CEA 2007

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HOUSE PRICES IN CANADA:
AN EMPIRICAL INVESTIGATION

This paper investigates factors underlying changes in House Prices in Census Metropolitan Areas (CMAs) in Canada. We use a standard textbook model of house price determination to build an empirical panel data model for a sample of eighteen CMAs across Canada to examine the role of income, interest rates, changes in the housing stock, labor market conditions and demographic factors in accounting for recent trends in house prices. We use quarterly data for the period 1980 to 2005 for the fixed effects and random effects panel data models and 1987 to 2005 for the Generalized Method of Moments model. Our findings so far suggest a reasonable ability of the model to capture the main features of national prices. The results from the fixed effects and OLS models suggest an important role for fundamental factors including household income, changes in the housing stock and population.

Background

Trends in aggregate house prices are important for monetary policy and economic activity at the macro level. In the design and effectiveness of monetary policy, house price inflation can exert significant pressure on monetary policy especially in cases where the central bank sets inflation targets as bank of Canada does. A house price boom can be the main underlying factor for a tight monetary policy. In the case of the computation of Canada's CPI, of the 54 subcomponents in the 1996 basket at January 1998 prices for instance, the item with the highest weight was rented accommodation while mortgage interest costs had the third highest weight. House price inflation is thus a critical contributor to consumer price inflation.

Regarding economic activity in general, house prices are important in two respects. First, price developments in housing markets have a direct effect on consumer confidence and the investment behavior of households, which in turn partly accounts for some patterns in the business cycle. Second, they play an important role in the savings choices of households which in turn affect economic growth. Gary Engelhardt (1994) provides some evidence on the impact of house prices on households' decisions to save for down payments in Canada. Based on membership in the Registered Home ownership Savings Plan (RHOSP), data was obtained to estimate the effect of house prices on the likelihood of households to save for a down payment. By simulating a life cycle model, it was found that a 5% increase in house prices led to a decrease in the probability of a household saving for a down payment by one percentage point. The results also indicated that for every $1000 increment in house prices incurred by households saving for down payment, a loss of $300 was registered in accumulated assets.

At the regional level, an analysis of house price trends and their effects on saving for down payments has the potential to shed some light on the cross variation in savings rates by province. As pointed out by Egelhardt (1994), the existence of asymmetric information in mortgage lending markets to varying degrees implies a corresponding variation in down payments required in the markets. While down payments range between 5% and 25% in North America, they go as high as 50% in Japan, South Korea and Italy which generally also have higher saving rates than North America. If theses liquidity constraints can explain any of the cross variation in savings rates among these countries, then an analysis along similar lines may explain cross variation among provinces in Canada. We have not been able to identify any studies on this aspect in the case of Canada.

At the micro level, for most individual investors, the house price constitutes the most substantial proportion of the investment portfolio. The performance of home ownership as an asset is partly determined by the regime of inflation and real interest rates. Such a combination of high overall inflation and low real interest rates is documented in O'Donovan and Rae (1996) in the case of the housing boom experienced in New Zealand. It is therefore useful to be aware of the short and long run dynamics of inflation as well as house price inflation in appraising personal investment decisions in real estate. The foregoing motivates an empirical investigation of house prices in Canada in a policy context and with respect to individual investors.

Research Issue

The seminal work on house prices dates back to Hendry (1984), followed by a substantial literature in this spirit whereby prices are determined in equilibrium by demand and supply conditions. The supply side is usually assumed fixed in the short run while an inverse demand function is used to estimate a reduced form of the model. For the UK studies commonly cited in the literature include Mayes (1979), Nellis and Longbottom (1981), Bradley (1981), Hendry (1984), Meen (1990) and Kapparova and White (2001). Meese and Wallace (1997) use the same approach for the USA, Ahlgren (1999) studies house prices in Finland and Tse (1999) applies the same model to House prices in Hong Kong's markets. Barot and Yang (2002) provides a more detailed review and additional references in the literature.

Another approach, less commonly used is to apply the error correction methodology to a stock-flow model e.g. Jaffe (1994). The stock in this case represents the outstanding stock of all structures with the interaction of demand and supply determine asset prices. The rate of new construction constitutes the flow which is driven by profitability as reflected in the ratio of asset prices to construction costs i.e. Tobin's q. The inverted long run demand for housing is modeled so that real house prices are a function of the housing stock income ratio, the debt income ratio and financial wealth to income ratio. Real interest rates and the housing stock income ratio affect real house prices negatively while the debt income ratio and the financial wealth income ratio have a positive effect. When real house prices deviate from their long run equilibrium path, an error correction mechanism is triggered whereby the level of interest rates and the three ratios will move in such a way as to force real house prices and stock back to their equilibrium.

The supply side can again be assumed to be perfectly inelastic in the short run. Alternatively, supply has been cast in the framework of Tobin's q. Measuring Tobin's q as a ratio of the house price index to the construction price index, it is posited that this ratio will converge to 1 in the long run.

In the case of Canada, Mario Fortin and Andre Leclerc (2000) estimated a structural model of the housing market to determine factors driving real house prices. They used annual data at the national level. Their main focus was to highlight the role of demographic factors while separating out the non-demographic influences on real price movements. They invoked a perfectly elastic long run supply side together with a cointegrating relationship between property prices and real per capita income to assess prior trends and uncover what the demographics portend for future price changes. They not only found demographic factors to be important but also concluded that the same factors will underpin a prolonged house price increase nationwide, save for the Atlantic provinces and Manitoba which are characterized by declining population trends.

Another study by Yvon Fauvel and Bruno Duhamel (2004) uses a vector autoregressive (VAR) model to estimate the response of actual house prices to shocks rendered by the main determinants of house prices. This is done at both the national and Census Metropolitan Area (CMA) levels. They use quarterly data covering ten CMAs, namely Vancouver, Calgary, Edmonton, Winnipeg, Toronto, Hamilton, Ottawa, Montreal, Quebec City and Halifax over the period 1972 to 2003. Their model is a panel VAR consisting of six variables: house prices, employment, housing starts, interest rates, inflation and construction costs. The panel VAR helps somewhat deal with the severe data limitations at the CMA level. They find supply factors as represented by housing starts and construction costs to have a rather limited role in accounting for house prices. From their analysis while monetary factors contributed 22 percent of observed price variations, inflation and employment shocks contributed 15 percent and 11 percent respectively. See Yvon Fauvel and Bruno Duhamel (2004) for a more substantive review of the empirical literature in the Canadian context and John Engeland el al (2005) for an in-depth look at housing trends in Canada's CMAs.

