What's the Beef with House Prices? Economic Shocks and Local Housing Markets

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Motu Working Paper 04-08
Motu Economic and Public Policy Research

October 2004

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Acknowledgements

We wish to acknowledge, with thanks, the assistance of three funders for making this research possible: Lincoln Institute of Land Policy, Centre for Housing Research Aotearoa New Zealand, and the New Zealand Foundation for Research Science and Technology (Programme on Understanding Adjustment and Inequality).

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Abstract

We examine the impact of shocks on community outcomes. The shocks that we examine are exogenous economic shocks which occur externally to the local community, and which are hypothesised to impact on the community. By testing the impact of these shocks on community developments, we enrich understanding of what causes communities to develop as they do over time. In particular, we gain a greater understanding of the impact of factors largely or wholly outside the control of local communities which lead to inequality in outcomes between communities. To focus our analysis, we concentrate on the price of houses within each community as the community outcome variable. The local price of houses summarises, in one dimension, a host of tangible and intangible components relating to the community of interest. We use a multivariate panel structure to estimate the long-run and short-run impacts of price, production and demographic variables on real house prices.

JEL classification
R10 (General Spatial Economics), R21 (Housing Demand)

Keywords
House prices, commodity prices, regional shocks, adjustment dynamics

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1 Introduction

This paper examines the impact of shocks on community outcomes. The shocks that we examine are exogenous economic shocks which occur externally to the local community, and which are hypothesised to impact on the community. By testing the impact of these shocks on community developments, we enrich understanding of what causes communities to develop as they do over time. In particular, we gain a greater understanding of the impact of factors largely or wholly outside the control of local communities which lead to inequality in outcomes between communities. We find that each of price, production and demographic variables, measured at the local level, impacts on local outcomes.

To focus our analysis, we concentrate on the price of houses within each community as the community outcome variable. The local price of houses summarises, in one dimension, a host of tangible and intangible components relating to the community of interest. Tangible components include the incomes that can be earned by living in a particular locality. Intangible components include the availability of local services, the demographic make-up of the community and factors such as climate and proximity to natural amenities—e.g. beaches and forests. The way that these factors are valued may change over time and may itself be related to tangible developments.[1] By examining the impact of exogenous events on local house prices, we can interpret how exogenous economic and demographic shocks have affected the desirability of living in different parts of New Zealand over time.

Our analysis is at the Territorial Local Authority (TLA) level. There are 73 TLAs in New Zealand,[2] implying an average population per TLA of just over 50,000.[3] Most TLAs are reasonably homogeneous within themselves in the sense that they are either mainly urban (e.g. Manukau City, Upper Hutt) or mainly rural with a dominant commodity-based or tourism-based activity [e.g. Matamata-Piako

[1] For example, people may value beaches more or forests less as they become wealthier.
[2] In fact, there are 74 TLAs, but we exclude the Chatham Islands from our analysis owing to their remoteness and small size.
[3] Population size of TLAs in the 2001 census varied from a maximum of 367,700 (Auckland City) to 3,480 (Kaikoura).

District (dairying), Kawerau (forestry), Queenstown-Lakes District (tourism)]. They are also, in the main, small enough to enable commuting across all parts of the TLA to be a realistic possibility.[4] By virtue of their size and degree of homogeneity, house prices within a TLA are expected to be subject to similar influences to one another as a result of exogenous shocks impinging on the specific TLA.[5]

While being small in these senses, TLAs are generally large enough to have reasonable data; their legal administrative status assists in compilation of the appropriate data. A major contribution of this project has been to derive TLA-specific proxies for many variables which were not hitherto available. This data, which is discussed in Section 0 of the paper, are of potential use in other studies based on TLA area definitions.

Our analysis builds on other recent regional adjustment work and geographically based housing work.[6] In particular, it builds on Grimes et al (2004), which estimates the determinants of house prices at a Regional Council (RC) level within New Zealand. It is also substantially informed by the TLA and RC time series work in Grimes et al (2004). In our structural modelling (Section 4), we adopt a similar theoretical approach to the former study. That study focused on financial efficiency aspects related to the housing market. While these aspects are referred to in the current analysis, we focus here on estimating the impact of specific production, price and demographic variables on local authority house price outcomes. The use of more specific shock variables contrasts with our earlier work, which employed a generalised "economic activity" variable at RC level.

[4] Maré and Timmins (2004) use an alternative community definition, labour market areas, derived from work-home relationships. They divide New Zealand into 58 labour market areas compared with our use of 73 TLAs. In some cases, especially in urban conglomerations, there is more than one TLA in a labour market area. We expect that in these cases, the neighbouring TLAs within a labour market area will be subject to similar exogenous shocks.

[5] That is not to say, of course, that other influences do not also impact on the price of specific houses. For our purposes, these house-specific influences induce noise in the data, but this noise is reduced by the use of median house price data.

[6] See especially Fabling and Grimes (2003), Grimes et al (2003), Maré and Timmins (2003, 2004).

