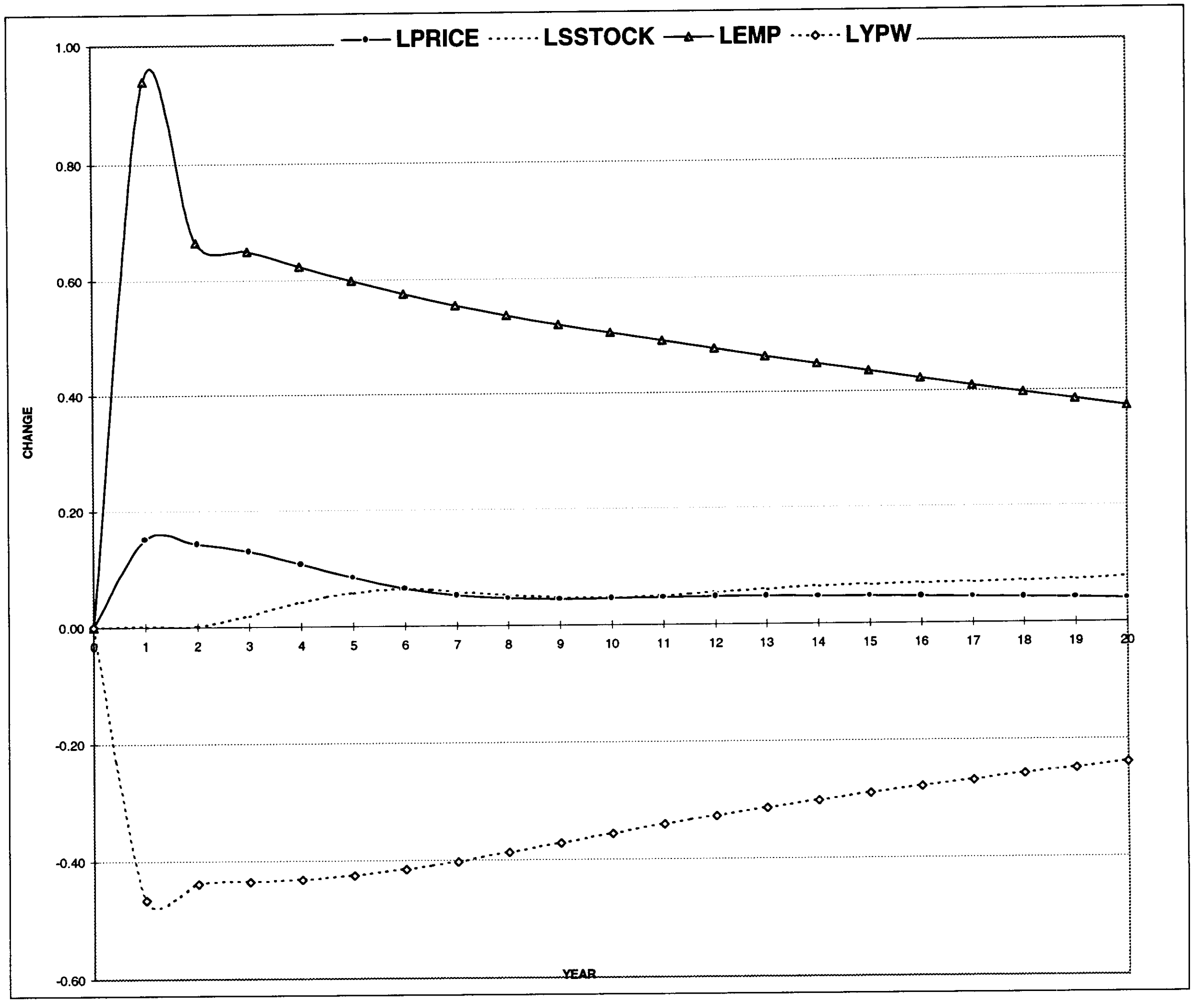
Atlanta MSA

Innovations in Price, Stock, Wage and Employment from a Positive Shock Labor Demand (LEMP)

Year	LPRICE	LSSTOCK	LEMP	LYPW
0	0.0000	0.0000	0.0000	0.0000
1	0.1513	0.0000	0.9392	-0.4663
2	0.1432	0.0000	0.6647	-0.4383
3	0.1295	0.0186	0.6497	-0.4355
4	0.1075	0.0413	0.6227	-0.4314
5	0.0840	0.0572	0.5974	-0.4250
6	0.0646	0.0619	0.5742	-0.4154
7	0.0521	0.0581	0.5536	-0.4027
8	0.0463	0.0512	0.5355	-0.3879
9	0.0452	0.0463	0.5192	-0.3721
10	0.0461	0.0457	0.5042	-0.3564
11	0.0474	0.0490	0.4899	-0.3415
12	0.0479	0.0542	0.4758	-0.3275
13	0.0478	0.0593	0.4619	-0.3145
14	0.0472	0.0632	0.4482	-0.3022
15	0.0464	0.0659	0.4348	-0.2906
16	0.0456	0.0677	0.4216	-0.2795
17	0.0447	0.0695	0.4088	-0.2689
18	0.0435	0.0715	0.3962	-0.2588
19	0.0420	0.0739	0.3841	-0.2491
20	0.0404	0.0764	0.3722	-0.2398

Decomposition of Variance for Series LEMP

Entry	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.02	1.02	7.62	91.36	0.00
2	0.03	0.78	4.88	84.71	9.64
3	0.04	0.89	3.70	82.25	13.15
4	0.04	1.59	3.02	81.27	14.12
5	0.04	2.33	2.60	81.33	13.74
6	0.05	2.80	2.47	81.92	12.81
7	0.05	2.93	2.72	82.59	11.77
8	0.05	2.83	3.25	83.07	10.85
9	0.05	2.65	3.88	83.37	10.10
10	0.05	2.49	4.42	83.59	9.50
11	0.05	2.36	4.83	83.81	9.00
12	0.06	2.27	5.10	84.05	8.58
13	0.06	2.20	5.29	84.30	8.21
14	0.06	2.14	5.44	84.53	7.89
15	0.06	2.08	5.58	84.73	7.61
16	0.06	2.03	5.73	84.88	7.37
17	0.06	1.98	5.88	84.99	7.15
18	0.06	1.93	6.03	85.07	6.96
19	0.06	1.89	6.20	85.12	6.79
20	0.06	1.85	6.36	85.15	6.64



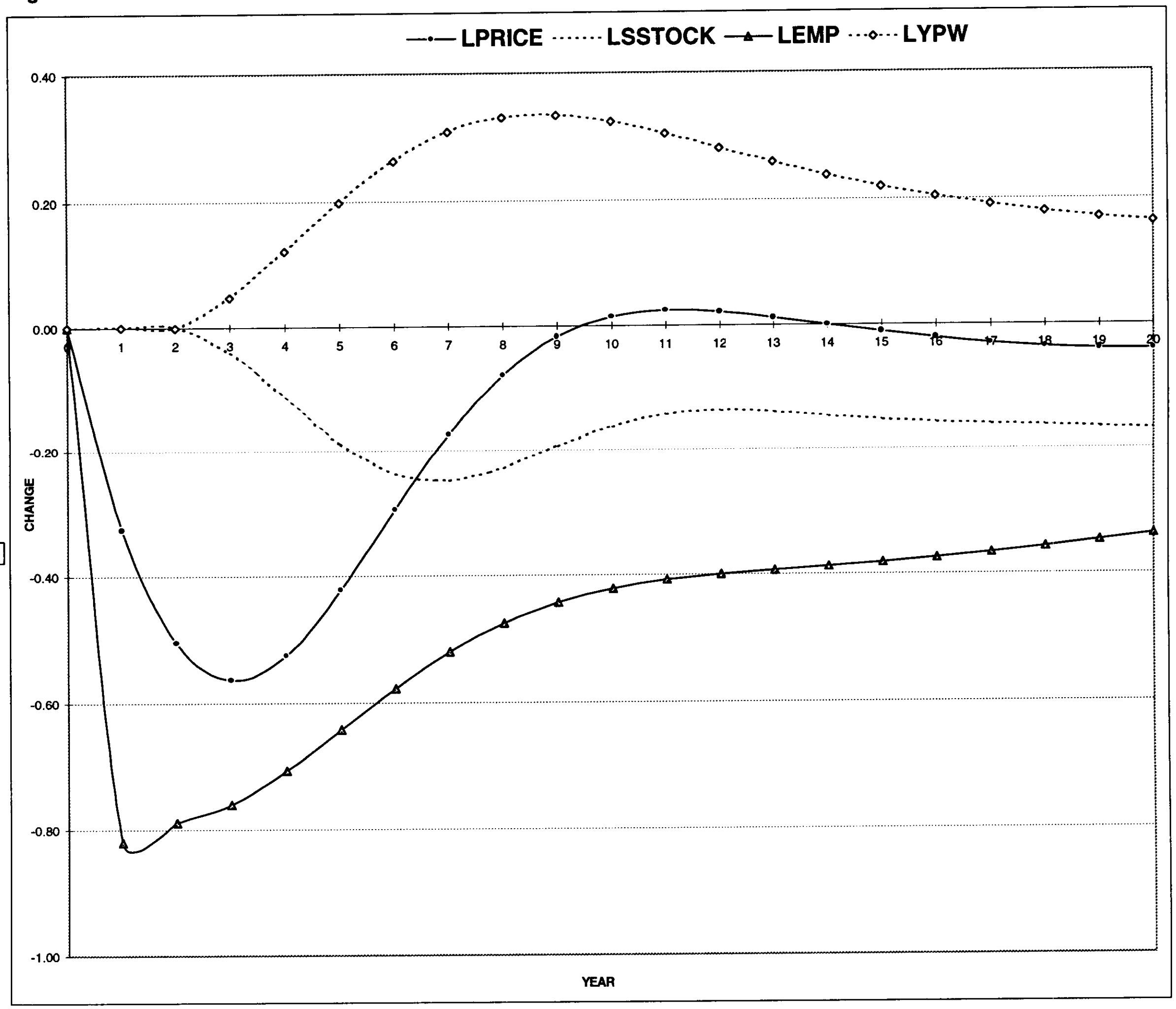
Atlanta MSA

Innovations in Price, Stock, Employment and Wage to Adverse Shock in Labor Demand (LEMP)

Year	LPRICE	LSSTOCK	LEMP	LYPW
0	0.00	0.00	0.00	0.00
1	-0.33	0.00	-0.82	0.00
2	-0.50	0.00	-0.79	0.00
3	-0.56	-0.04	-0.76	0.05
4	-0.53	-0.11	-0.71	0.12
5	-0.42	-0.19	-0.64	0.20
6	-0.29	-0.24	-0.58	0.26
7	-0.17	-0.25	-0.52	0.31
8	-0.08	-0.23	-0.48	0.33
9	-0.02	-0.20	-0.44	0.33
10	0.01	-0.16	-0.42	0.32
11	0.02	-0.14	-0.41	0.30
12	0.02	-0.14	-0.40	0.28
13	0.01	-0.14	-0.39	0.26
14	0.00	-0.15	-0.39	0.24
15	-0.01	-0.15	-0.38	0.22
16	-0.02	-0.16	-0.37	0.20
17	-0.03	-0.16	-0.37	0.19
18	-0.04	-0.16	-0.36	0.18
19	-0.04	-0.17	-0.35	0.17
20	-0.04	-0.17	-0.34	0.16

Decomposition of Variance for Series LEMP

Entry	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.02	1.02	7.62	91.36	0.00
2	0.03	0.78	4.88	84.71	9.64
3	0.04	0.89	3.70	82.25	13.15
4	0.04	1.59	3.02	81.27	14.12
5	0.04	2.33	2.60	81.33	13.74
6	0.05	2.80	2.47	81.92	12.81
7	0.05	2.93	2.72	82.59	11.77
8	0.05	2.83	3.25	83.07	10.85
9	0.05	2.65	3.88	83.37	10.10
10	0.05	2.49	4.42	83.59	9.50
11	0.05	2.36	4.83	83.81	9.00
12	0.06	2.27	5.10	84.05	8.58
13	0.06	2.20	5.29	84.30	8.21
14	0.06	2.14	5.44	84.53	7.89
15	0.06	2.08	5.58	84.73	7.61
16	0.06	2.03	5.73	84.88	7.37
17	0.06	1.98	5.88	84.99	7.15
18	0.06	1.93	6.03	85.07	6.96
19	0.06	1.89	6.20	85.12	6.79
20	0.06	1.85	6.36	85.15	6.64