Objectives

The aim of the study is twofold. Firstly, the main determinants of house prices at the metropolitan level will be investigated by way of estimating a static panel data model. The equations specified for estimation in this case are reduced forms resulting from the standard model described in the section on Methodology below. Secondly, we estimate a dynamic panel data model using the generalized method of moments estimator discussed in Arellano (1988), Arellano and Bond (1991) Arellano and Bover (1995) and Blundell and Bond (1998).

The sample is extended to eighteen CMAs. These are Victoria, Vancouver, Calgary, Edmonton, Regina, Saskatoon, Winnipeg, Sudbury, Toronto, Hamilton, London, Kitchener, Windsor, Ottawa, Montreal, Quebec City, Halifax and St. Johns. The data is quarterly, ranging from 1987.1 to 2005.2. The reference dynamic panel model has six variables: real house prices, household income, housing stock, user cost of housing, housing completions and population.

The theoretical model followed here is to specify demand for and supply of housing separately having motivated the functional forms from the perspective of an optimizing agent. The corresponding reduced forms a are then estimated separately.

Methodology: The Standard Textbook Model of House Prices

The standard textbook model has been extensively used in empirical studies of consumption behavior. Some previous applications include Buckley and Ermisch (1982), Mankiw and Weil (1989), Meen(1990, 1996 and 2000), Muellbauer and Murphy (1997) and Poterba(1984, 1991). In this model there are two components of the demand for housing services comprising an investment and a consumption component. Thus the pertinent price of housing is the user cost of housing

The supply of housing services on the other hand is assumed to be proportional to the stock of housing, which stock is typically itself held fixed in the short run. This aspect of the model partly explains why house prices tend to overshoot their steady state fundamental values in the event of a boom even if there is no speculative bubble at work. Also, as pointed out by Murphy (2005) in the case of Ireland, the model implies that in the short run the bulk of fiscal incentives to home buyers will be capitalized into higher house prices.

The empirical work based on the standard textbook model has provided some stylized facts , such as price and income elasticities of demand for housing.

The model is composed of three equations. First is a demand equation whereby for a given housing stock, real household incomes, population and interest rates sets house prices in the short run. The second is a supply equation for the determination of new housing by accounting for new house completions in the short run. Lastly, it also has an equation reflecting the evolution of the housing stock given the rate of house completions. In order to specify a price equation, the demand equation is inverted to render house prices as the subject of the equation. The standard model can be pared down as follows.

Housing services demand, which is proportional to the housing stock, is given by

$$\frac{hs}{pop} = y^{\alpha} r_h^{-\beta} d \tag{1}$$

where hs denotes housing stock, r_h is the real rental price, pop is population and y is real income, while d represents other housing demand shifters like employment and demographic factors. The exponents α and β denote income and price elasticities of housing services demand. In most estimated equations the rental price, which is difficult to measure in practice, is replaced by the user cost given that in equilibrium, the rental price equals the user cost of housing. There are many ways to calculate user cost, depending on data availability depending on one's choice of how to represent expectations of house price appreciation. One representation is as follows:

$$uc_h = ph\left(r^a + m + t_h - \frac{\dot{p}h^e}{ph}\right) \equiv ph.V_h \tag{2}$$

uc_h is the user cost of housing

Ph is real house price

$\frac{\dot{p}h^e}{ph}$ is the expected rate of appreciation of real house prices

t_h is the net rate of tax on housing

r^a is a tax adjusted real interest rate

V_h is the user cost of housing as a proportion

M is the rate of expenditure on house repairs and maintenance

Substitution of (2) into (1) provides the inverted demand curve

$$ph = y^{\frac{\alpha}{\beta}} \left(\frac{hs}{pop}\right)^{-\beta} V_h^{-1} d^{\frac{1}{\beta}} \tag{3}$$

The price of housing is positively related to real income and the demand shifters while it is negatively dependent on the per capita housing stock and the user cost of housing. A simplified log-linear form of (3) is

$$\ln ph_t = \beta_0 + \beta_1 \ln y_t - \beta_2 \ln\left(\frac{hs_t}{pop_t}\right) - \beta_3 V_{ht} + \beta_4 \ln d_t + u_t \tag{4}$$

Where the user cost is as explained before. Equation (4) can also be derived from the solution to a multi period optimization problem where the adopted notion of income is that of permanent income. In practice, there are numerous variations on the implementation of equation (4) on the basis of differing choices of proxies for user costs and demand shifters. Given that empirical versions are dynamic, there are also differences from the choice of lag lengths. The most difficult

variable to deal with is the unobserved expected house price ph_t^e in the expression for the user cost of housing. Fortin and Andre Leclerc (2000) use the previous period percent change in the consumer price index in what they term a crude calculation of user cost. We experimented with moving averages of past inflation different over a number of ranges without any meaningful result from the overall performance of the model. More elaborate schemes using piecemeal regressions on predetermined variables were even less promising.
The next component of the standard model is an additional equation on the supply side representing the evolution of the housing stock by changes in housing completions thus:

$$\ln hc_t = \gamma_0 + \gamma_1 \ln ph_t^e - \gamma_2 \ln cc_t + v_t \qquad (5)$$

Where hc_t denotes housing completions, cc_t are costs of construction. The level and expansion of housing completions depends positively on future expected house prices while it depends negatively on construction costs.
The housing stock consequently evolves according to

$$hs_t = (1-\delta)hs_{t-1} + hc_t \qquad (6)$$

where δ is the rate of depreciation of the stock of housing.

The empirical treatment of the supply equation is usually some form of dynamic model given the lags involving the housing stock. At the CMA level, the Metropolitan Forecast of the Conference Board of Canada's e-data which we use here does not provide data on the stock of housing. Therefore as a proxy we use the provincial data on the value of investment in residential property on a per capita basis for each of the cities in a given province. This is a highly unreliable representation especially for the larger provinces such as Ontario where it is not that plausible to assume a uniformly distributed evolution of housing stock for the cities covered.