Our analysis places the variables that appear in our theoretical specification into a multivariate panel (time series—cross-section) equation derived directly from our theoretical structure. This structure is, in turn, derived from a consumer optimisation model. We estimate the long-run and short-run impacts of each of the variables on real house price outcomes. From these estimates, we can infer the impact that each variable has on house prices with reference to the underlying theoretical approach.

We find that each of production, price and demographic variables impacts on house prices. Particularly interesting is the impact of commodity prices which are likely to be completely outside the control of any firm or individual in a specific TLA. An increase in real commodity prices relevant to the TLA has both a long-run and a short-run effect on TLA real house prices. For instance, if a TLA is heavily forestry-oriented (e.g. Kawerau or South Waikato) a downturn in forestry prices will lead to downward pressure on house prices in that TLA even if production and employment levels remained unaffected. The mechanism by which this occurs is hypothesised to be a reduction in incomes for people working in the relevant sectors and in sectors servicing the industry.

In addition, national production in sectors relevant to each TLA affects TLA house prices. The effect is again hypothesised to be via the impact on TLA incomes. Demographic variables are also found to impact on house prices. Finally, an increase in housing density (decline in house numbers relative to population) increases house prices, as predicted by theory.

The structure of the paper is as follows. The underlying theoretical model of consumer optimisation is outlined in Section 2. This is followed by a description of the data used in the paper. Most of this data is TLA-specific and has been specially derived for all New Zealand TLAs quarterly from 1981 onwards. This is the first time much of this data has been used and a detailed description of the data is given since the data may be used in subsequent studies by other researchers. Estimation of the panel long-run and short-run equations based on the theoretical model is presented in Section 4. Finally, Section 5 provides additional interpretation of the results and our conclusions.

2 Theoretical structure

Our theoretical approach to modelling long-run house price determinants in each region is based on the model of Pain and Westaway (1996), subsequently utilised by O'Donovan and Rae (1997) to model national determinants of house prices in New Zealand. That model was adapted by Grimes et al (2004) to model long-run and short-run house price determinants at RC level in New Zealand using data available at that level of disaggregation. As described in Section 0 of this paper, our TLA data is more refined than that available for the RC study; we have adapted the Pain and Westaway framework to suit the data at hand.

As described in more detail in Grimes et al (2004), Pain and Westaway formulate the consumer problem as one where each household allocates its lifetime wealth over consumption of housing services (c^h) and non-housing consumption (c) in each period of life and over its bequest. We adopt a constant relative risk aversion utility function (with coefficient of relative risk aversion, γ) and assume that housing services can be proxied by a constant, θ, multiplied by the housing stock, h. Aggregating over individuals in each region results in the optimising equation explaining equilibrium real house prices (g) in (1):

$$\ln(g) = (1 - \gamma)\ln(\theta) - \gamma\ln(h/pop) + \gamma\ln(cx) - \ln(uc) \qquad (1)$$

where: g is the ratio of quality-adjusted price of housing (p^h) to the price of non-housing consumption goods (p^c)
h is the housing stock
pop is population
cx is per capita non-housing consumption (c/pop)
uc is the real user cost of capital.

Region and time subscripts are suppressed for clarity.

We assume that cx is determined by the real purchasing power of incomes in each TLA, proxied by variables representing real per capita production and the relative price of commodity production within the TLA (consumer prices are used to deflate commodity prices). Thus we have the auxiliary hypothesis:

$$\ln(cx) = \alpha_0 + \alpha_1\ln(xprod) + \alpha_2\ln(com) \qquad (2)$$

where xprod is real per capita production in the TLA and com is the TLA-specific price of primary commodities produced in the TLA relative to consumer prices. (Details of the empirical counterparts to each of these variables are given in Section 0.)

This theoretical structure pertains to quality-adjusted house prices. In practice, observed house prices represent the price paid for a bundle of housing and related services. These services are related to housing quality (e.g. house age, size, standard of maintenance) and to neighbourhood and amenity values pertaining to the location of the house. We can represent any stable or deterministically trending qualities pertaining to house and location quality through inclusion of fixed effects (TLA-specific constant terms) and TLA-specific time trends.

We hypothesise that additional demographic variables which are not necessarily fixed or trending in a deterministic fashion may be relevant to the perceived quality of a location. Specifically, based on the results of O'Donovan and Rae (1997), we expect that location quality is viewed more positively where a greater proportion of the population is engaged in the workforce. We also assume that location quality is enhanced by increased provision of local services (private and public), which in turn are related to population density. We hypothesise that as the population for a fixed (TLA) area increases, the number and quality of services that it is profitable to provide increases. Together, these quality adjustments affect the observed (quality-unadjusted) price of houses relative to the quality-adjusted price of houses as in (3):

$$\ln(p^u/ p^c) = \ln(p^h/ p^c) + \beta_0 + \beta_1\text{time} + \beta_2\ln(\text{xemp}) + \beta_3\ln(\text{pop}) \qquad (3)$$