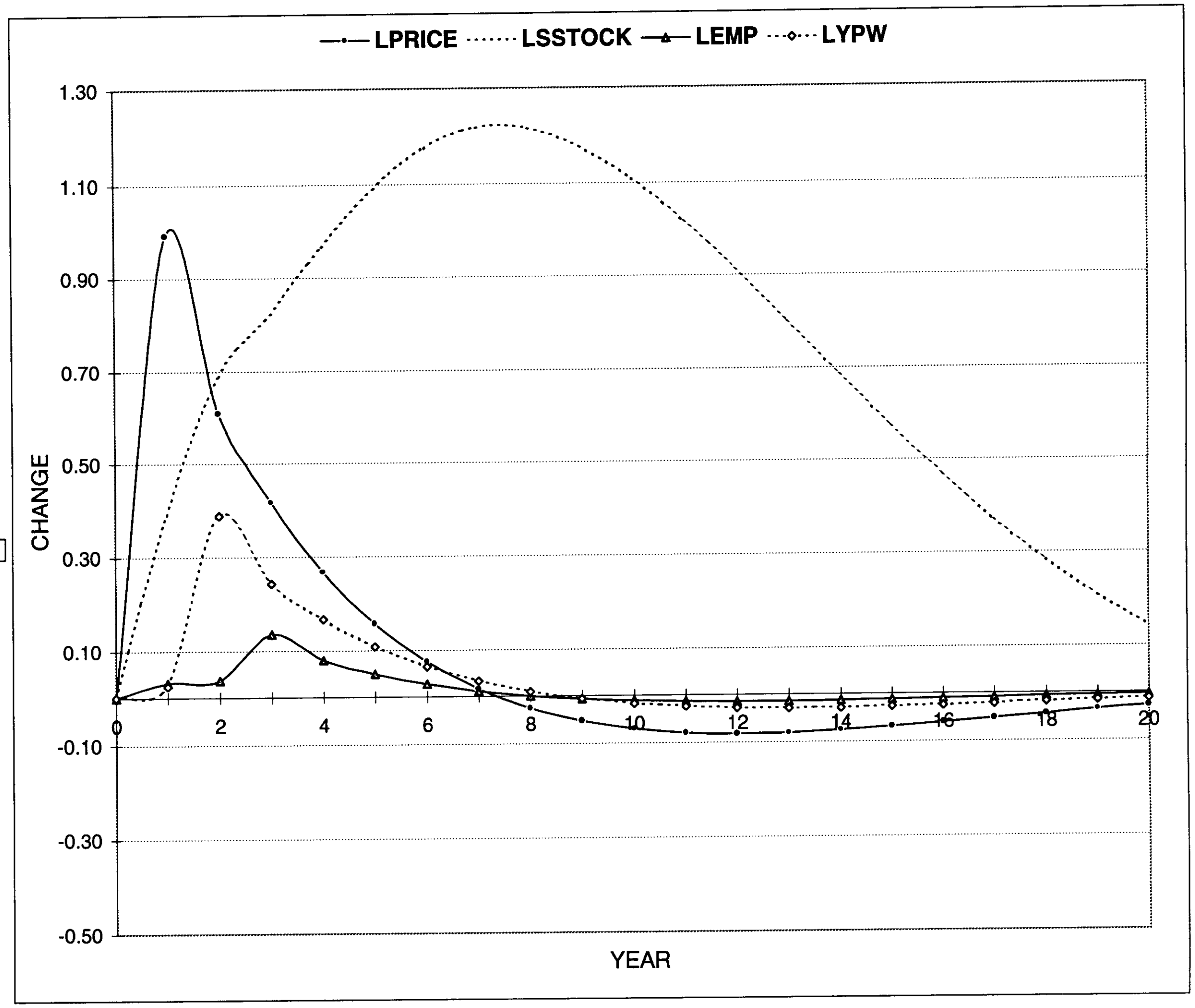
Boston NECMA

Innovations in Price, Stock , Wage and Employment from Positive Shock in Single Family Demand (PRICE)

Year	LPRICE	LSSTOCK	LEMP	LYPW
0	0.00	0.00	0.00	0.00
1	0.99	0.39	0.03	0.02
2	0.61	0.69	0.04	0.39
3	0.42	0.82	0.14	0.24
4	0.27	0.96	0.08	0.17
5	0.16	1.09	0.05	0.11
6	0.08	1.17	0.03	0.06
7	0.02	1.22	0.01	0.03
8	-0.03	1.22	0.00	0.01
9	-0.05	1.18	-0.01	-0.01
10	-0.07	1.11	-0.01	-0.02
11	-0.08	1.02	-0.01	-0.02
12	-0.08	0.91	-0.01	-0.03
13	-0.08	0.80	-0.01	-0.03
14	-0.08	0.69	-0.01	-0.03
15	-0.07	0.57	-0.01	-0.03
16	-0.06	0.47	-0.01	-0.03
17	-0.05	0.37	-0.01	-0.02
18	-0.04	0.28	-0.01	-0.02
19	-0.04	0.21	-0.01	-0.02
20	-0.03	0.14	0.00	-0.01

Decomposition of Variance for Series LPRICE

Entry	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.07	88.50	0.18	8.09	3.22
2	0.08	75.45	0.40	14.91	9.25
3	0.10	62.35	0.89	23.10	13.66
4	0.11	51.01	1.65	31.60	15.73
5	0.12	41.94	2.58	39.58	15.90
6	0.13	34.95	3.54	46.56	14.95
7	0.15	29.65	4.44	52.38	13.53
8	0.16	25.66	5.20	57.10	12.05
9	0.17	22.63	5.81	60.86	10.70
10	0.18	20.31	6.27	63.84	9.59
11	0.19	18.51	6.60	66.18	8.71
12	0.19	17.10	6.82	68.04	8.04
13	0.20	15.98	6.95	69.51	7.56
14	0.21	15.07	7.02	70.70	7.21
15	0.21	14.34	7.03	71.65	6.97
16	0.22	13.73	7.02	72.44	6.81
17	0.22	13.23	6.98	73.08	6.71
18	0.22	12.81	6.93	73.62	6.64
19	0.23	12.46	6.87	74.07	6.60
20	0.23	12.17	6.81	74.45	6.57



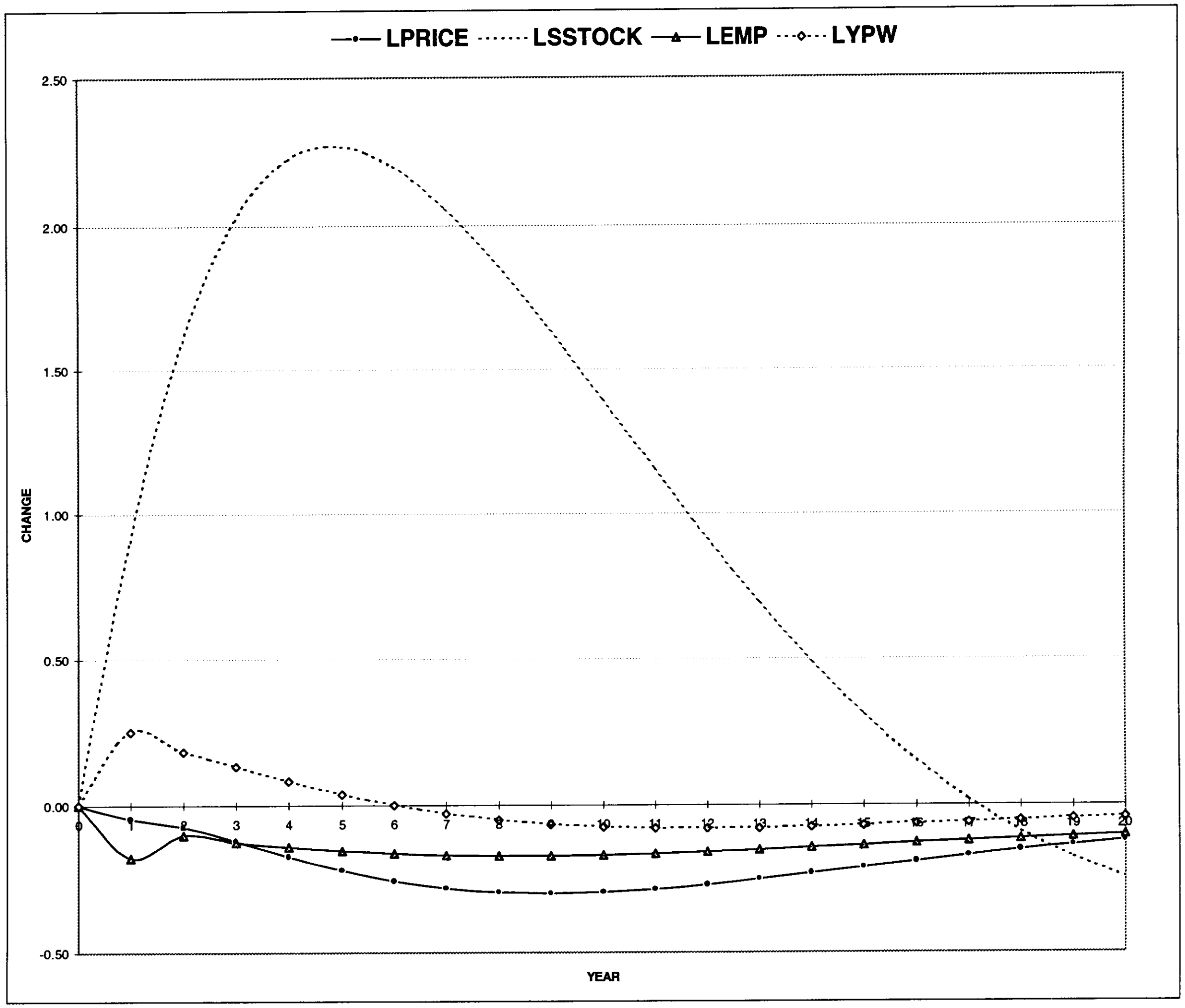
Boston NECMA

Innovations in Price, Stock, Employment and Wage from a Positive Shock SF Supply (SFSTOCK)

Year	LPRICE	LSSTOCK	LEMP	LYPW
0	0.0000	0.0000	0.0000	0.0000
1	-0.0451	0.9025	-0.1764	0.2525
2	-0.0713	1.5943	-0.1012	0.1847
3	-0.1213	2.0158	-0.1238	0.1337
4	-0.1735	2.2204	-0.1390	0.0828
5	-0.2197	2.2671	-0.1524	0.0380
6	-0.2559	2.2011	-0.1622	0.0008
7	-0.2806	2.0570	-0.1683	-0.0284
8	-0.2944	1.8613	-0.1711	-0.0499
9	-0.2984	1.6347	-0.1708	-0.0648
10	-0.2944	1.3935	-0.1681	-0.0740
11	-0.2840	1.1502	-0.1635	-0.0786
12	-0.2690	0.9144	-0.1576	-0.0796
13	-0.2509	0.6928	-0.1507	-0.0780
14	-0.2310	0.4904	-0.1432	-0.0744
15	-0.2105	0.3100	-0.1355	-0.0696
16	-0.1901	0.1530	-0.1278	-0.0640
17	-0.1705	0.0199	-0.1203	-0.0582
18	-0.1522	-0.0901	-0.1131	-0.0523
19	-0.1354	-0.1783	-0.1063	-0.0467
20	-0.1203	-0.2465	-0.0999	-0.0414

Decomposition of Variance for Series LSTOCK

Entry	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.00	15.64	84.36	0.00	0.00
2	0.01	15.64	84.36	0.00	0.00
3	0.01	14.87	85.13	0.00	0.00
4	0.02	15.27	84.73	0.00	0.00
5	0.02	16.31	83.69	0.00	0.00
6	0.02	17.64	82.32	0.03	0.02
7	0.02	19.05	80.77	0.11	0.07
8	0.03	20.40	79.13	0.29	0.17
9	0.03	21.61	77.41	0.65	0.33
10	0.03	22.61	75.60	1.24	0.55
11	0.03	23.36	73.70	2.13	0.81
12	0.03	23.83	71.70	3.37	1.09
13	0.03	24.04	69.61	4.99	1.36
14	0.03	23.99	67.44	6.97	1.60
15	0.03	23.71	65.22	9.28	1.79
16	0.03	23.25	62.99	11.84	1.91
17	0.03	22.66	60.78	14.57	1.98
18	0.03	21.98	58.64	17.38	2.00
19	0.04	21.26	56.60	20.16	1.98
20	0.04	20.54	54.67	22.86	1.93