Another difficulty is the potential of an omitted variable problem. We do not account for the role of government regulations and commissions. The cost of construction for instance includes costs of capital and land which come under different regulatory environments in different CMAs. The dynamic panel GMM model consists in estimating the following inverted demand and new supply equations:

$$\ln ph_t = \alpha_0 + \alpha_1 \Delta \ln y + \alpha_2 y_{t-1} - \alpha_3 \ln\left(\frac{hs}{pop}\right)_{t-1} - \alpha_4 uc + \alpha_5 pop + u_t \qquad (7)$$

$$\ln hc_t = \beta_0 + \beta_1 \ln hc_{t-1} + \beta_2 \Delta \ln phn + \beta_3 phn_{t-1} + e_t \qquad (8)$$

Regional House Prices

We look at house prices across CMAs with a view to explaining the role of fundamentals that may be present. In particular, metropolitan house prices are modeled as a function of demand factors such as per capita income, labor market conditions and demographic changes in conjunction with housing supply factors such as changes in the stock of housing reflected by movements in hosing completions and housing starts. We discuss some of the factors including income, unemployment rates, population changes and building costs.

The per capita income of a CMA influences house prices from the demand side. Higher and rising relative per capita incomes are associated with house price increases because more buyers bid for each square unit of accommodation space and more clients can afford larger and more equipped homes. Rising incomes also contribute towards the relaxation of financing constraints involving down payments on homes thereby enhancing further, the increases in demand. The charts at the end of the paper give an illustration of how prices have evolved along with real incomes for the CMAs covered in the sample.

Unemployment rates are good indicators of labor market conditions. A city that experiences prolonged spells of unemployment will undergo some degree of outward migration as people move to look for job opportunities elsewhere. This reduces demand for housing in the affected city. In addition, cities with rising unemployment will have decreasing demand for houses through two other channels. First, the down payment becomes a more acute constraint as workers drop out of jobs and new participants in the labor market undergo longer job searches. Secondly, there is a shift in preference from owner occupied accommodation to renting. The overall effect of the three factors is to reduce demand for houses, so that a negative relationship obtains between unemployment and house prices with high unemployment rates leading to low house prices.

The other main factor underlying metropolitan differences in house prices is the population level and structure. City population numbers are affected by patterns of migration and immigration faced by each city. At the national level, an increase in the number of households gives impetus to demand for houses thereby contributing to house price increases. These price effects have been studied at the metropolitan level, with the empirical evidence pointing to substantial effects in the case of Vancouver and Toronto[1]; See for example Ley and Tutchener (1999). A population decrease partly because of the changing lifestyle whereby most couples opt not to have children also has implications for the demand for homes.

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[1] They study the effects of globalization generally and immigration in particular on house prices in the cities of Halifax, Calgary, Hamilton, Montreal, Ottawa, Toronto, Vancouver and Victoria

Lastly, construction costs especially when one accounts for prices of land do vary by region and city location. The distinction shared by Vancouver and Los Angeles as coastal areas with a sharply inelastic supply of land is part of the explanation for the relatively high level of house prices in the two cities. CMAs also have different regulatory environments as well as tax rates which explain some of the variation in house prices. The tables below report some of the results from estimating the standard textbook model to highlight some of the aforementioned influences especially real income and population growth.

Preliminary Results

The results in figures 1 and 2 are from running a static version of panel data models whereby the real house prices, Lrphs, depend on real income Linc, the housing stock Lhstk, the mortgage rate Mr, population LPop and unemployment, Unemp. All variables are in logs except the rate of unemployment which is a percent. The OLS model yields a low R-squred ar 40 percent with only population being significant while the mortgage rate bears a wrong sign. The fixed effects model has highly significant results with a much higher R-squared but stll throws up a wrong sign on the mortgage rate.

Figure 1

Modelling Lrphs by OLS: Static Panel Data Model				
Variable	Coefficient	Std. Error	t-value	t-prob
LInc	1.35613	0.7456	1.82	0.069
Lhstk	-0.219659	0.1868	-1.18	0.240
Mr	0.00535619	0.006482	0.826	0.409
LPop	0.146181	0.07184	2.03	0.042
Unemp	-0.00605410	0.01548	-0.391	0.696
Constant	-0.982212	6.445	-0.152	0.879
R-Squared 0.4086				

Figure 2

Modelling Lrphs by LSDV(Least squares dummy variables): Static Panel Data Model				
Variable	Coefficient	Std. Error	t-value	t-prob
LInc	0.861482	0.2034	4.24	0.000
Lhstk	-0.245936	0.06609	-3.72	0.000
Mr	0.0158783	0.004506	3.52	0.000
LPop	0.688627	0.1726	3.99	0.000
Unemp	-0.0124791	0.006338	-1.97	0.049
Constant	0.278560	1.728	0.161	0.872
R-Squared 0.9391				

Figures 3 and 4 report the results of estimating the dynamic version in equations (7) and (8) using GMM. Again from figure 3 we see that income and population are significant even although for income it is only the lagged income that is significant at conventional levels. The signs are all correct except that on the user cost of housing, Ucr. This may be due to the very round about manner in which user cost was derived with assumptions on tax rates to obtain the adjusted real after tax interest rates as well as the use consumer price inflation to proxy expected house price appreciation.

Figure 3

Modelling Lrphs by 1-step GMM Dynamic Panel Data Model					
	Coefficient	Std.Error	t-value	t-prob	
Variable					
LInc	0.360417	0.4998	0.721	0.471	
LInc(-1)	1.09101	0.2036	5.36	0.000	
Lhstk	-0.180877	0.1539	-1.18	0.240	
Ucr	0.00907369	0.005156	1.76	0.079	
DPop	0.0268458	0.009352	2.87	0.004	
Constant	-1.43286	4.8000	-0.298	0.765	
R-squred	0.45281				
Wald(joint) Chi square(5)		71.27(0.000)			

Figure 4

Modelling hc(housing completions) GMM Dynamic Panel Data Model				
	Coefficient	Std.Error	t-value	t-prob
Variable				
Lhc(-1	0.966288	0.008870	109	0.000
Dnphs	1.20196e-006	1.770e-006	0.679	0.497
Dnphs(-1)	-2.93452e-007	3.600e-007	-0.815	0.415
Constant	0.270543	0.06663	4.06	0.000
R-squred	0.9323			
Wald(joint) Chi square(3)		1.324e+004		

In figure 4, the results confirm that equation (8) is almost an identity. The lagged first difference of new housing prices also bear the wrong sign. This is ongoing work and the next step is to go back and subject the model to a battery of diagnostic tests with a view to improving the statistical soundness of the findings.