where p^u is the observed (quality unadjusted) house price, xemp is the proportion of the population aged over 15 employed in the workforce, and time is a time trend. Combining (1) to (3), together with three modifications discussed subsequently, yields:

$$\ln(p^u/ p^c) = [(1-\gamma)\ln(\theta) + \alpha_0\gamma + \beta_0] - \gamma\ln(h/\text{pop}) + \alpha_1\gamma\ln(\text{xprod}) + \alpha_2\gamma\ln(\text{com}) + \beta_1\text{time} + \beta_2\ln(\text{xemp}) + \beta_3\ln(\text{pop}) - \delta_1(\text{uc}) + \delta_2(\text{ucd}) + \varphi\ln(\text{cpid}) \qquad (4)$$

where cpid is the relative price of construction costs to consumer prices and ucd is a dummy variable discussed further below. Inclusion of cpid (the first modification noted above) builds on the work of Glaeser and Gyourko (2003) and Glaeser et al (2003), who discuss mechanisms by which an increase in building costs can force up house prices. Consider, for instance, a region in which house prices are on their equilibrium path. The region is then faced with an unexpected rise in construction costs relative to other prices. The very long-term effect will be to reduce the supply of houses, which, through (4), leads to an increase in the real house price. However, in the short to medium term, the supply of houses is largely fixed (in particular, material reductions in the house stock may take decades to eventuate). The relative construction price shock will be embedded in current house prices in expectation of this prolonged cost effect as competing (new) house prices rise.

The second modification is replacement of ln(uc) by δ_1(uc) where δ_1 is a parameter to be estimated. This modification is required in practice since the real user cost of capital at times becomes negative during our sample. Thus the logarithm of uc is replaced by the level together with a freely estimated coefficient. The third modification is addition of a dummy variable, ucd, to represent the period prior to financial deregulation (i.e. ucd = 1 prior to 1985(1) and 0 thereafter); uc is entered only from 1985(1) onwards.[7]

In Equation (4) we hypothesise that all coefficients other than the fixed and deterministic trend effects are identical across regions, since each represents an underlying structural factor in the market. We can therefore rewrite (4), making TLA and time subscripts (i and t respectively) explicit as:

$$\ln(p^u/ p^c)_{i,t} = \lambda_{i0} + \lambda_1 \ln(h/pop)_{i,t} + \lambda_2 \ln(xprod)_{i,t} + \lambda_3 \ln(com)_{i,t} + \lambda_4 \ln(xemp)_{i,t} + \lambda_5 \ln(pop)_{i,t} + \lambda_6 uc_{i,t} + \lambda_7 \ln(cpid)_{i,t} + \lambda_{i8} time_t + \lambda_9 ucd_t \quad (5)$$

From the analysis above, we expect each of λ_2, λ_3, λ_4, λ_5, and λ_7 to be positive, with each of λ_1 and λ_6 negative. The fixed effects (λ_{i0}) and deterministic

[7] See Grimes et al (2004) for further details.

trend effects (λ_{i8}) are of indeterminate sign; so too is the impact of financial regulation (λ_9).

Equation (5) represents the posited long-run relationship determining real TLA house prices. Based on the analysis in Grimes et al (2004) we hypothesise that the short-run dynamic adjustment equation is of the form in (6):

$$\begin{aligned}\Delta\ln(p^u/p^c)_{i,t} = {} & \omega_0[\ln(p^u/p^c)_{i,t-1} - \ln(p^u/p^c)^*_{i,t-1}] + \omega_1\Delta\ln(h/pop)_{i,t} + \omega_2\Delta\ln(xprod)_{i,t} \\ & + \omega_3\Delta\ln(com)_{i,t} + \omega_4\Delta\ln(xemp)_{i,t} + \omega_5\Delta\ln(pop)_{i,t} + \omega_6\Delta uc_{i,t} + \\ & \omega_7\Delta\ln(cpid)_{i,t} + \omega_8 sale_{t-2} + \omega_9\Delta\ln(p^c)_t + \omega_{i10} \qquad (6)\end{aligned}$$

where $\ln(p^u/p^c)^*$ represents the long-run (equilibrium) value of real TLA house prices determined by (5), and sale is the number of house sales in a TLA as a proportion of the housing stock in the TLA.

The form of (6) is an error correction equation in which house prices adjust to disequilibrium in last period's house prices, with adjustment coefficient ω_0; ω_0 is expected to lie in the interval (–1,0). The current quarterly change in each of the variables in (5) may impact on current house price changes as allowed for in (6). One such variable is consumer price inflation. This variable is entered separately to allow for short-run non-neutral effects of generalised consumer price inflation on real house prices; ω_9 is expected to lie in the interval (–1,0).

The sale variable is added to the specification to test for effects of sales activity that impact on prices separately from any long-run determinant. Grimes et al (2004) found that the second lag of this variable had the greatest explanatory power over house prices at RC level, and preliminary work for this study confirmed this finding; henceforth we consider only this lag of the sale variable.