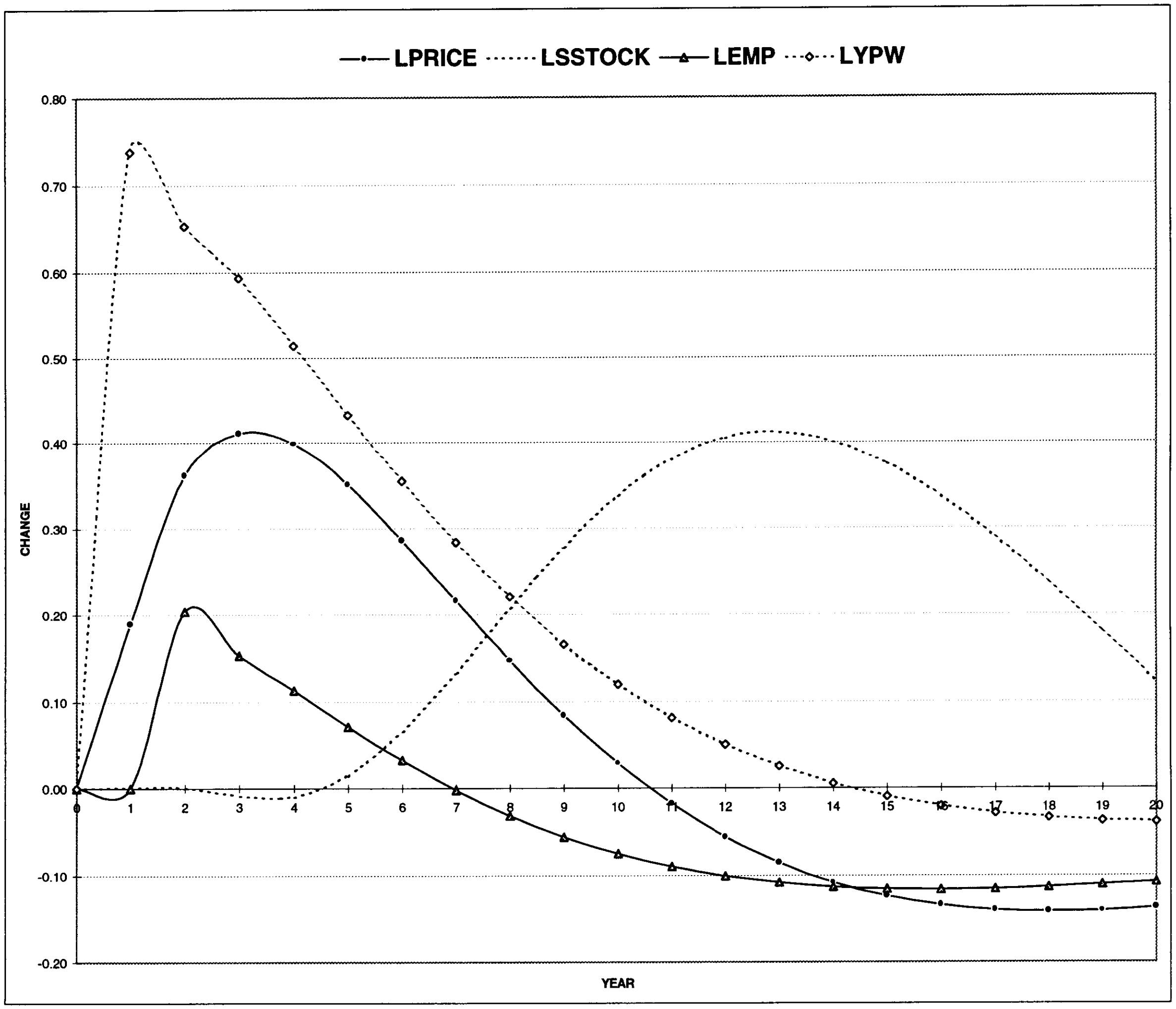
Boston NECMA

Innovations in Price, Stock, Employment and Wage from a Positive Shock in Labor Supply (LYPW)

Year	LPRICE	LSSTOCK	LEMP	LYPW
0	0.0000	0.0000	0.0000	0.0000
1	0.1893	0.0000	0.0000	0.7378
2	0.3611	0.0000	0.2032	0.6534
3	0.4113	-0.0089	0.1530	0.5929
4	0.3985	-0.0099	0.1133	0.5139
5	0.3506	0.0147	0.0715	0.4324
6	0.2859	0.0648	0.0324	0.3544
7	0.2159	0.1321	-0.0021	0.2832
8	0.1474	0.2059	-0.0315	0.2202
9	0.0845	0.2762	-0.0557	0.1659
10	0.0293	0.3356	-0.0751	0.1199
11	-0.0175	0.3790	-0.0900	0.0816
12	-0.0556	0.4043	-0.1010	0.0504
13	-0.0857	0.4110	-0.1087	0.0253
14	-0.1082	0.4003	-0.1135	0.0057
15	-0.1242	0.3746	-0.1161	-0.0094
16	-0.1345	0.3366	-0.1167	-0.0206
17	-0.1401	0.2896	-0.1158	-0.0286
18	-0.1418	0.2365	-0.1138	-0.0340
19	-0.1405	0.1802	-0.1109	-0.0373
20	-0.1369	0.1233	-0.1073	-0.0389

Decomposition of Variance for Series LYPW

Entry	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.03	0.06	6.60	36.96	56.38
2	0.03	8.84	5.71	28.83	56.63
3	0.04	9.58	5.27	24.96	60.20
4	0.04	9.49	4.89	22.37	63.25
5	0.04	9.22	4.58	20.73	65.47
6	0.04	8.94	4.36	19.88	66.82
7	0.04	8.68	4.25	19.72	67.35
8	0.05	8.46	4.22	20.10	67.22
9	0.05	8.27	4.26	20.88	66.59
10	0.05	8.10	4.34	21.93	65.62
11	0.05	7.95	4.45	23.12	64.48
12	0.05	7.82	4.55	24.35	63.28
13	0.05	7.70	4.65	25.56	62.09
14	0.05	7.58	4.73	26.71	60.99
15	0.05	7.48	4.79	27.76	59.98
16	0.05	7.38	4.83	28.71	59.08
17	0.05	7.30	4.86	29.55	58.29
18	0.05	7.22	4.88	30.30	57.61
19	0.05	7.15	4.88	30.95	57.02
20	0.05	7.08	4.88	31.52	56.52



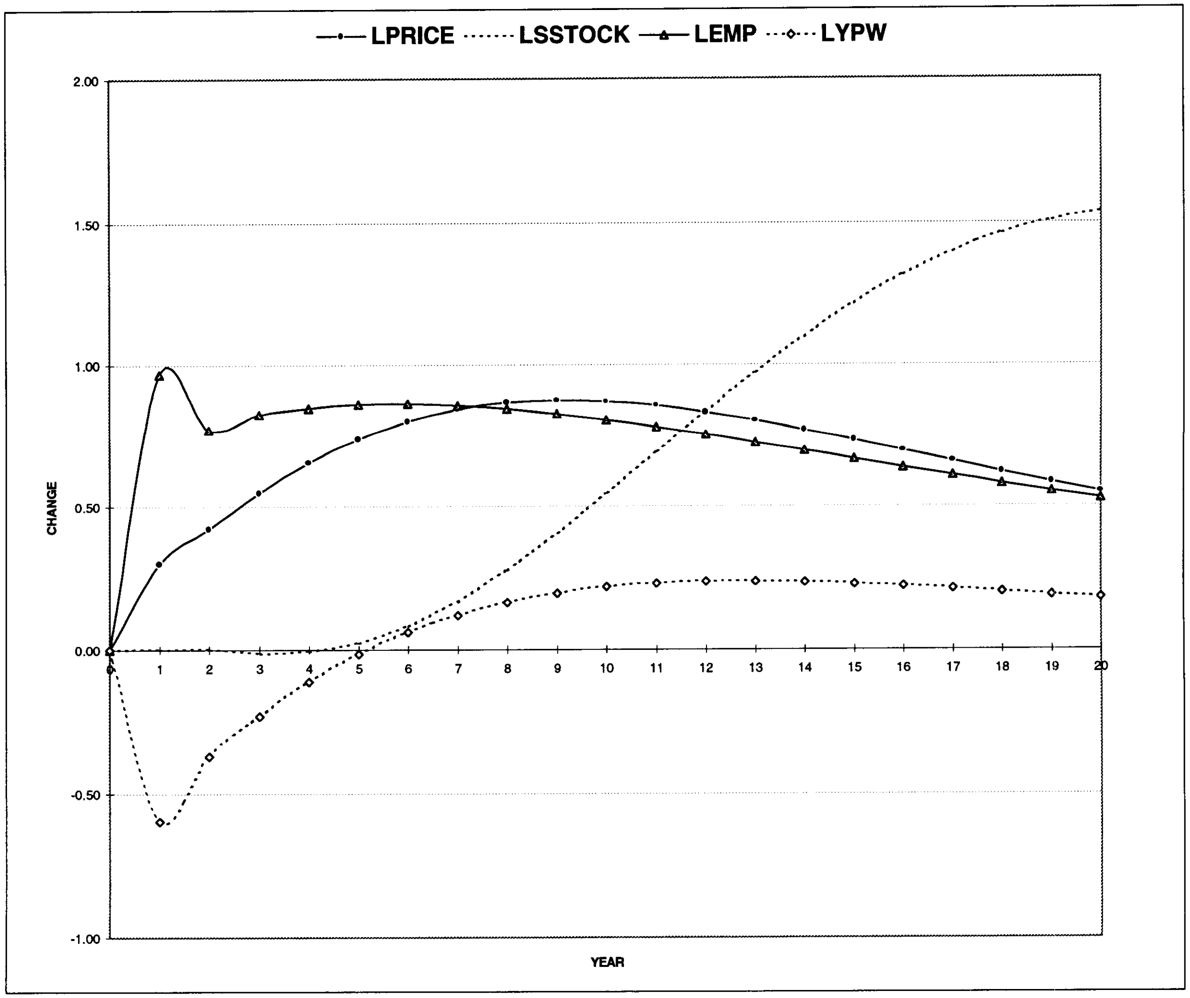
Boston NECMA

Innovations in Price, Stock, Wage and Employment from a Positive Shock Labor Demand (LEMP)

Year	LPRICE	LSSTOCK	LEMP	LYPW
0	0.0000	0.0000	0.0000	0.0000
1	0.3000	0.0000	0.9661	-0.5973
2	0.4221	0.0000	0.7711	-0.3709
3	0.5469	-0.0141	0.8256	-0.2325
4	0.6525	-0.0086	0.8479	-0.1131
5	0.7370	0.0226	0.8605	-0.0163
6	0.7999	0.0815	0.8630	0.0605
7	0.8425	0.1672	0.8573	0.1197
8	0.8668	0.2761	0.8448	0.1640
9	0.8753	0.4031	0.8269	0.1957
10	0.8707	0.5420	0.8049	0.2169
11	0.8555	0.6867	0.7799	0.2297
12	0.8320	0.8311	0.7527	0.2358
13	0.8026	0.9699	0.7241	0.2367
14	0.7689	1.0988	0.6949	0.2336
15	0.7327	1.2141	0.6655	0.2276
16	0.6951	1.3136	0.6362	0.2196
17	0.6573	1.3957	0.6076	0.2102
18	0.6201	1.4598	0.5796	0.2001
19	0.5841	1.5061	0.5526	0.1896
20	0.5497	1.5353	0.5267	0.1791

Decomposition of Variance for Series LEMP

Entry	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.03	0.10	3.22	96.68	0.00
2	0.03	0.15	2.56	94.73	2.56
3	0.04	0.88	2.41	93.96	2.75
4	0.05	0.87	2.44	94.19	2.49
5	0.05	0.76	2.56	94.55	2.13
6	0.06	0.65	2.70	94.85	1.80
7	0.06	0.56	2.84	95.05	1.54
8	0.06	0.49	2.97	95.16	1.37
9	0.07	0.44	3.09	95.19	1.28
10	0.07	0.41	3.18	95.18	1.24
11	0.07	0.38	3.26	95.13	1.24
12	0.08	0.35	3.32	95.06	1.27
13	0.08	0.33	3.36	94.98	1.32
14	0.08	0.32	3.39	94.91	1.38
15	0.08	0.30	3.42	94.83	1.45
16	0.08	0.29	3.43	94.76	1.52
17	0.09	0.28	3.44	94.70	1.58
18	0.09	0.28	3.44	94.64	1.64
19	0.09	0.27	3.44	94.59	1.70
20	0.09	0.26	3.44	94.55	1.75



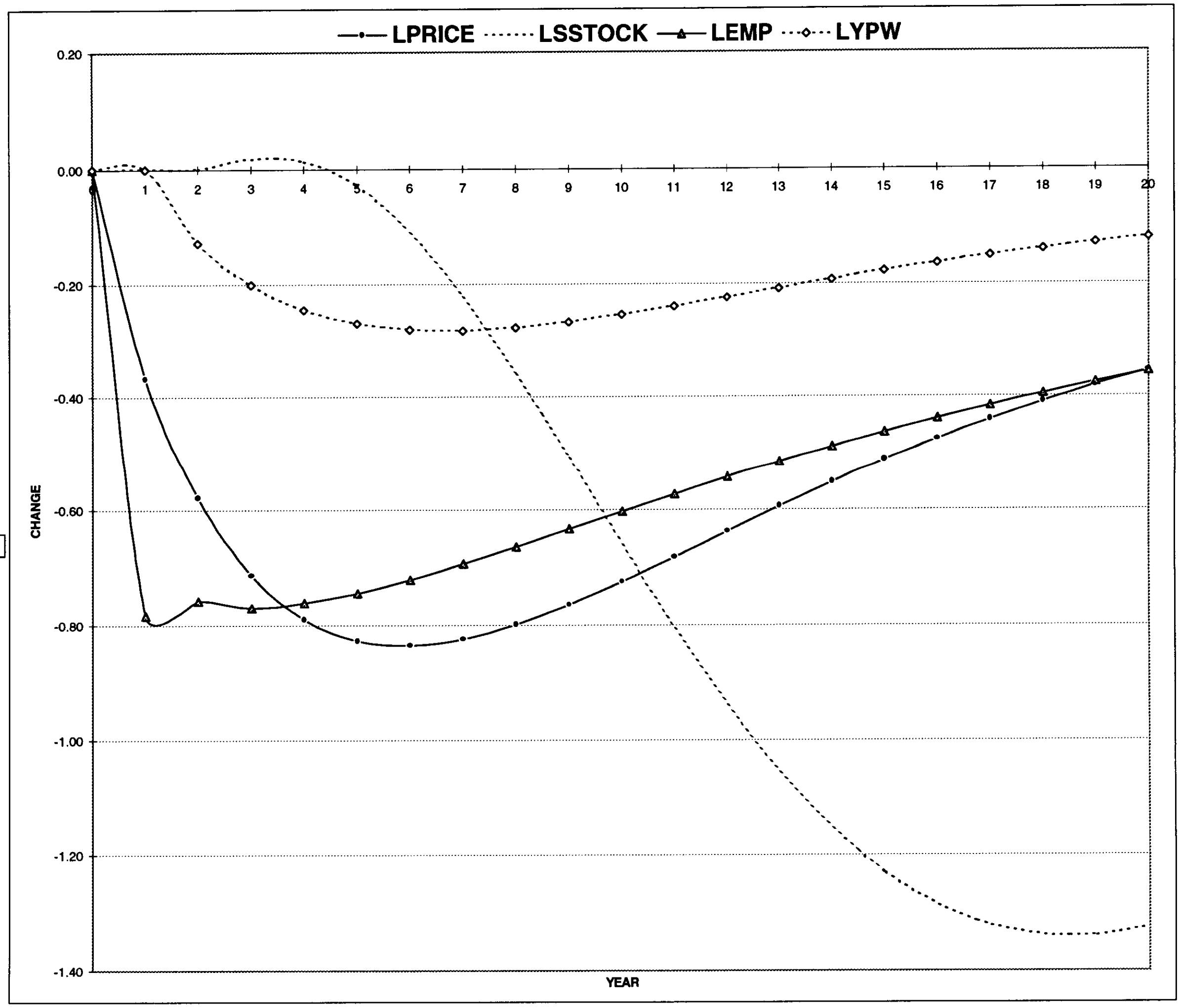
Boston NECMA

Innovations in Price, Stock, Employment and Wage to Adverse Shock in Labor Demand (LEMP)