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Conclusion

A panel data model of metropolitan house prices was estimated to provide a reasonable representation of the main influences on real prices. The preliminary results from the panel data model reveal a predominant role for real household income population. Even if the results from both the static and dynamic version are not firm, a re-examination of the model while incorporating the effects of commodity price shocks, changes in returns on the stock market and implications of the regulatory environment should yield an improvement in model performance. for all provinces. Commodity price shocks are significant for Nova Scotia, Manitoba, Alberta and British Columbia. The charts in Appendix 1 show that major relative price trends come out clearly from the model. Improvements that can be considered include accounting for economic growth in the AIDS model, modeling structural change and short run dynamics.

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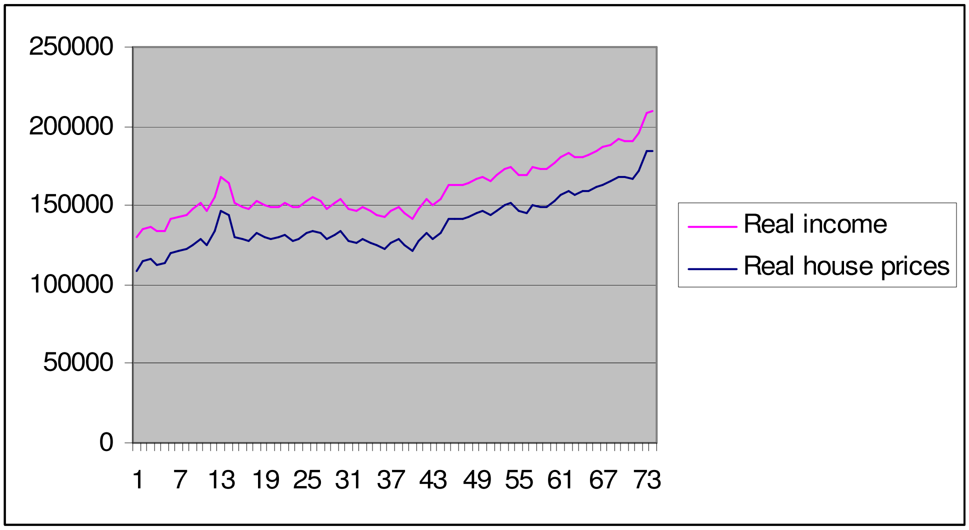
Trend Real House Prices and Real Income

Calgary



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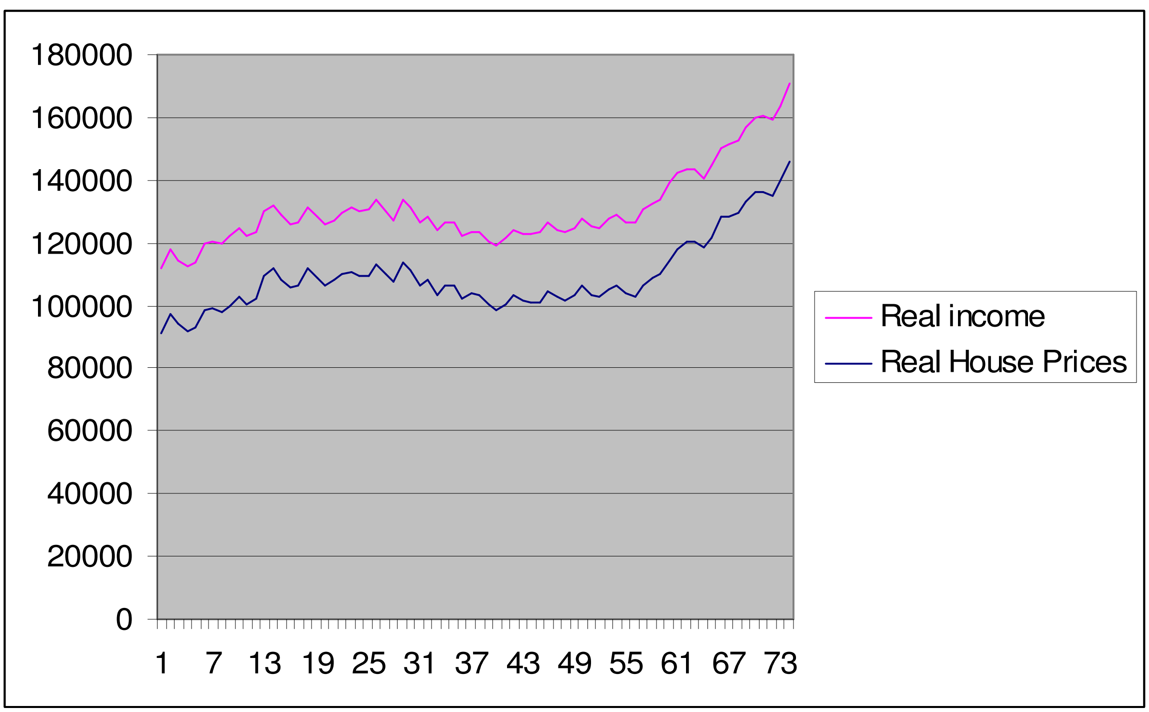