Grimes et al (2004) tested for asymmetric adjustment within (6) according to whether last period's house prices were above or below equilibrium (i.e. according to whether the first term in (6) is positive or negative), finding considerable asymmetries for certain variables. We test for asymmetries again in the current work. The previous paper also tested for other non-linearities in the adjustment coefficients but did not find material results in this respect and we do not investigate that aspect further here.

3 Data

Our data corresponding to the variables in (5) and (6) is outlined below. We outline in detail those variables that have been derived at the TLA level specifically for this study. The variables that we refer to for the remainder of the paper are defined as follows, with theoretical counterparts from Section 2 shown in square brackets:

P_{it}	is the log of the real median house price in region i [$\ln(p^u/ p^c)$]
$XPROD_{it}$	is the log of per capita production for region i [ln(xprod)]
$XEMP_{it}$	is the log of the workforce participation rate for people aged over 15 in region i [ln(xemp)]
POP_{it}	is the log of usually resident population in region i [ln(pop)]
COM_{it}	is the log of the real commodity price for region i [ln(com)]
DD_{it}	is the log of the dwelling density (dwellings/population) in region i [ln(h/pop)]
$CPID_t$	is the log of the ratio of CPI for purchase and construction of new dwellings to total CPI (national) [(ln(cpid)]
PC_t	is the log of the consumer price index excluding the impact of interest rates and the imposition and subsequent increase of goods and services tax (national) [$\ln(p^c)$]
S_{it}	is the ratio of house sales to housing stock in region i [sale]
UC_{it}	is the real user cost of capital in region i [uc]
UCD_t	is a dummy variable = 1 prior to 1985(1) (financial deregulation), 0 thereafter to proxy for financial deregulation [ucd].

In addition there is a set of dummy variables (fixed effects) for each of the 73 TLAs and a set of TLA-specific linear time trends for each TLA.

We use Quotable Value New Zealand (QVNZ) quarterly data for median residential house sale prices in each region. QVNZ is a state-owned entity that collects data on all house sales and also values properties for local authority property tax purposes. We have measures from this source of the median sales price in each TLA and the number of house sales. In order to compare "like with like" as much as possible, we restrict our attention to the residential house market, which excludes all multi-unit residential sales and all non-residential transactions. All data is available quarterly from 1981(1)–2002(4). Further detail on this data is contained in Grimes et al (2003).

XPROD is formed by weighting quarterly GDP by industry[8] (two-digit ANZSIC[9]) by industry employment data (two-digit ANZSIC) from the 1986, 1991, 1996 and 2001 censuses.[10] This variable is therefore akin to a Bartik index (Bartik, 1991). While data unavailability necessitates the use of national industry production data (albeit weighted by TLA-specific weights), an advantage is that we thereby mitigate endogeneity issues which could arise from use of TLA-specific production data (if such data was available).[11]

COM is constructed from the ANZ Bank's Commodity Price Indices, Statistics New Zealand's (SNZ) export price data and QVNZ valuation data. The ANZ's commodity price indices are available monthly from 1986 to the present, and were aggregated to quarterly observations. Export price data for dairy, meat, horticulture and forestry is used to backcast the commodity price data to form quarterly observations for the period 1981(1)–1985(4). Each price series was weighted by the respective capital value of land used in production of the relevant commodity as a proportion of the total capital value of land in a TLA. These four terms are summed and added to a further term which takes into account the value of land not used for commodity production (i.e. all land excluding dairy, meat, horticultural and forestry). The price attributed to land with non-commodity production is the CPI. The sum of the five terms is then deflated by the CPI. This results in a constant commodity price for those TLAs that have no dairy, meat, horticultural or forestry production.

[8] The GDP data (constant prices) was seasonally adjusted using X-12 ARIMA.
[9] Australian New Zealand Standard Industrial Classification. There are 18 industry groups in the two-digit classification: Agriculture, forestry and fish (AGR), Mining (MIN), Manufacturing (MAN), Electricity, gas and water (EGW), Construction (CON), Wholesale trade (WHO), Retail trade (RET), Accommodation, cafes and restaurants (ACR), Transport and storage (TRN), Communication services (COM), Finance and insurance (FIN), Property and business services (PRP), Government administration and defence (GOV), Education (EDN), Health and community services (HEA), Cultural and recreational services (CUL), Personal and other services (PER) and Industry not specified (NSP).
[10] The Census employment data has been linearly interpolated to quarterly observations. Due to some 1981 census data being unavailable, 1981(1)–1985(4) weights are set equal to the 1986(1) figure.
[11] Endogeneity issues would, however, only arise with the dynamic estimates, since we are dealing with non-stationary data and the cointegration approach means that the long-run coefficients are consistent even in the presence of endogenous regressors.

XEMP is the number of people employed over the age of 15 as a proportion of the total usually resident population aged over 15. Data was obtained from the 1981, 1986, 1991, 1996 and 2001 censuses and linearly interpolated to form quarterly observations.