Year	LPRICE	LSSTOCK	LEMP	LYPW
0	0.00	0.00	0.00	0.00
1	-0.37	0.00	-0.78	0.00
2	-0.58	0.00	-0.76	-0.13
3	-0.71	0.02	-0.77	-0.20
4	-0.79	0.01	-0.76	-0.25
5	-0.83	-0.03	-0.74	-0.27
6	-0.84	-0.11	-0.72	-0.28
7	-0.82	-0.22	-0.69	-0.28
8	-0.80	-0.36	-0.66	-0.28
9	-0.76	-0.51	-0.63	-0.27
10	-0.72	-0.66	-0.60	-0.25
11	-0.68	-0.81	-0.57	-0.24
12	-0.64	-0.94	-0.54	-0.22
13	-0.59	-1.06	-0.52	-0.21
14	-0.55	-1.15	-0.49	-0.19
15	-0.51	-1.23	-0.46	-0.18
16	-0.48	-1.29	-0.44	-0.16
17	-0.44	-1.32	-0.42	-0.15
18	-0.41	-1.34	-0.40	-0.14
19	-0.38	-1.34	-0.38	-0.13
20	-0.36	-1.33	-0.36	-0.12

Decomposition of Variance for Series LEMP

Entry	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.03	0.10	3.22	96.68	0.00
2	0.03	0.15	2.56	94.73	2.56
3	0.04	0.88	2.41	93.96	2.75
4	0.05	0.87	2.44	94.19	2.49
5	0.05	0.76	2.56	94.55	2.13
6	0.06	0.65	2.70	94.85	1.80
7	0.06	0.56	2.84	95.05	1.54
8	0.06	0.49	2.97	95.16	1.37
9	0.07	0.44	3.09	95.19	1.28
10	0.07	0.41	3.18	95.18	1.24
11	0.07	0.38	3.26	95.13	1.24
12	0.08	0.35	3.32	95.06	1.27
13	0.08	0.33	3.36	94.98	1.32
14	0.08	0.32	3.39	94.91	1.38
15	0.08	0.30	3.42	94.83	1.45
16	0.08	0.29	3.43	94.76	1.52
17	0.09	0.28	3.44	94.70	1.58
18	0.09	0.28	3.44	94.64	1.64
19	0.09	0.27	3.44	94.59	1.70
20	0.09	0.26	3.44	94.55	1.75



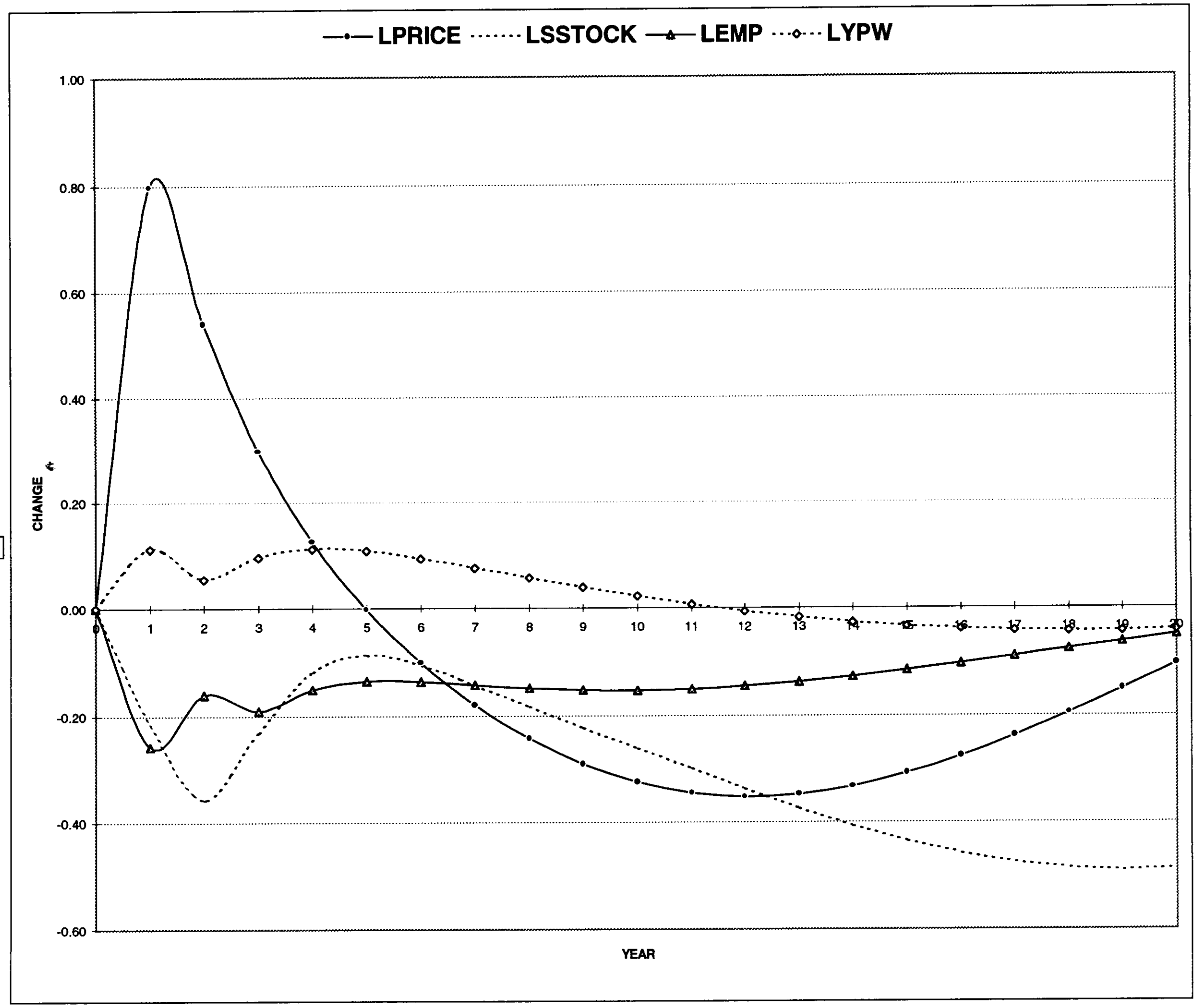
Detroit MSA

Innovations in Price, Stock , Wage and Employment from Positive Shock in Single Family Demand (PRICE)

Year	LPRICE	LSSTOCK	LEMP	LYPW
0	0.00	0.00	0.00	0.00
1	0.80	-0.22	-0.26	0.11
2	0.54	-0.36	-0.16	0.05
3	0.30	-0.23	-0.19	0.10
4	0.13	-0.12	-0.15	0.11
5	0.00	-0.09	-0.14	0.11
6	-0.10	-0.11	-0.14	0.09
7	-0.18	-0.14	-0.14	0.08
8	-0.24	-0.18	-0.15	0.06
9	-0.29	-0.22	-0.15	0.04
10	-0.32	-0.26	-0.15	0.02
11	-0.35	-0.30	-0.15	0.01
12	-0.35	-0.34	-0.14	-0.01
13	-0.35	-0.37	-0.14	-0.02
14	-0.33	-0.41	-0.13	-0.03
15	-0.31	-0.43	-0.12	-0.04
16	-0.28	-0.46	-0.10	-0.04
17	-0.24	-0.47	-0.09	-0.04
18	-0.20	-0.49	-0.08	-0.04
19	-0.15	-0.49	-0.06	-0.04
20	-0.11	-0.49	-0.05	-0.04

Decomposition of Variance for Series LPRICE

Entry	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.04	53.92	2.70	43.38	0.01
2	0.06	31.22	6.64	56.36	5.78
3	0.08	19.47	7.02	65.49	8.01
4	0.10	13.44	5.99	73.35	7.22
5	0.12	10.06	4.75	79.52	5.66
6	0.13	8.05	3.77	83.67	4.51
7	0.15	6.85	3.19	85.85	4.11
8	0.16	6.15	3.01	86.39	4.45
9	0.17	5.77	3.19	85.69	5.35
10	0.18	5.60	3.65	84.11	6.64
11	0.19	5.57	4.33	81.95	8.15
12	0.20	5.61	5.16	79.47	9.76
13	0.20	5.68	6.09	76.88	11.35
14	0.21	5.77	7.06	74.34	12.83
15	0.21	5.84	8.03	71.98	14.14
16	0.21	5.90	8.94	69.92	15.24
17	0.22	5.92	9.77	68.23	16.08
18	0.22	5.91	10.47	66.95	16.67
19	0.22	5.87	11.03	66.09	17.01
20	0.22	5.81	11.44	65.62	17.13



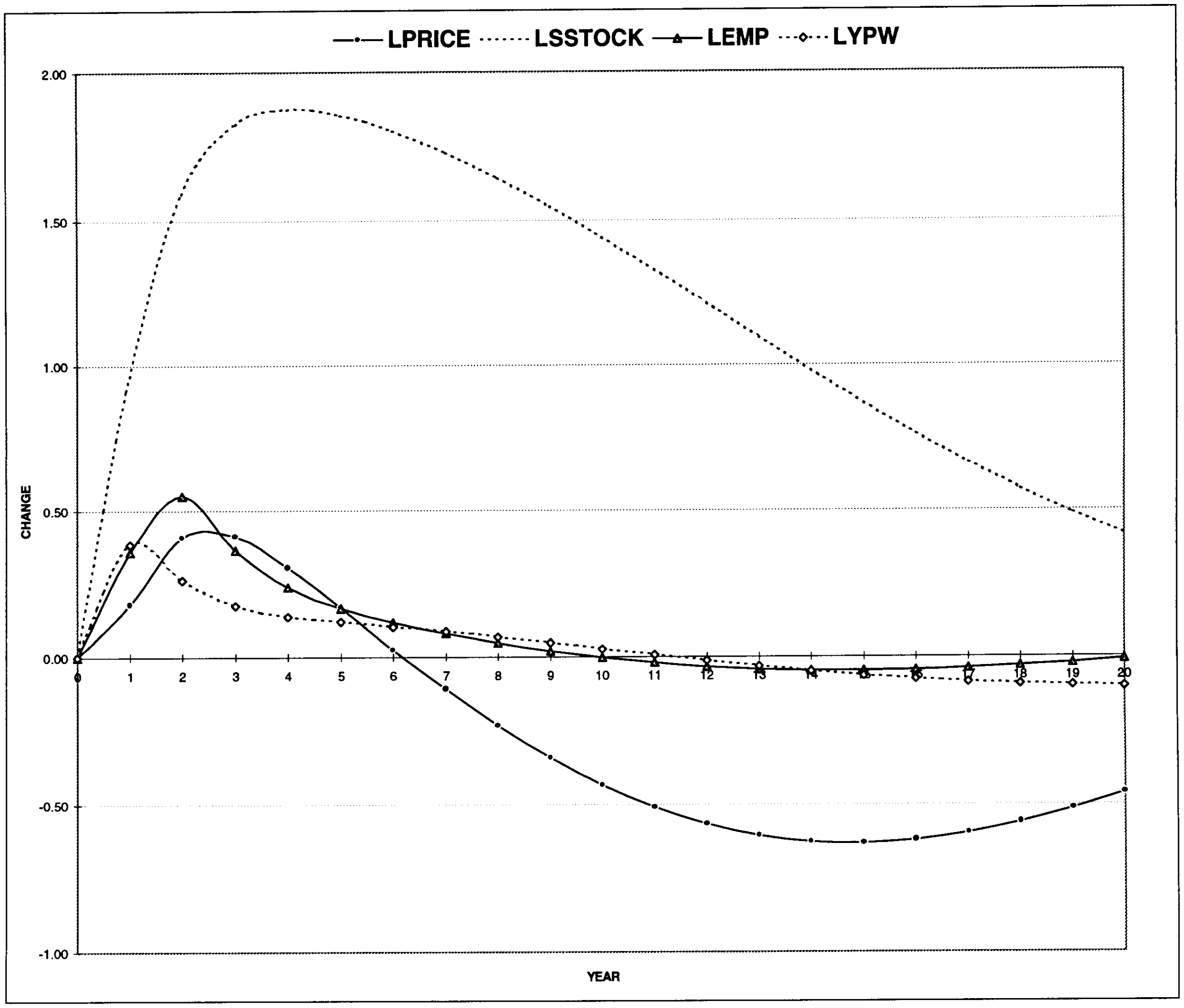
Detroit MSA

Innovations in Price, Stock, Employment and Wage from a Positive Shock SF Supply (SFSTOCK)