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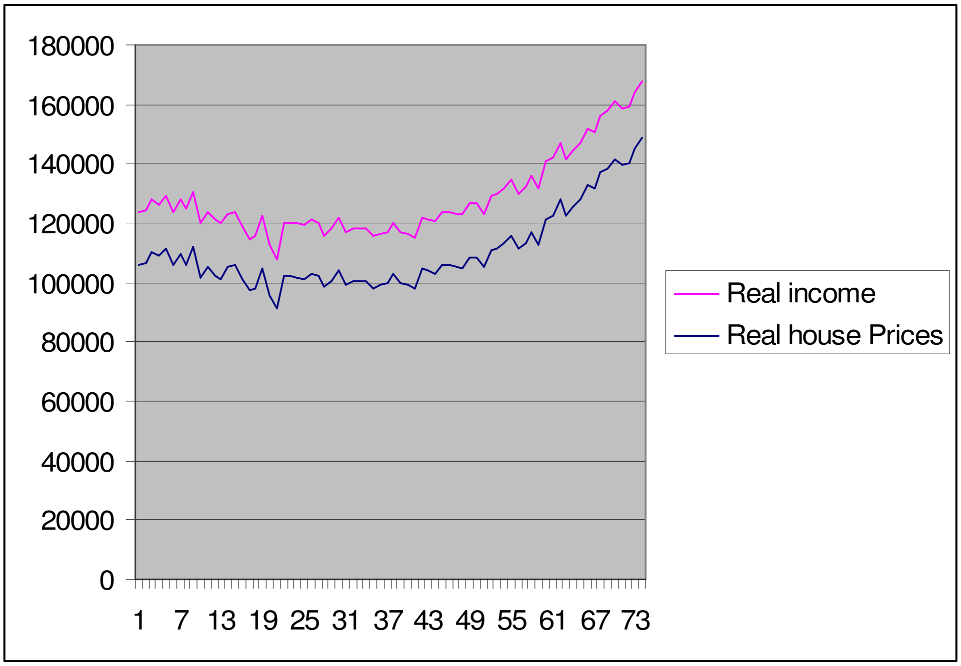

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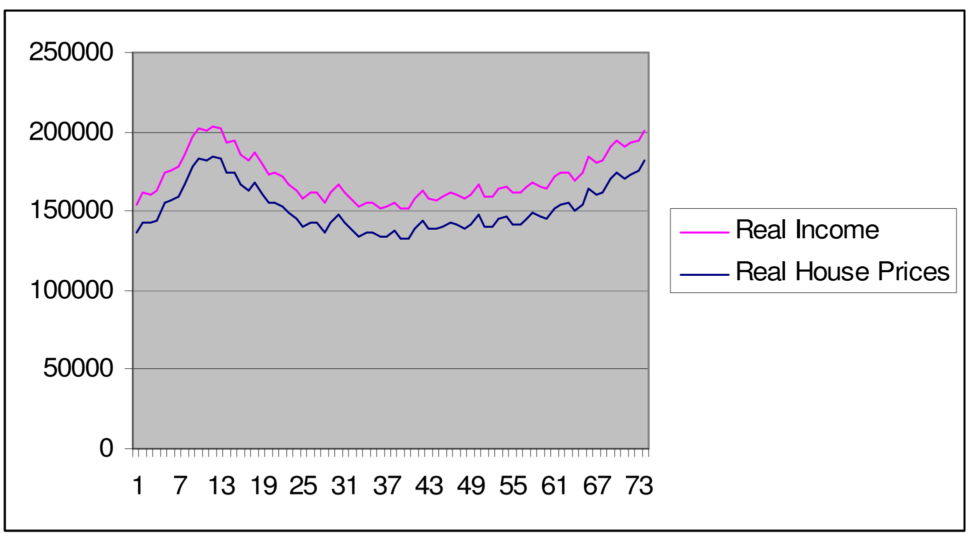

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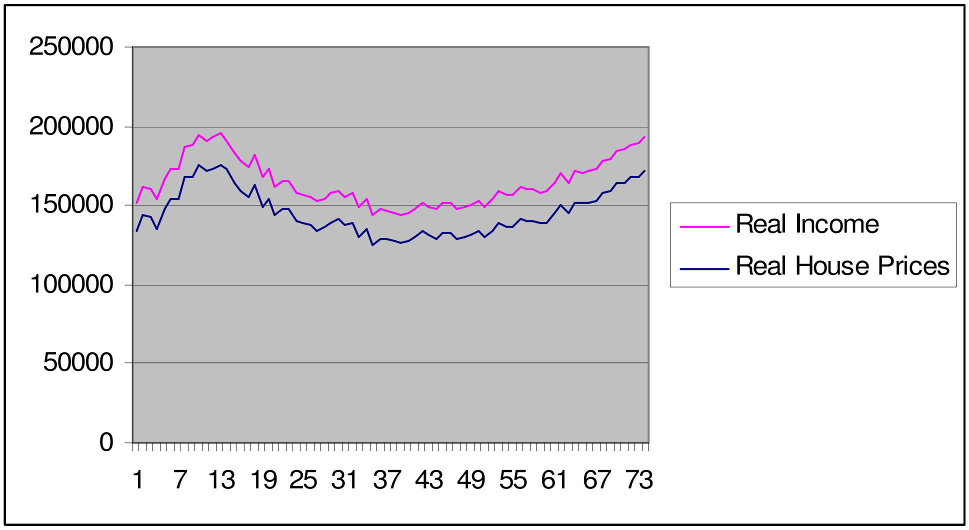

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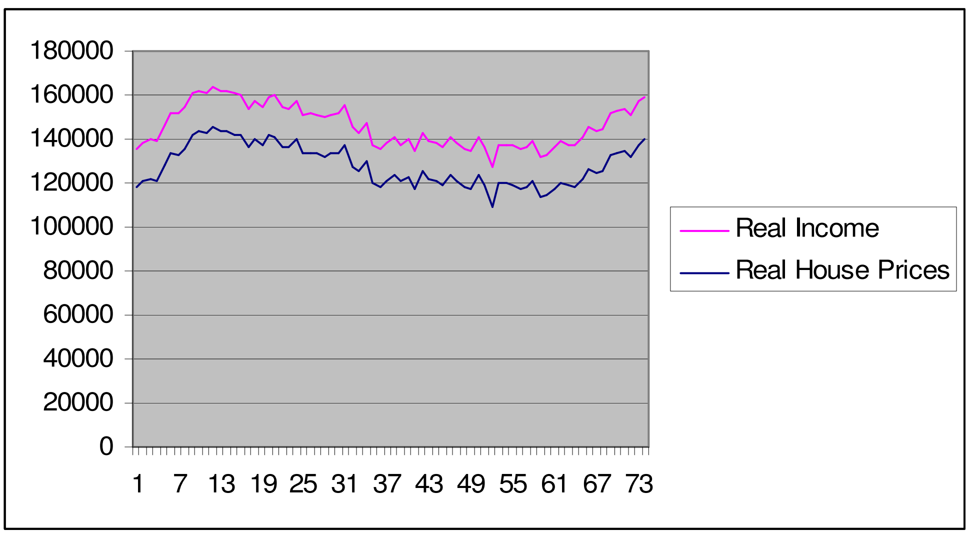