Data on the number of houses in each TLA is from the 1981, 1986, 1991, 1996 and 2001 censuses. This data was linearly interpolated to form quarterly observations[12] and used to calculate dwelling density (DD: houses/ population). Population estimates were obtained similarly from the same censuses.

CPID is a quarterly price index from SNZ for the purchase and construction of new dwellings. This is deflated by the CPI.

UC, the real user cost of capital, was formulated exactly as in Grimes et al (2004). It comprises the real 90-day bank bill rate (i.e. the nominal rate less annual CPI inflation) minus the expected rate of real capital gain on housing within a TLA. The past three years annual rate of real capital gain on houses at the TLA level is used as the measure of expected real capital gains.[13]

S is the ratio of house sales to the housing stock in each region. Data on the number of quarterly sales in each TLA is obtained from QVNZ.

Each of the variables P_i, $XPROD_i$, COM_i, $XEMP_i$, POP_i, DD_i and UC_i is tested for non-stationarity using the panel unit root tests of Levin et al (2002) and Im et al (2003). We also test S_i, which is included in the dynamic specification. We test each variable including a constant and a trend, and again including a constant only. In at least one variant of each test the results indicate that the variables are non-stationary [I(1)]. Where the tests give conflicting results we prefer to treat the series as non-stationary, unless theory suggests that stationarity is more appropriate. For this reason S_i is treated as I(0) since the house sales to

[12] It is not possible to get 1981 census dwelling data on current TLA boundaries. ArcView GIS was used to dissolve pre-1991 county boundaries onto current TLA boundaries. In cases where counties cut across TLA boundaries the data were weighted by the area of the county in the TLA.
[13] Grimes et al (2004) tested a variety of expected real capital gains proxies, finding that extrapolative expectations based on the past three years developments performed best.

house stock ratio must be bounded above and below, indicating stationarity. A standard ADF test was used to test for non-stationarity in CPID, which is a national variable. The result is ambiguous, but as for the other ambiguous results we treat it as I(1).

4 Structural estimates

4.1 Long-run estimates

We estimate (5) to test the long-run impact of each of the hypothesised influences on real house prices.[14] The TLA house price data is noisy since it uses quarterly median sales data; as discussed in Grimes et al (2003) the sales data for smaller TLAs contains considerable volatility in quarter to quarter movements, possibly as a result of sales composition effects. To illustrate the degree of noise, when the panel is estimated with just TLA fixed effects and linear TLA-specific time trends included in the equation, the standard error (s.e.) of the system is 11.0% using Ordinary Least Squares (OLS). In other words, a measure of the average deviation between each observation and the trend real house price in each TLA is 11%.

When we estimate Equation (5) using OLS, the estimated s.e. for the system falls to 8.5%. With Prais-Winsten (PW) regression the estimated s.e. is 7.3%.[15] Table 1 presents these estimates using the TLA explanatory variables (with the exception of CPID, which is a national variable). TLA fixed effects and

[14] We also examined the bivariate influence of economic variables on nominal and real house prices (and vice versa) using Granger Causality Tests. The economic variables—each in change form—tested for possible influence are nominal TLA commodity prices, COM^N; nominal national construction costs, $CPID^N$; TLA real production, XPROD; and TLA real user cost of capital, UC. Other variables are constructed using data interpolated between censuses and so cannot be used for testing dynamic reactions. Each of COM^N, XPROD, UC and $CPID^N$ is found to Granger-cause real and/or nominal house prices. In testing for reverse causality, we find little support for house prices Granger-causing XPROD, but some evidence for their Granger-causing CPID. Perhaps surprisingly, we also find some evidence that house prices Granger-cause commodity prices. Even if commodity prices were completely exogenous to the TLA, it would be possible for house prices to Granger-cause commodity prices if market participants were able to predict some portion of next quarter's commodity price developments.

[15] PW is a form of GLS regression that produces s.e.s corrected for disturbances that are heteroskedastic and contemporaneously correlated across panels and also for panel-specific first order autocorrelation.

TLA-specific linear time trends are included, but not reported for clarity.[16] In the following discussion, unless otherwise specified, we refer to the PW estimates.

Table 1: Long-run real house price (P) estimates

Independent Variable: P Dependent Variables:	(1) OLS	(2) PW
XPROD	0.3675*** (10.52)	0.2645*** (3.61)
COM	0.6092*** (7.94)	0.5920*** (4.95)
XEMP	0.4305*** (7.86)	0.5750*** (4.78)
POP	0.9207*** (14.28)	0.9356*** (7.20)
CPID	0.3062*** (13.22)	0.2697*** (5.00)
DD	–0.2331*** (3.91)	–0.3428*** (3.90)
UC	–0.0111*** (43.90)	–0.0082*** (13.92)
UCD	–0.0424*** (8.81)	–0.0073 (0.66)
Observations	6424	6424
Adjusted R-squared	0.9997	
R-squared		0.9992
s.e.	0.0846	0.0726
All variables defined in Section 0. Absolute value of t statistics (OLS) or z statistics (PW) in parentheses. *** significant at 1% TLA constants and TLA-specific linear time trends included but not reported.		