Year	LPRICE	LSSTOCK	LEMP	LYPW
0	0.0000	0.0000	0.0000	0.0000
1	0.1783	0.9585	0.3565	0.3842
2	0.4062	1.5879	0.5493	0.2615
3	0.4107	1.8202	0.3636	0.1744
4	0.3055	1.8725	0.2362	0.1371
5	0.1666	1.8534	0.1647	0.1182
6	0.0243	1.8017	0.1172	0.1025
7	-0.1107	1.7302	0.0794	0.0855
8	-0.2338	1.6445	0.0472	0.0666
9	-0.3424	1.5475	0.0196	0.0464
10	-0.4348	1.4419	-0.0032	0.0257
11	-0.5097	1.3302	-0.0213	0.0051
12	-0.5666	1.2148	-0.0346	-0.0148
13	-0.6055	1.0982	-0.0433	-0.0334
14	-0.6268	0.9827	-0.0478	-0.0503
15	-0.6315	0.8706	-0.0484	-0.0651
16	-0.6208	0.7636	-0.0456	-0.0776
17	-0.5964	0.6634	-0.0399	-0.0876
18	-0.5601	0.5713	-0.0317	-0.0950
19	-0.5140	0.4884	-0.0217	-0.0999
20	-0.4601	0.4152	-0.0103	-0.1022

Decomposition of Variance for Series LSTOCK

Entry	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.00	4.85	95.15	0.00	0.00
2	0.01	4.85	95.15	0.00	0.00
3	0.01	3.28	96.39	0.33	0.00
4	0.01	2.29	96.12	1.52	0.07
5	0.01	1.73	94.36	3.61	0.29
6	0.01	1.42	91.62	6.42	0.54
7	0.02	1.26	88.32	9.76	0.66
8	0.02	1.19	84.67	13.49	0.66
9	0.02	1.19	80.79	17.43	0.59
10	0.02	1.23	76.80	21.44	0.52
11	0.02	1.32	72.81	25.37	0.50
12	0.02	1.45	68.90	29.09	0.56
13	0.02	1.61	65.18	32.49	0.72
14	0.02	1.79	61.69	35.52	1.00
15	0.03	1.99	58.50	38.14	1.37
16	0.03	2.20	55.62	40.34	1.84
17	0.03	2.42	53.06	42.13	2.39
18	0.03	2.65	50.82	43.55	2.99
19	0.03	2.86	48.89	44.62	3.63
20	0.03	3.08	47.25	45.39	4.28



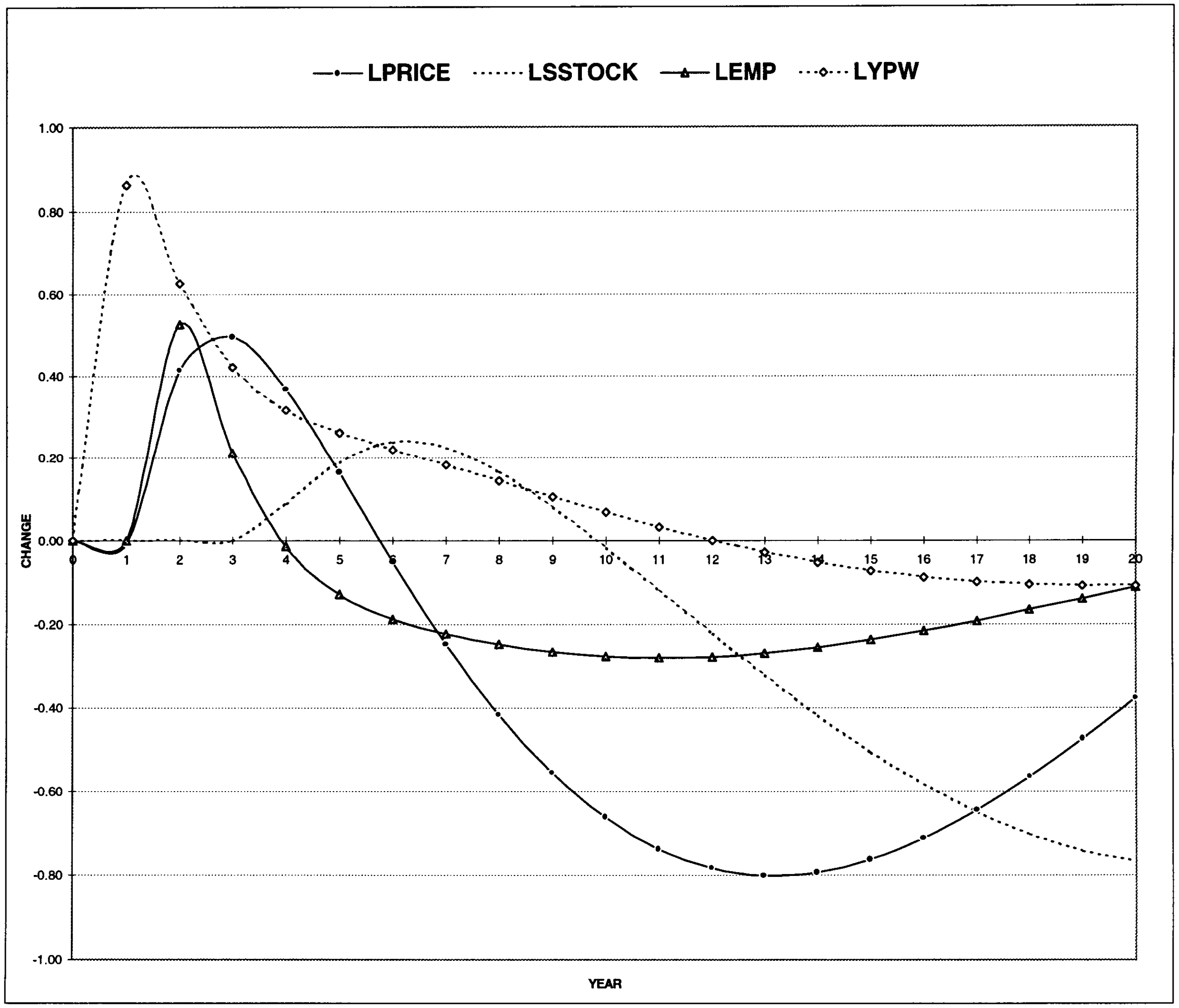
Detroit MSA

Innovations in Price, Stock, Employment and Wage from a Positive Shock in Labor Supply (LYPW)

Year	LPRICE	LSSTOCK	LEMP	LYPW
0	0.0000	0.0000	0.0000	0.0000
1	-0.0081	0.0000	0.0000	0.8636
2	0.4138	0.0000	0.5255	0.6262
3	0.4960	-0.0017	0.2130	0.4218
4	0.3682	0.0866	-0.0138	0.3176
5	0.1637	0.1878	-0.1282	0.2611
6	-0.0511	0.2373	-0.1874	0.2198
7	-0.2484	0.2241	-0.2235	0.1815
8	-0.4176	0.1653	-0.2484	0.1431
9	-0.5557	0.0806	-0.2659	0.1047
10	-0.6622	-0.0165	-0.2765	0.0675
11	-0.7378	-0.1187	-0.2804	0.0324
12	-0.7838	-0.2216	-0.2779	0.0004
13	-0.8017	-0.3222	-0.2694	-0.0279
14	-0.7938	-0.4178	-0.2557	-0.0521
15	-0.7629	-0.5057	-0.2376	-0.0720
16	-0.7121	-0.5837	-0.2159	-0.0875
17	-0.6445	-0.6499	-0.1915	-0.0985
18	-0.5639	-0.7031	-0.1653	-0.1053
19	-0.4737	-0.7425	-0.1382	-0.1080
20	-0.3775	-0.7677	-0.1108	-0.1070

Decomposition of Variance for Series LYPW

Entry	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.02	16.25	0.25	22.50	61.00
2	0.02	15.68	0.44	17.52	66.36
3	0.03	12.86	1.81	29.93	55.41
4	0.03	12.74	3.99	43.89	39.39
5	0.04	12.56	6.60	52.31	28.54
6	0.04	11.55	9.49	56.83	22.13
7	0.05	10.15	12.42	59.23	18.20
8	0.05	8.81	15.11	60.47	15.61
9	0.06	7.72	17.37	61.12	13.79
10	0.06	6.91	19.11	61.54	12.45
11	0.06	6.30	20.34	61.94	11.42
12	0.06	5.84	21.11	62.42	10.63
13	0.07	5.46	21.52	63.02	10.00
14	0.07	5.15	21.64	63.72	9.49
15	0.07	4.88	21.55	64.50	9.08
16	0.07	4.65	21.30	65.31	8.73
17	0.07	4.47	20.95	66.13	8.44
18	0.08	4.33	20.53	66.94	8.20
19	0.08	4.23	20.08	67.71	7.98
20	0.08	4.17	19.61	68.43	7.79



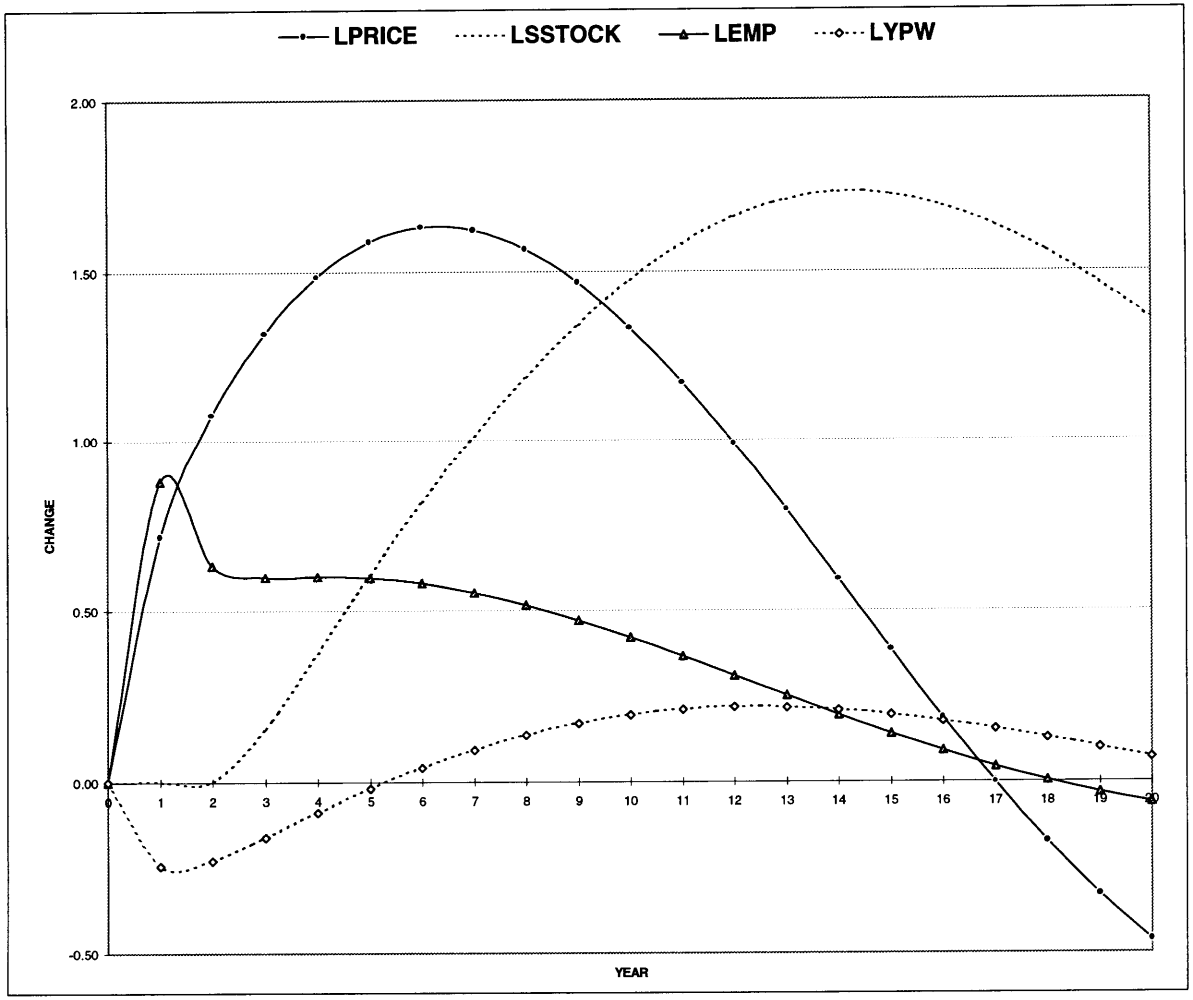
Detroit MSA

Innovations in Price, Stock, Wage and Employment from a Positive Shock Labor Demand (LEMP)