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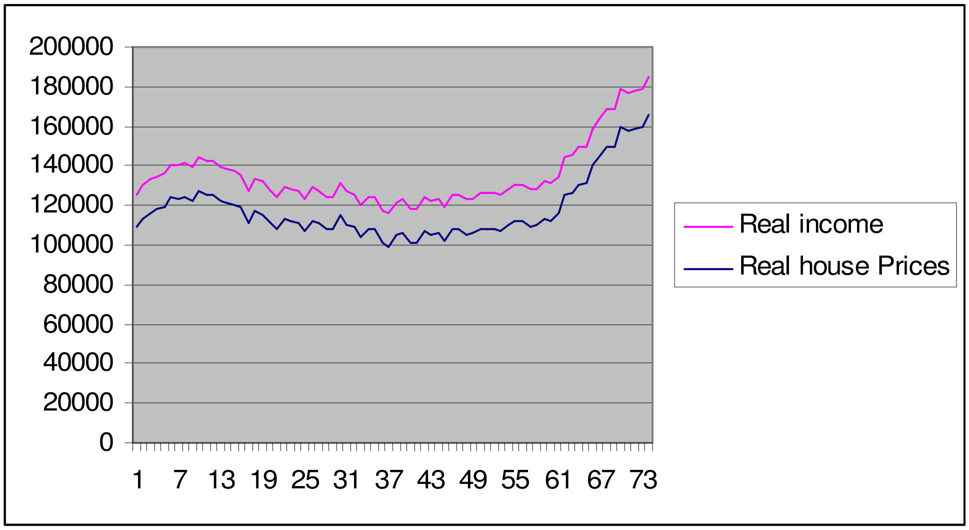

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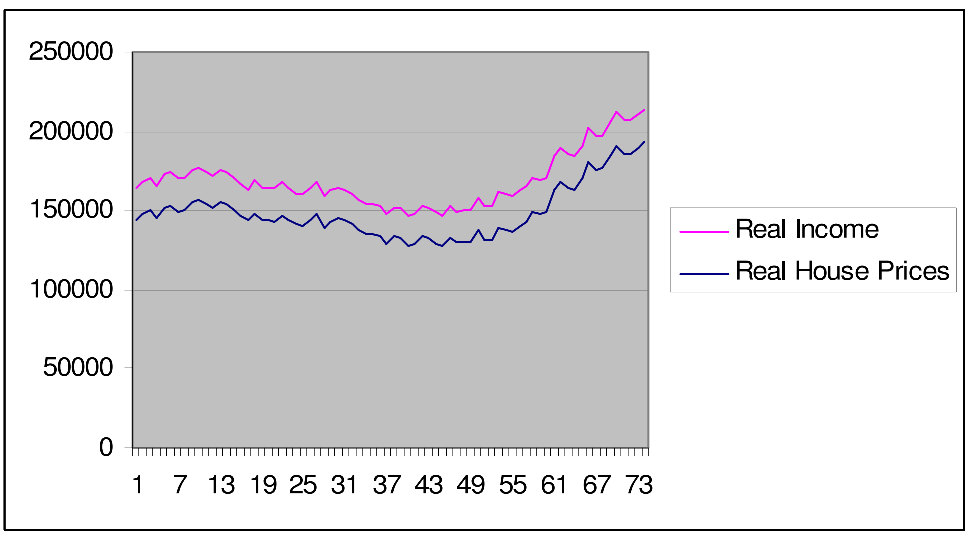

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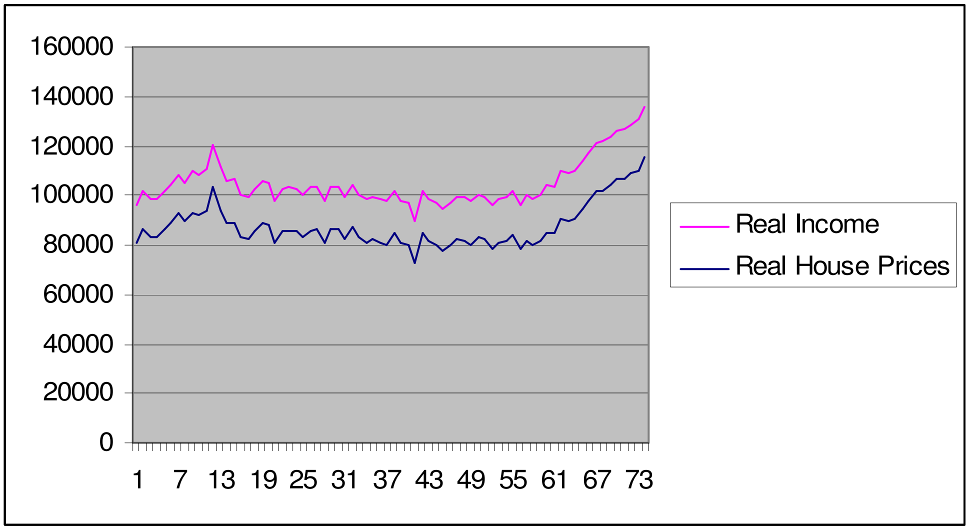

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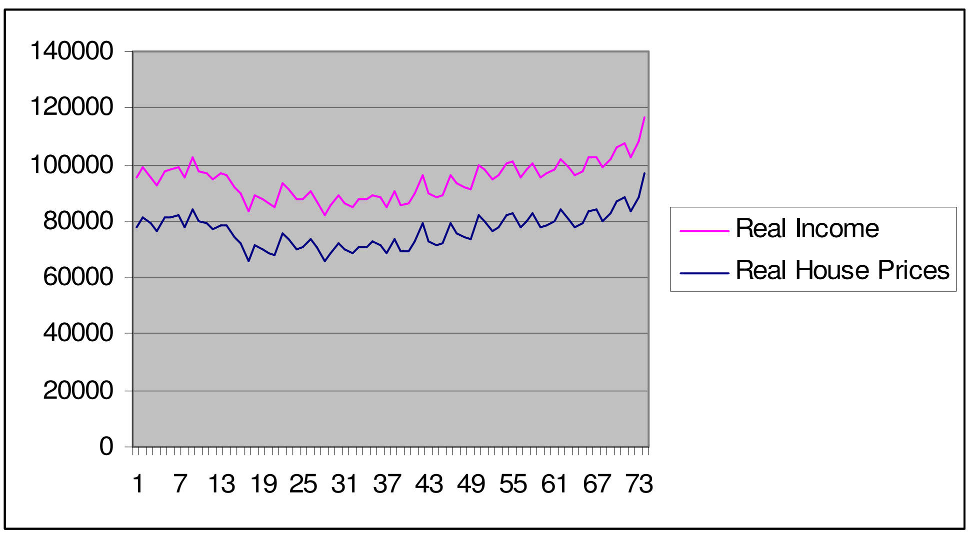