All variables included in (5), with the exception of the UC dummy (UCD), are highly significant (and of the expected sign) in the estimates in Table 1. A 1% increase in real incomes caused by an increase in per capita production (XPROD) raises real house prices by at least 0.25%. The relative price effect supplements this income effect, with a permanent 1% increase in a TLA's real commodity prices increasing that TLA's real house prices in the long run by 0.6%.

[16] Variants of some of the variables were also tested. For instance, the wage index in the construction sector was tried in place of CPID; also inward tourism, net tourism, inward migration and net migration were tried but did not provide significant supplementary information to that contained already in XPROD. In addition to COM, another price variable was constructed by weighting the national Producers Price Index by TLA employment. None of these variables was found to be significant.

We note that the COM variable is likely to be exogenous to the local TLA since internationally determined commodity prices have been used in its construction. The significance of this variable has implications for the determinants of community outcomes. International markets for dairy, beef, lamb, wool, forestry and horticulture affect local house prices in New Zealand: a BSE crisis in Britain impinges on house prices in Te Kuiti.

Construction costs impact on house prices separately from consumer prices (through CPID). One way of interpreting this estimate is to replace the current CPI deflator for real house prices with a deflator that is weighted approximately three-quarters by general consumer prices and one quarter by the cost of construction of new dwellings.

The cost of capital has a significant impact. A 1 percentage point (p.p.) increase in the user cost of capital (e.g. through a 1 p.p. increase in interest rates, ceteris paribus) decreases real house prices by 0.8%. The magnitude of this impact is fractionally stronger than that estimated in Grimes et al (2004) using RC data with a similar specification for UC. The similarity in estimates using different levels of data aggregation gives confidence in the robustness of this estimate.

An increase in the housing stock relative to the population has a negative effect on house prices as predicted by the theoretical model. Each 1% increase in the house stock (relative to population) results in just over a 0.33% drop in house prices. This estimate is smaller than that using RC data in Grimes et al (2004) although the direction is identical; both estimates are statistically significant. The relatively poor quality of the house stock data is likely to make it difficult to pinpoint this coefficient accurately.

The two demographic variables have a material effect on equilibrium house prices.[17] Having a higher proportion of the working aged population in employment (XEMP) has a positive effect on house prices over and above any real income effects already captured through XPROD and COM. This is likely to reflect an increased desirability of areas in which non-participation in the

[17] Two other demographic variables were also tested but found to be insignificant. These were the population aged less than 15 years and the population aged over 65 years.

workforce is low. Perhaps a more intuitive way of interpreting this variable is to consider that a higher proportion of unemployed, retired and other non-participant adults has a negative effect on house prices.

A social agglomeration effect is apparent. Population size has a particularly important effect on house prices over and above any dwelling density (DD) and community income effects, suggesting a social agglomeration effect arising from greater density. We find that a 1% increase in population raises the real house price of an area by almost 1%. This finding is consistent with the view that a denser population facilitates greater provision of (private and public) services, so increasing the desirability of living in a particular community (at least up to some saturation point where negative externalities may begin to dominate).

There are two issues with the inclusion of POP in this specification. The first is that each of XPROD and DD includes the population in the denominator and XEMP includes a similar variable in its denominator. As a result, there may be some collinearity between these variables and that collinearity may make for inefficient estimates. Second, there is almost certainly bi-directional causality between real house prices and population, with migration patterns being affected by house prices (see Maré and Timmins, 2004). Our estimates are consistent given that we are estimating a cointegrating equation with non-stationary variables (Engle and Granger, 1987). However, it is useful to check the robustness of our estimates with POP excluded to see if each of the other explanatory variables remains significant.[18]

The results are presented in Table 2. All estimates remain strongly significant, although the equation s.e. rises slightly. Most coefficient estimates are stable, although the coefficient on DD, which has POP as its denominator, has a material change in magnitude (from –0.34 to –0.57).

[18] Deterministic trends in POP will be accounted for by the inclusion of TIME in the equation.

Given the theoretical relevance of POP to the equation, we favour the results in Table 1.[19]

Table 2: Long-run real house price (P) estimates (excluding POP)

Independent Variable: P Dependent Variables:	(1) OLS	(2) PW
XPROD	0.1859*** (5.62)	0.1965*** (2.63)
COM	0.6051*** (7.76)	0.5799*** (4.74)
XEMP	0.4818*** (8.68)	0.5378*** (4.31)
CPID	0.3785*** (16.48)	0.3452*** (6.23)
DD	–0.5704*** (10.27)	–0.5664*** (6.09)
UC	–0.0112*** (43.60)	–0.0083*** (13.71)
UCD	–0.0511*** (10.54)	–0.0171 (1.51)
Observations	6424	6424
Adjusted R-squared	0.9996	
R-squared		0.9992
s.e.	0.0860	0.0728
All variables defined in Section 0. Absolute value of t statistics (OLS) or z statistics (PW) in parentheses. *** significant at 1% TLA constants and TLA-specific linear time trends included but not reported.		