Year	LPRICE	LSSTOCK	LEMP	LYPW
0	0.0000	0.0000	0.0000	0.0000
1	0.7147	0.0000	0.8786	-0.2441
2	1.0771	0.0000	0.6290	-0.2300
3	1.3189	0.1523	0.5957	-0.1622
4	1.4857	0.3733	0.5971	-0.0887
5	1.5885	0.6011	0.5934	-0.0201
6	1.6328	0.8140	0.5780	0.0409
7	1.6239	1.0084	0.5511	0.0932
8	1.5670	1.1842	0.5144	0.1362
9	1.4682	1.3399	0.4699	0.1699
10	1.3341	1.4726	0.4194	0.1943
11	1.1718	1.5795	0.3649	0.2098
12	0.9886	1.6586	0.3082	0.2169
13	0.7917	1.7088	0.2509	0.2161
14	0.5881	1.7305	0.1945	0.2083
15	0.3841	1.7244	0.1405	0.1944
16	0.1857	1.6923	0.0900	0.1755
17	-0.0021	1.6367	0.0439	0.1525
18	-0.1749	1.5603	0.0030	0.1265
19	-0.3292	1.4662	-0.0321	0.0986
20	-0.4624	1.3580	-0.0612	0.0698

Decomposition of Variance for Series LEMP

Entry	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.03	6.88	13.16	79.95	0.00
2	0.04	4.69	21.83	59.43	14.06
3	0.04	5.07	22.15	60.10	12.69
4	0.05	5.09	20.78	63.30	10.84
5	0.05	5.01	19.04	65.96	10.00
6	0.05	4.97	17.38	67.79	9.86
7	0.05	5.00	15.94	68.89	10.16
8	0.06	5.10	14.76	69.40	10.74
9	0.06	5.25	13.80	69.45	11.50
10	0.06	5.42	13.06	69.14	12.38
11	0.06	5.61	12.49	68.59	13.31
12	0.06	5.79	12.07	67.90	14.24
13	0.06	5.96	11.77	67.14	15.12
14	0.06	6.12	11.57	66.39	15.93
15	0.06	6.25	11.43	65.69	16.64
16	0.06	6.36	11.33	65.08	17.23
17	0.06	6.44	11.27	64.59	17.70
18	0.06	6.51	11.22	64.22	18.05
19	0.06	6.55	11.18	63.98	18.29
20	0.06	6.57	11.15	63.85	18.44



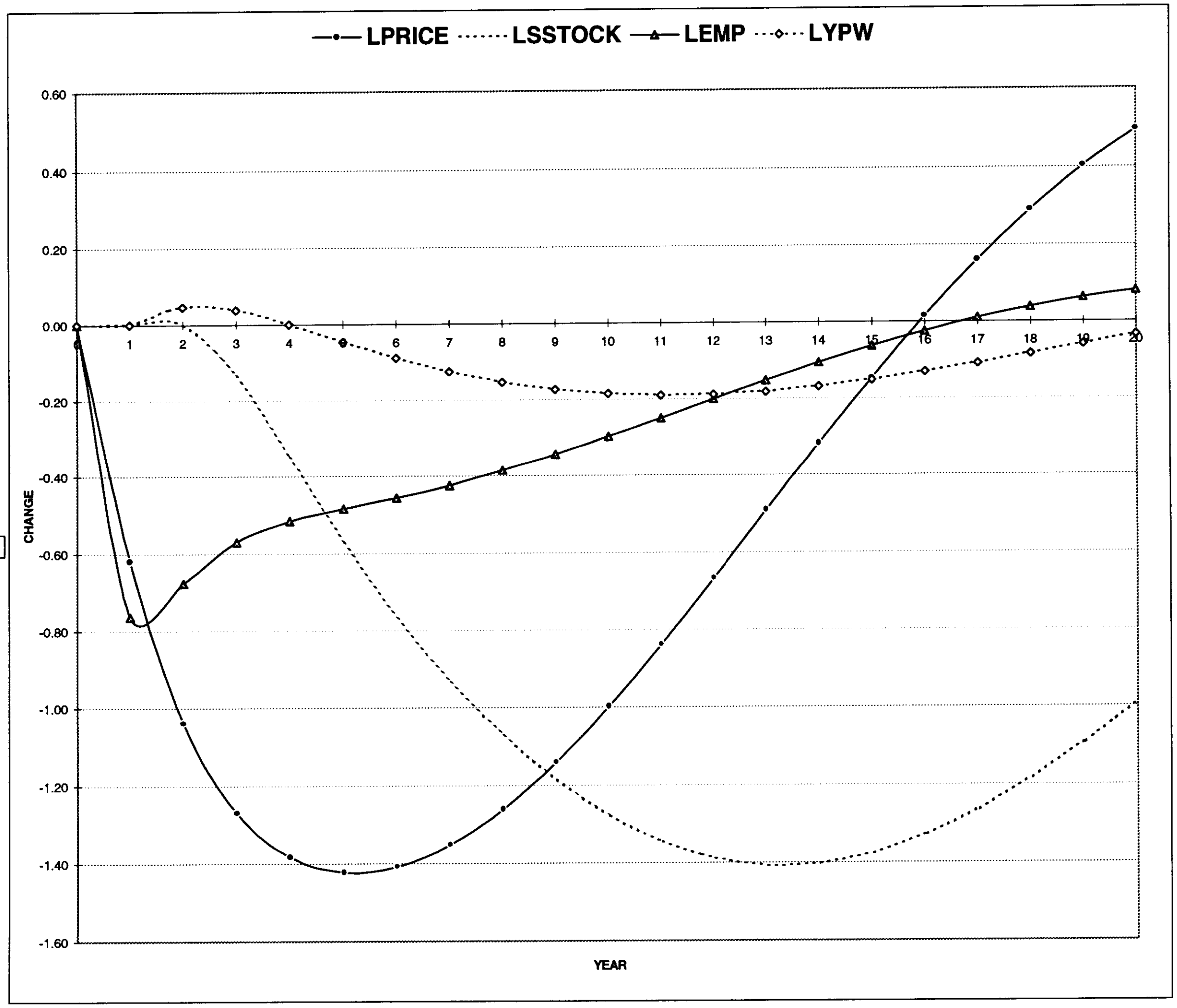
Detroit MSA

Innovations in Price, Stock, Employment and Wage to Adverse Shock in Labor Demand (LEMP)

Year	LPRICE	LSSTOCK	LEMP	LYPW
0	0.00	0.00	0.00	0.00
1	-0.62	0.00	-0.76	0.00
2	-1.04	0.00	-0.68	0.05
3	-1.27	-0.13	-0.57	0.04
4	-1.38	-0.35	-0.52	0.00
5	-1.42	-0.57	-0.48	-0.05
6	-1.41	-0.77	-0.46	-0.09
7	-1.35	-0.93	-0.42	-0.13
8	-1.26	-1.07	-0.39	-0.15
9	-1.14	-1.19	-0.34	-0.17
10	-1.00	-1.28	-0.30	-0.19
11	-0.84	-1.34	-0.25	-0.19
12	-0.67	-1.39	-0.20	-0.19
13	-0.49	-1.41	-0.15	-0.18
14	-0.32	-1.40	-0.11	-0.17
15	-0.15	-1.38	-0.06	-0.15
16	0.01	-1.33	-0.03	-0.13
17	0.16	-1.26	0.01	-0.11
18	0.29	-1.18	0.04	-0.08
19	0.40	-1.09	0.06	-0.06
20	0.50	-0.99	0.08	-0.03

Decomposition of Variance for Series LEMP

Entry	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.03	6.88	13.16	79.95	0.00
2	0.04	4.69	21.83	59.43	14.06
3	0.04	5.07	22.15	60.10	12.69
4	0.05	5.09	20.78	63.30	10.84
5	0.05	5.01	19.04	65.96	10.00
6	0.05	4.97	17.38	67.79	9.86
7	0.05	5.00	15.94	68.89	10.16
8	0.06	5.10	14.76	69.40	10.74
9	0.06	5.25	13.80	69.45	11.50
10	0.06	5.42	13.06	69.14	12.38
11	0.06	5.61	12.49	68.59	13.31
12	0.06	5.79	12.07	67.90	14.24
13	0.06	5.96	11.77	67.14	15.12
14	0.06	6.12	11.57	66.39	15.93
15	0.06	6.25	11.43	65.69	16.64
16	0.06	6.36	11.33	65.08	17.23
17	0.06	6.44	11.27	64.59	17.70
18	0.06	6.51	11.22	64.22	18.05
19	0.06	6.55	11.18	63.98	18.29
20	0.06	6.57	11.15	63.85	18.44



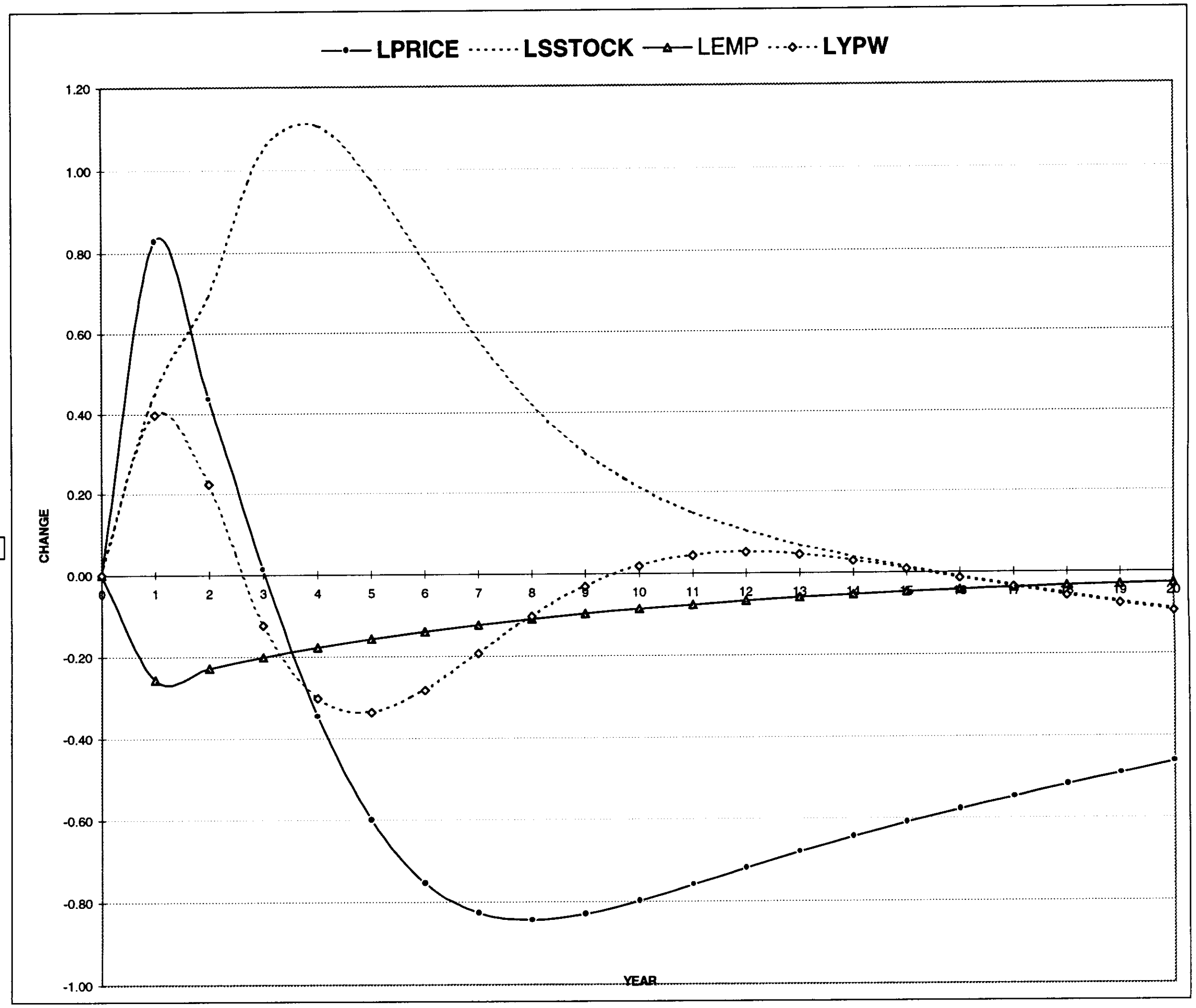
Houston MSA

Innovations in Price, Stock , Wage and Employment from Positive Shock in Single Family Demand (PRICE)

Year	LPRICE	LSSTOCK	LEMP	LYPW
0	0.00	0.00	0.00	0.00
1	0.83	0.45	-0.26	0.40
2	0.44	0.69	-0.23	0.22
3	0.01	1.04	-0.20	-0.12
4	-0.35	1.11	-0.18	-0.30
5	-0.60	0.98	-0.16	-0.34
6	-0.75	0.78	-0.14	-0.28
7	-0.83	0.58	-0.12	-0.19
8	-0.84	0.42	-0.11	-0.10
9	-0.83	0.30	-0.10	-0.03
10	-0.80	0.21	-0.09	0.02
11	-0.76	0.15	-0.08	0.04
12	-0.72	0.10	-0.07	0.05
13	-0.68	0.07	-0.06	0.04
14	-0.64	0.04	-0.05	0.03
15	-0.61	0.01	-0.05	0.01
16	-0.58	-0.01	-0.04	-0.01
17	-0.55	-0.03	-0.04	-0.04
18	-0.52	-0.05	-0.03	-0.06
19	-0.49	-0.07	-0.03	-0.08
20	-0.46	-0.09	-0.03	-0.10