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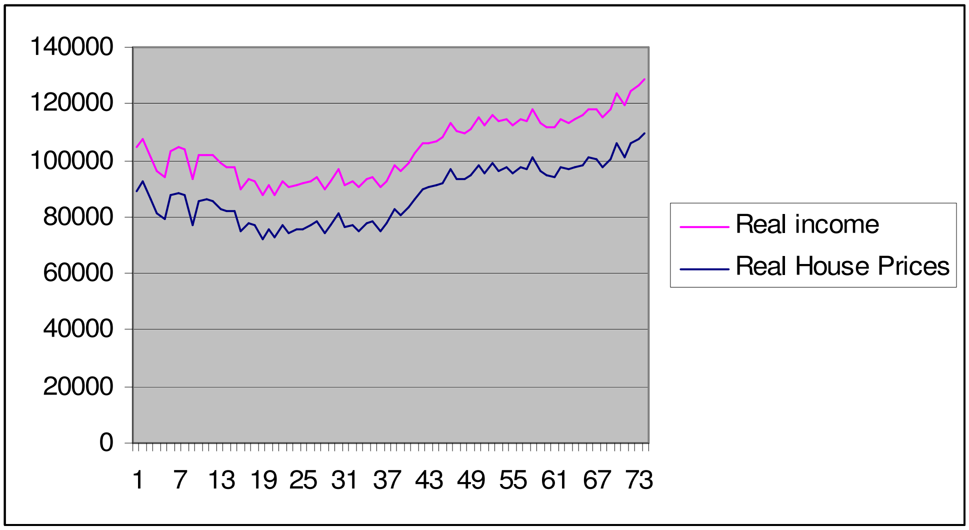

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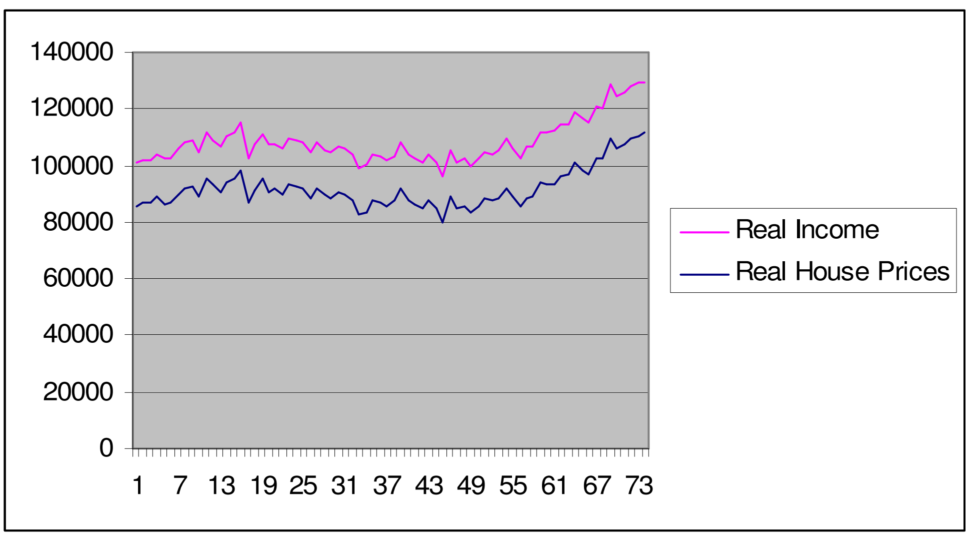

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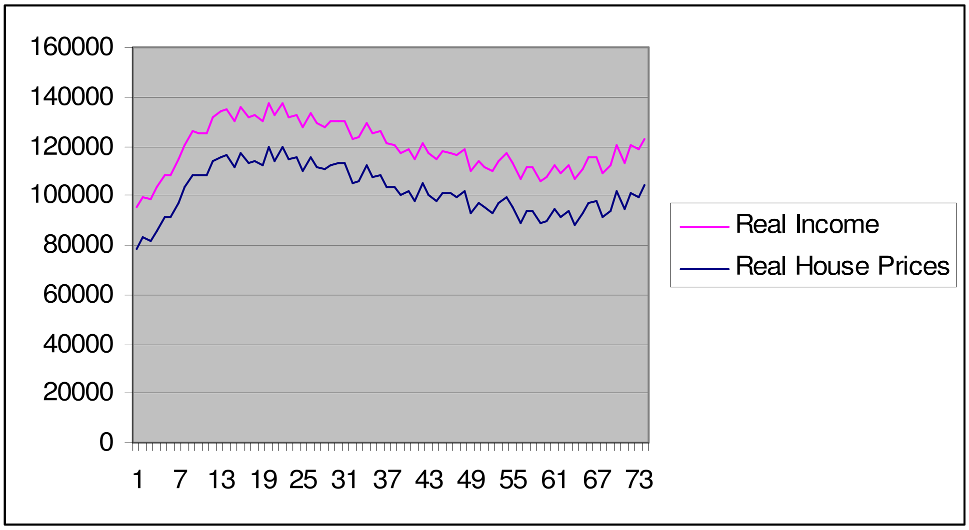