[19] As well as using the regional variables to estimate the determinants of long-run house prices as in Table 1, we have estimated the model solely using explanatory variables constructed at the national level. We do so to test whether our constructed TLA data adds to the explanatory power of predicted TLA outcomes. If it does so, researchers can be more confident that we are capturing TLA-relevant information through this data. The s.e. rises significantly from 8.5% (OLS) to 9.8% and XEMP swaps signs. We have also re-estimated the Table 1 equation replacing each TLA explanatory variable by its national counterpart while using other TLA variables in each equation. In almost every case, the TLA variable outperforms the corresponding national variable. We conclude that our TLA data provides significantly better explanation of TLA house price developments than does national data.

Before concluding our examination of the long-run estimation results, we need to confirm whether the estimated equations are cointegrated, so representing a valid long-run equilibrium. Using the panel cointegration tests of Kao (1999), we find that the null of no cointegration is strongly rejected. Therefore, the validity of the long-run relationship among the variables in each of the estimated equations is supported.

4.2 Dynamic estimates

Having estimated the long-run determinants of real house price developments, we now estimate the dynamic influences on house prices. These estimates indicate how house prices adjust towards their long-run values. The equation that we estimate is based on (6). A number of the variables that we include in the long-run equation are formulated by interpolating five-yearly census data and so have no observed dynamic counterpart. We do not include the changes in these variables in the dynamic specification; the levels of these variables still appear through the cointegrating term by virtue of their inclusion as determinants of long-run house prices. The variables that we drop for this reason are XEMP, POP and DD. The resulting dynamic house price equation, with symmetric adjustment to equilibrium, is given as Columns (1) and (2) in Table 3, using PW and OLS respectively. This equation is of the form expressed in (6).[20] Columns (3)–(6) provide the asymmetric adjustment estimates, where the adjustment process depends on whether the lagged residual (i.e. disequilibrium) is positive or negative.

[20] We also tested a sales composition term, as in Grimes et al (2004), to reflect any differences in the quality of houses sold within a TLA relative to the trend in house quality in the TLA over time. However, this variable was not significantly different from zero and so is omitted.

Table 3: Dynamic real house price estimates

	(1) PW symmetric	(2) OLS symmetric	(3) PW asymmetric (+ve RES_{t-1})	(4) PW asymmetric (–ve RES_{t-1})	(5) OLS asymmetric (+ve RES_{t-1})	(6) OLS asymmetric (–ve RES_{t-1})
	ΔP	ΔP	ΔP	ΔP	ΔP	ΔP
RES_{t-1}	–0.4556*** (24.00)	–0.4732*** (41.84)	–0.8201*** (53.31)	–0.7793*** (47.80)	–0.7862*** (68.94)	–0.7754*** (63.41)
$\Delta XPROD_t$	0.3652*** (3.95)	0.3484*** (5.65)	0.3115*** (4.72)	0.3976*** (5.16)	0.2903*** (5.24)	0.3920*** (6.61)
ΔCOM_t	1.4184*** (2.58)	1.4496*** (3.16)	1.0344** (2.35)	0.8352 (1.56)	1.0218** (2.53)	0.8444* (1.84)
ΔUC_t	–0.0011 (1.31)	–0.0010* (1.76)	–0.0053*** (8.94)	–0.0051*** (7.56)	–0.0057*** (12.14)	–0.0053*** (9.54)
S_{t-2}	0.7916*** (2.67)	0.7348*** (3.18)	–0.3063 (1.16)	0.7853*** (3.01)	–0.3323 (1.61)	0.7382*** (3.25)
$\Delta CPID_t$	0.1577* (1.68)	0.1765*** (2.79)	0.3776*** (5.03)	0.0074 (0.10)	0.4258*** (7.18)	0.0225 (0.38)
ΔPC_t	–0.4344*** (4.21)	–0.3910*** (5.70)	–0.1620** (1.99)	–0.3278*** (4.15)	–0.0778 (1.22)	–0.2731*** (4.25)
Observations	6278	6278	3198	3080	3198	3080
R-squared	0.2349	0.2429	0.7197	0.6737	0.7002	0.6631
s.e.	0.0709	0.0727	0.0435	0.0477	0.0454	0.0494
Overall s.e.			0.0466		0.0474	
Overall R-squared			0.6845		0.6816	

All variables defined in Section 0 except RES_{t-1}, which is the residual from the PW equation in Table 1.
Absolute value of t statistics (OLS) or z statistics (PW) in parentheses.
* significant at 10%; ** significant at 5%; *** significant at 1%
TLA constants included but not reported.

Several features stand out from the symmetric results [Columns (1) and (2)] of Table 3. First, approximately half of the adjustment to the previous quarter's disequilibrium takes place within one quarter. This is similar to the RC level estimates reported in Grimes et al (2004). The high "z-value" on the lagged residual confirms the finding of cointegration from the long-run estimates.