Decomposition of Variance for Series LPRICE

Entry	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.04	88.61	3.21	8.07	0.11
2	0.05	63.07	13.24	23.63	0.06
3	0.06	38.23	25.22	36.43	0.12
4	0.08	26.62	32.55	40.61	0.23
5	0.10	23.81	35.84	40.03	0.33
6	0.12	24.18	37.32	38.10	0.39
7	0.14	25.31	38.18	36.07	0.44
8	0.15	26.41	38.86	34.26	0.47
9	0.16	27.30	39.52	32.70	0.48
10	0.17	27.97	40.20	31.34	0.49
11	0.18	28.47	40.90	30.14	0.50
12	0.19	28.83	41.60	29.07	0.50
13	0.20	29.11	42.30	28.10	0.49
14	0.20	29.31	42.99	27.21	0.49
15	0.21	29.47	43.65	26.40	0.48
16	0.21	29.59	44.29	25.65	0.47
17	0.22	29.68	44.89	24.96	0.46
18	0.22	29.75	45.46	24.33	0.45
19	0.22	29.80	45.99	23.76	0.45
20	0.23	29.83	46.49	23.24	0.44



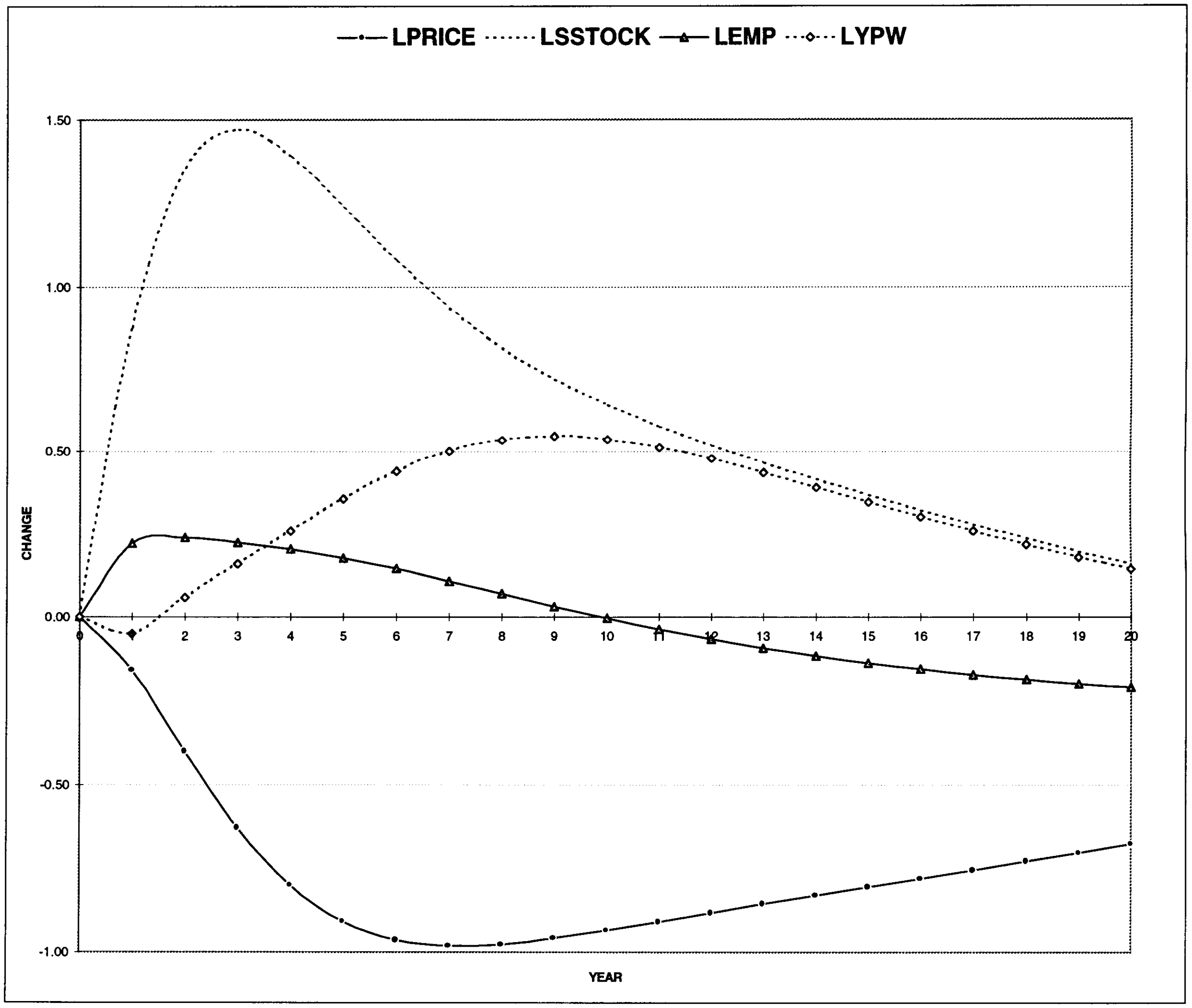
Houston MSA

Innovations in Price, Stock, Employment and Wage from a Positive Shock SF Supply (SFSTOCK)

Year	LPRICE	LSSTOCK	LEMP	LYPW
0	0.0000	0.0000	0.0000	0.0000
1	-0.1574	0.8758	0.2210	-0.0493
2	-0.3987	1.3552	0.2377	0.0580
3	-0.6276	1.4708	0.2237	0.1588
4	-0.7994	1.3925	0.2039	0.2583
5	-0.9076	1.2404	0.1775	0.3546
6	-0.9631	1.0788	0.1447	0.4377
7	-0.9812	0.9349	0.1079	0.4988
8	-0.9762	0.8161	0.0697	0.5343
9	-0.9584	0.7201	0.0321	0.5454
10	-0.9345	0.6416	-0.0033	0.5360
11	-0.9084	0.5752	-0.0359	0.5112
12	-0.8820	0.5167	-0.0654	0.4759
13	-0.8559	0.4634	-0.0918	0.4345
14	-0.8302	0.4133	-0.1154	0.3900
15	-0.8048	0.3658	-0.1362	0.3448
16	-0.7794	0.3204	-0.1547	0.3004
17	-0.7538	0.2770	-0.1710	0.2577
18	-0.7279	0.2356	-0.1852	0.2171
19	-0.7017	0.1965	-0.1976	0.1789
20	-0.6752	0.1596	-0.2083	0.1431

Decomposition of Variance for Series LSTOCK

Entry	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.01	20.56	79.44	0.00	0.00
2	0.03	20.56	79.44	0.00	0.00
3	0.04	26.91	72.99	0.10	0.00
4	0.04	30.60	68.84	0.56	0.00
5	0.05	31.83	66.63	1.53	0.00
6	0.05	31.59	65.38	3.02	0.01
7	0.06	30.62	64.44	4.91	0.02
8	0.06	29.38	63.53	7.04	0.05
9	0.06	28.10	62.55	9.26	0.08
10	0.06	26.91	61.52	11.45	0.12
11	0.06	25.83	60.45	13.56	0.16
12	0.06	24.88	59.38	15.55	0.19
13	0.07	24.04	58.31	17.41	0.23
14	0.07	23.31	57.27	19.15	0.27
15	0.07	22.66	56.26	20.78	0.30
16	0.07	22.09	55.28	22.30	0.33
17	0.07	21.59	54.33	23.72	0.36
18	0.07	21.15	53.42	25.04	0.39
19	0.07	20.77	52.55	26.27	0.42
20	0.07	20.43	51.72	27.40	0.45



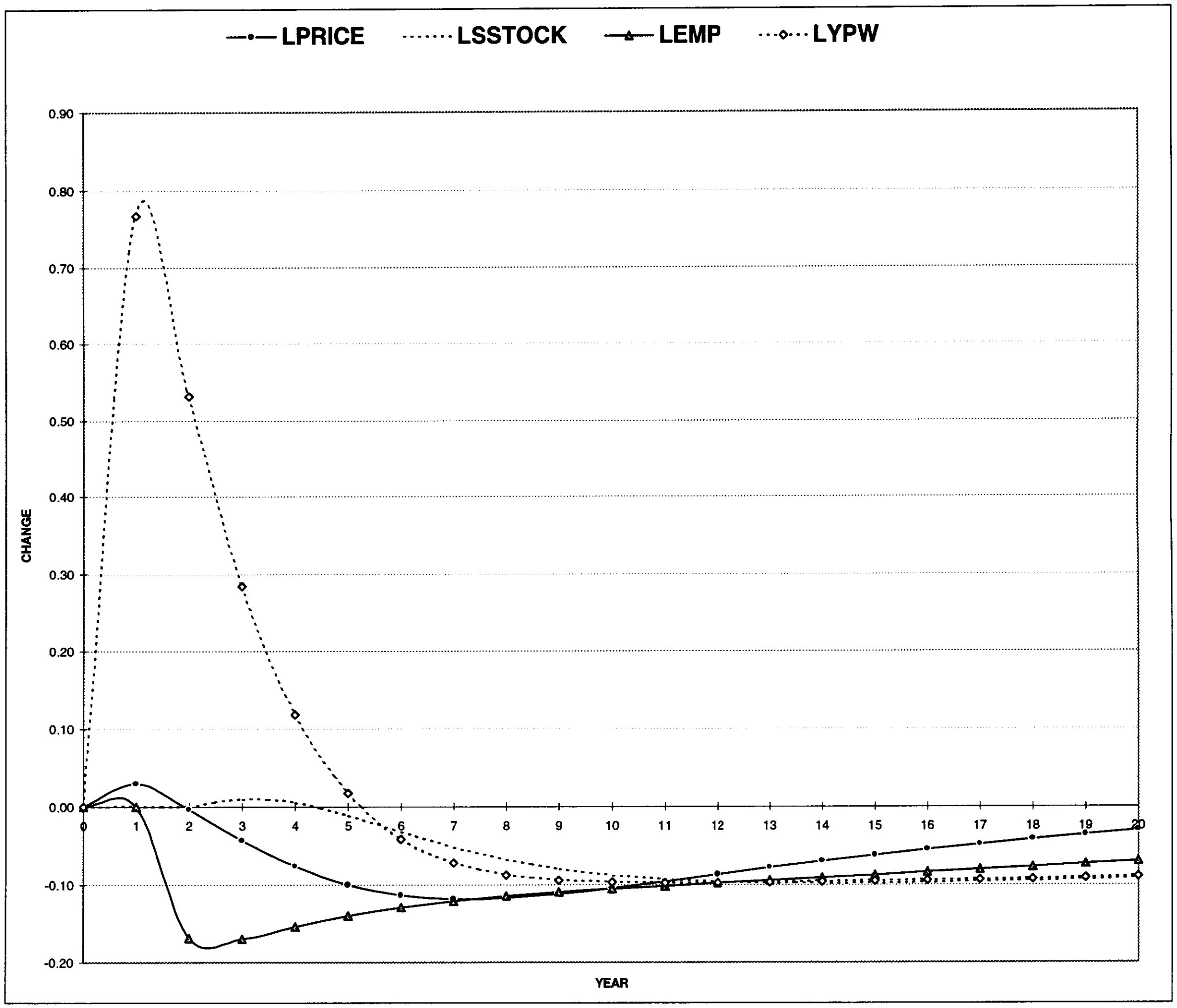
Houston MSA

Innovations in Price, Stock, Employment and Wage from a Positive Shock in Labor Supply (LYPW)

Year	LPRICE	LSSTOCK	LEMP	LYPW
0	0.0000	0.0000	0.0000	0.0000
1	0.0294	0.0000	0.0000	0.7674
2	-0.0036	0.0000	-0.1685	0.5311
3	-0.0430	0.0095	-0.1698	0.2845
4	-0.0764	0.0051	-0.1539	0.1184
5	-0.0998	-0.0112	-0.1396	0.0170
6	-0.1130	-0.0320	-0.1285	-0.0411
7	-0.1179	-0.0518	-0.1203	-0.0723
8	-0.1166	-0.0681	-0.1141	-0.0877
9	-0.1114	-0.0802	-0.1092	-0.0946
10	-0.1040	-0.0884	-0.1051	-0.0971
11	-0.0955	-0.0936	-0.1014	-0.0976
12	-0.0867	-0.0966	-0.0978	-0.0973
13	-0.0781	-0.0980	-0.0943	-0.0968
14	-0.0698	-0.0983	-0.0908	-0.0961
15	-0.0619	-0.0980	-0.0873	-0.0954
16	-0.0546	-0.0973	-0.0837	-0.0945
17	-0.0477	-0.0962	-0.0801	-0.0935
18	-0.0412	-0.0948	-0.0765	-0.0923
19	-0.0352	-0.0933	-0.0729	-0.0908
20	-0.0295	-0.0916	-0.0693	-0.0892