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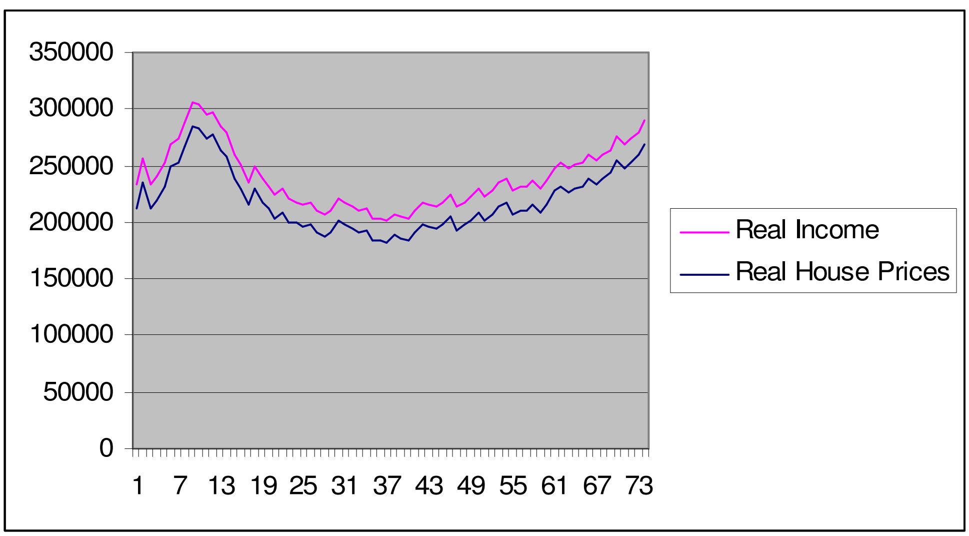

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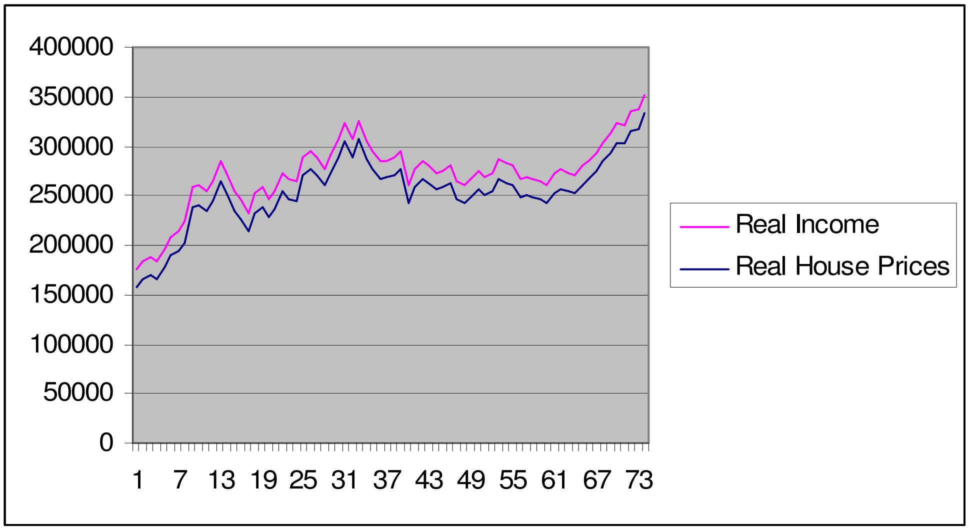

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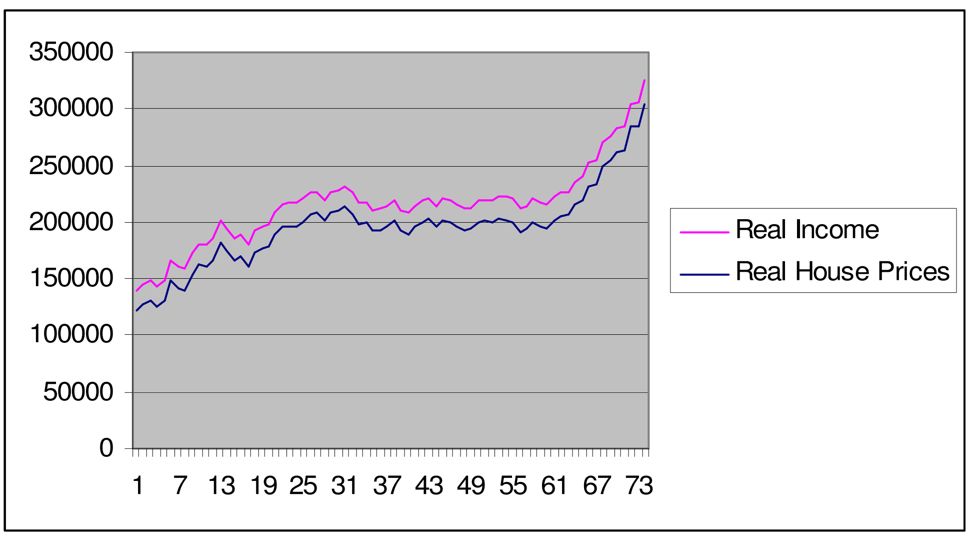

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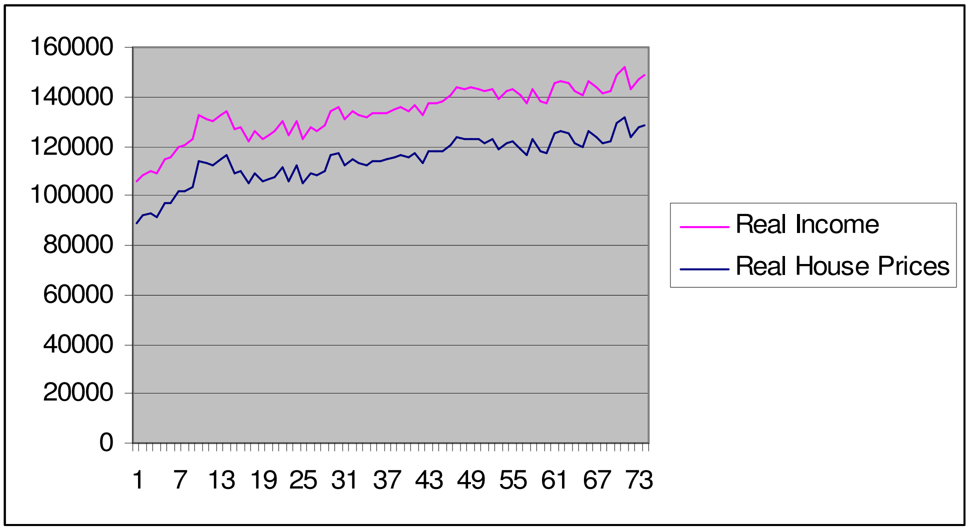

Winnipeg