Decomposition of Variance for Series LYPW

Entry	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.02	1.29	15.29	6.13	77.29
2	0.03	1.04	14.58	7.56	76.82
3	0.03	1.44	14.28	8.01	76.27
4	0.03	1.98	14.21	7.84	75.97
5	0.03	2.47	14.22	7.54	75.77
6	0.03	2.80	14.21	7.53	75.45
7	0.03	2.98	14.13	8.04	74.84
8	0.04	3.04	13.97	9.09	73.90
9	0.04	3.02	13.75	10.53	72.70
10	0.04	2.96	13.49	12.17	71.38
11	0.04	2.91	13.23	13.80	70.06
12	0.04	2.86	13.00	15.30	68.84
13	0.04	2.83	12.81	16.57	67.79
14	0.04	2.81	12.67	17.60	66.92
15	0.04	2.80	12.58	18.39	66.23
16	0.04	2.80	12.54	18.95	65.71
17	0.04	2.80	12.54	19.33	65.33
18	0.04	2.80	12.57	19.57	65.06
19	0.04	2.80	12.64	19.70	64.86
20	0.04	2.81	12.72	19.75	64.72



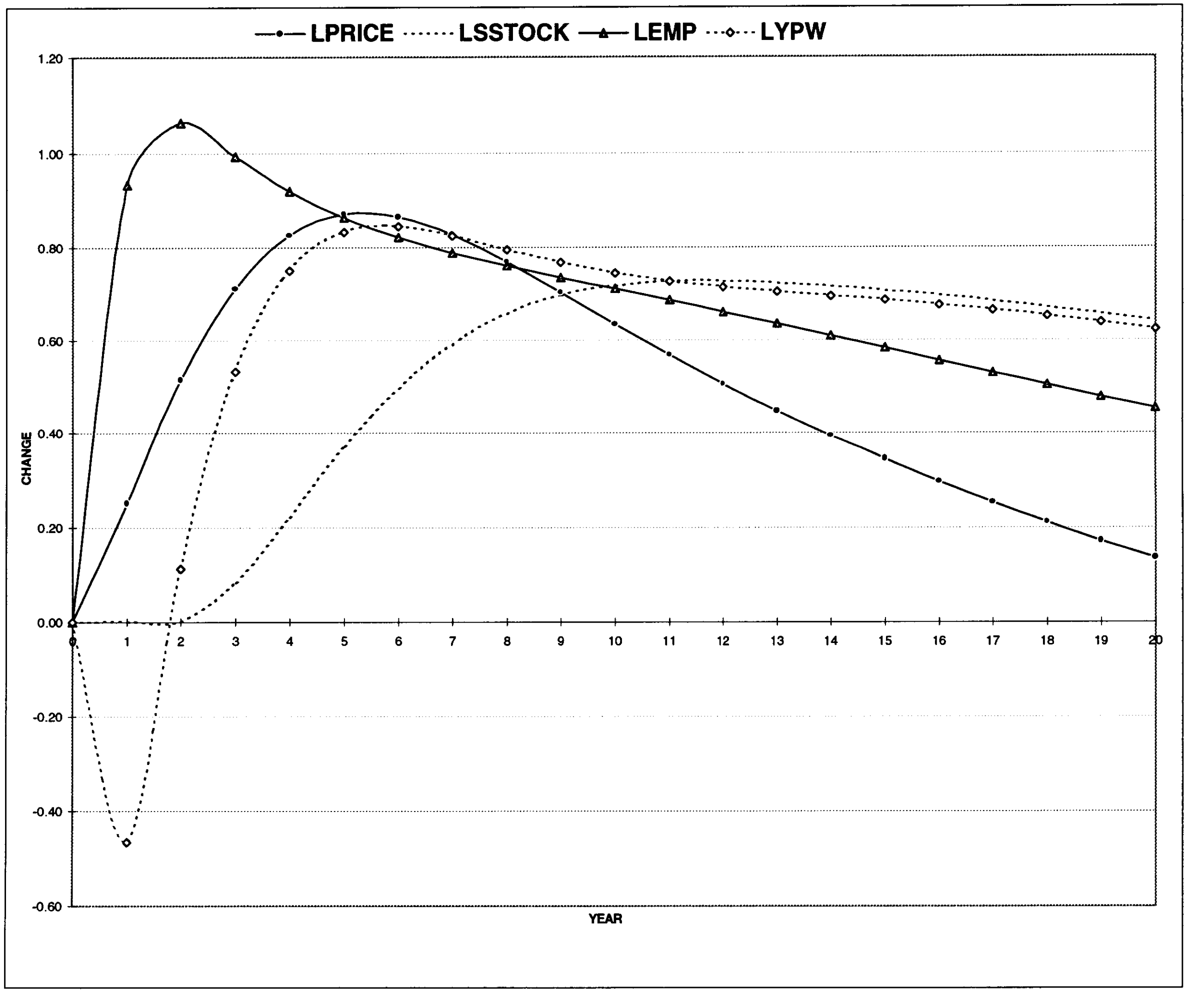
Houston MSA

Innovations in Price, Stock, Wage and Employment from a Positive Shock Labor Demand (LEMP)

Year	LPRICE	LSSTOCK	LEMP	LYPW
0	0.0000	0.0000	0.0000	0.0000
1	0.2498	0.0000	0.9351	-0.4661
2	0.5153	0.0000	1.0626	0.1124
3	0.7115	0.0805	0.9937	0.5331
4	0.8269	0.2188	0.9209	0.7497
5	0.8725	0.3671	0.8644	0.8335
6	0.8665	0.4948	0.8217	0.8453
7	0.8273	0.5909	0.7884	0.8250
8	0.7694	0.6559	0.7605	0.7952
9	0.7032	0.6957	0.7352	0.7669
10	0.6352	0.7170	0.7108	0.7441
11	0.5690	0.7259	0.6863	0.7270
12	0.5064	0.7268	0.6613	0.7144
13	0.4478	0.7228	0.6358	0.7043
14	0.3932	0.7156	0.6098	0.6953
15	0.3425	0.7064	0.5836	0.6862
16	0.2952	0.6958	0.5572	0.6764
17	0.2511	0.6838	0.5309	0.6653
18	0.2098	0.6707	0.5047	0.6529
19	0.1713	0.6566	0.4788	0.6393
20	0.1352	0.6414	0.4533	0.6244

Decomposition of Variance for Series LEMP

Entry	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.03	4.37	5.06	90.57	0.00
2	0.05	5.78	4.64	88.33	1.25
3	0.06	6.34	4.54	87.45	1.67
4	0.07	6.24	4.49	87.44	1.84
5	0.08	5.99	4.37	87.72	1.92
6	0.08	5.77	4.18	88.10	1.96
7	0.09	5.63	3.93	88.47	1.98
8	0.09	5.58	3.65	88.78	1.98
9	0.10	5.62	3.39	89.00	1.99
10	0.10	5.75	3.17	89.09	1.99
11	0.10	5.95	2.99	89.07	1.98
12	0.10	6.20	2.88	88.94	1.98
13	0.11	6.50	2.83	88.71	1.97
14	0.11	6.82	2.83	88.39	1.97
15	0.11	7.16	2.89	88.00	1.96
16	0.11	7.51	3.00	87.55	1.95
17	0.12	7.86	3.15	87.06	1.94
18	0.12	8.21	3.34	86.53	1.93
19	0.12	8.55	3.56	85.97	1.92
20	0.12	8.89	3.81	85.39	1.91



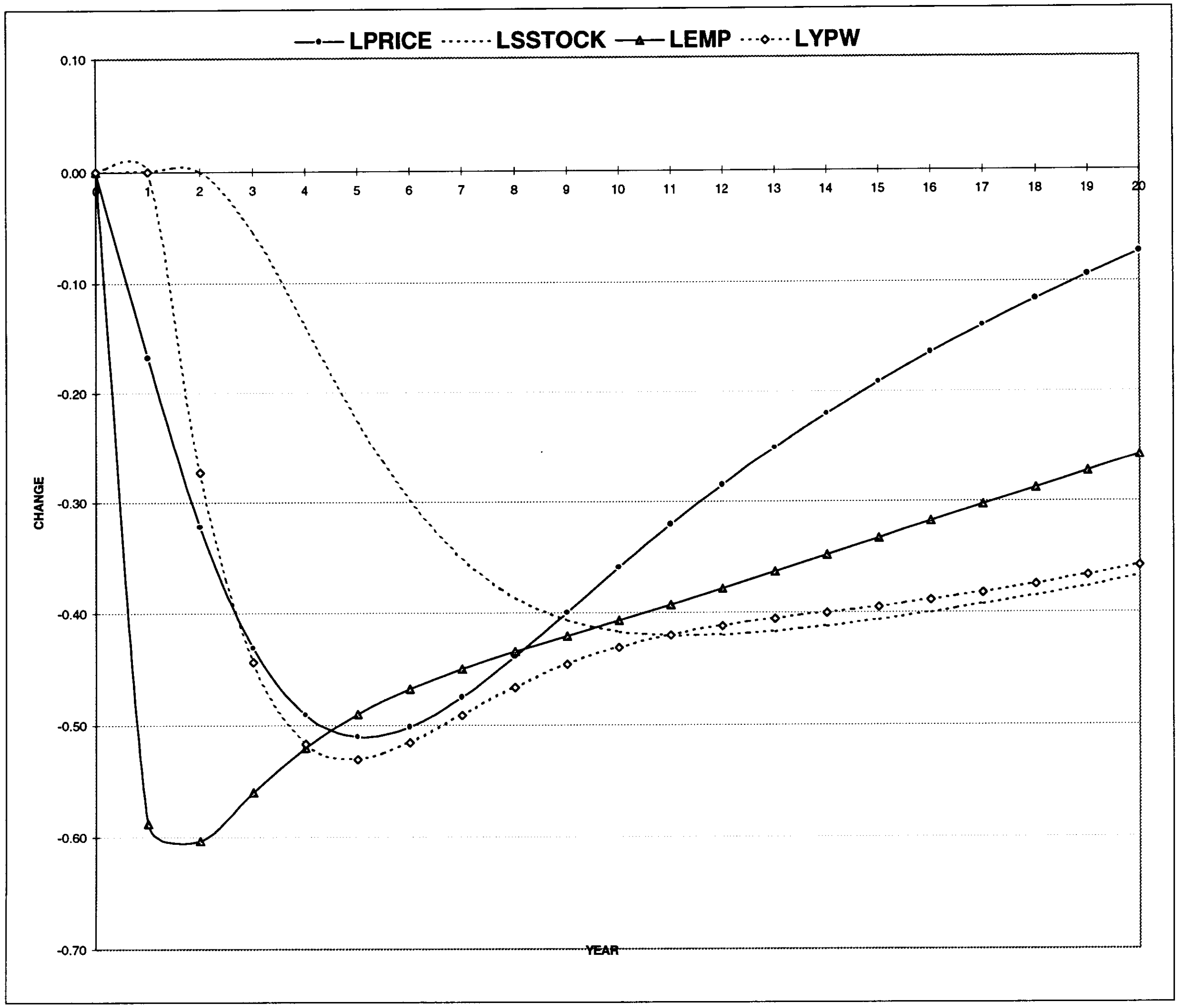
Houston MSA

Innovations in Price, Stock, Employment and Wage to Adverse Shock in Labor Demand (LEMP)

Year	LPRICE	LSSTOCK	LEMP	LYPW
0	0.00	0.00	0.00	0.00
1	-0.17	0.00	-0.59	0.00
2	-0.32	0.00	-0.60	-0.27
3	-0.43	-0.05	-0.56	-0.44
4	-0.49	-0.14	-0.52	-0.52
5	-0.51	-0.23	-0.49	-0.53
6	-0.50	-0.30	-0.47	-0.52
7	-0.48	-0.35	-0.45	-0.49
8	-0.44	-0.39	-0.43	-0.47
9	-0.40	-0.41	-0.42	-0.45
10	-0.36	-0.42	-0.41	-0.43
11	-0.32	-0.42	-0.39	-0.42
12	-0.29	-0.42	-0.38	-0.41
13	-0.25	-0.42	-0.36	-0.41
14	-0.22	-0.41	-0.35	-0.40
15	-0.19	-0.41	-0.33	-0.39
16	-0.16	-0.40	-0.32	-0.39
17	-0.14	-0.39	-0.30	-0.38
18	-0.12	-0.39	-0.29	-0.38
19	-0.09	-0.38	-0.27	-0.37
20	-0.07	-0.37	-0.26	-0.36

Decomposition of Variance for Series LEMP

Entry	Std Error	LPRICE	LSSTOCK	LEMP	LYPW
1	0.03	4.37	5.06	90.57	0.00
2	0.05	5.78	4.64	88.33	1.25
3	0.06	6.34	4.54	87.45	1.67
4	0.07	6.24	4.49	87.44	1.84
5	0.08	5.99	4.37	87.72	1.92
6	0.08	5.77	4.18	88.10	1.96
7	0.09	5.63	3.93	88.47	1.98
8	0.09	5.58	3.65	88.78	1.98
9	0.10	5.62	3.39	89.00	1.99
10	0.10	5.75	3.17	89.09	1.99
11	0.10	5.95	2.99	89.07	1.98
12	0.10	6.20	2.88	88.94	1.98
13	0.11	6.50	2.83	88.71	1.97
14	0.11	6.82	2.83	88.39	1.97
15	0.11	7.16	2.89	88.00	1.96
16	0.11	7.51	3.00	87.55	1.95
17	0.12	7.86	3.15	87.06	1.94
18	0.12	8.21	3.34	86.53	1.93
19	0.12	8.55	3.56	85.97	1.92
20	0.12	8.89	3.81	85.39	1.91



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