Second, the adjustment to short-run production changes is similar to the long-run effect from Table 1, indicating full contemporaneous adjustment to this factor. By contrast, there appears to be a short-run overreaction of house prices to commodity price changes; the coefficient on ΔCOM considerably exceeds the coefficient in the long-run equation.

The contemporaneous effect of user cost of capital changes on house prices is much smaller than their long-run effect (similar to the RC estimates). Inflation is non-neutral in the short run, with a rise of 1% in the CPI being reflected in a contemporaneous 0.6% increase in nominal house prices. Real construction cost changes have a smaller short-run effect than their estimated long-run impact.

House sales activity lagged two quarters is estimated to impact on real house prices. As in the RC estimates, this finding opens up the possibility of complex dynamics in house prices as house prices drive up sales with sales then driving prices further upwards. Some of the current explanatory variables in Table 3 could be endogenous, i.e. affected by current TLA house prices. The nature of most of the variables and their construction (e.g. using national GDP, international commodity prices, national interest rates, inflation and construction costs) makes this possibility unlikely. However, we have tested the robustness of the results in Table 3 by replacing each of $\Delta XPROD_t$, ΔCOM_t, ΔUC_t, $\Delta CPID_t$ and ΔPC_t by the first lag of each variable. The results (not reported) indicate generally smaller coefficients than obtained with current variables. For instance, the coefficient on ΔCOM_{t-1} falls to 0.86 while that on ΔPC_{t-1} falls to –0.31. The coefficient on RES_{t-1} stays almost the same, while that on S_{t-2} increases to 0.96. Other (lagged) variables are not significantly different from zero.

The asymmetric estimates presented in Columns (3)–(6) of Table 3 result in additional insights regarding the dynamics of house price reaction to shocks. As with the RC estimates, the explanatory power of the asymmetric adjustment estimates is considerably higher than for the symmetric estimates. The asymmetric results are estimated on a split sample depending on whether the residuals are positive or negative, and also on the full sample with a dummy variable interacted with the independent variables. The s.e.s are reported for the two separate equations and also for the full sample. The s.e. of the asymmetric equation is 4.7%, compared with a s.e. of 7.1% for the symmetric case.

As in the RC case, considerably faster adjustment to the previous quarter's disequilibrium is estimated with the asymmetric estimates than with the symmetric estimates, with approximately three-quarters of the disequilibrium being closed within one quarter. Also in keeping with that work is the considerably higher estimated response to user cost changes, with over half of the long-run effect being experienced contemporaneously. One further similarity to the RC estimates is that consumer price inflation has an asymmetric effect on real house prices. In a buoyant market (positive residuals), we estimate that 84% of consumer price changes are transmitted immediately through to house prices, whereas this pass-through falls to 67% in depressed times (negative residuals). This finding accords with intuition regarding pricing behaviour. The finding that real construction costs also have an asymmetric effect, being significant in buoyant times but not in depressed times, is also intuitively reasonable. Asymmetries with respect to the income variables (ΔXPROD and ΔCOM) are mild.

Finally, lagged sales activity shows strongly asymmetric effects on real house prices. In keeping with the RC estimates, high sales activity boosts prices when prices are below equilibrium, so sales are acting as an equilibrating force in this instance. Sales also act as an equilibrating force when prices are above equilibrium; in this case a rise in sales acts to reduce prices, again bringing prices towards equilibrium (although the estimated coefficient in this latter case is not significantly different from zero).

Overall, the asymmetric estimates reveal a complex dynamic picture in which real house prices adjust towards equilibrium but house price dynamics react in quite diverse (but intuitively plausible) ways to economic shocks.

5 Conclusions

House prices are an extremely useful indicator of community fortunes. As detailed in Grimes et al (2003), communities with generally declining economic and demographic trends (e.g. Kawerau and South Waikato at TLA level; and Southland and Gisborne at RC level) experience low (or negative) real house price growth relative to other regions.

The estimates in this paper provide considerable additional detail as to the determinants of these trends. A community's income growth impacts on house price growth. We find, in turn, that income growth is not solely related to real production growth in an area. Price developments are also vitally important. As befits a commodity-exporting country, commodity price trends specific to the commodity base of each TLA affect house prices in that locality. Financial trends also impact heavily on house price outcomes, as do housing supply and demographic developments. With respect to the latter element, house-buyers appear to be willing to pay more to live in an area where there is higher workforce participation. Our estimates also indicate that people are prepared to pay more to live in areas in which extra services can be provided on the basis of higher population density.

The dynamic adjustment to the long-run influences determined by income, demographic, house supply and financial variables is complex. We find that changes in production, commodity prices, construction costs, consumer prices and the user cost of capital impact on house price changes. The influence of these variables may differ depending on whether house prices are above or below their long-run equilibrium.

These estimates confirm the common impression that communities in New Zealand are to some extent at the mercy of uncontrollable trends in commodity prices and other exogenous economic shocks affecting the locality. Commodity price shocks can impact on house prices, income, wealth, employment and the rates base.

For example, a person living in South Waikato and working in the forestry industry has their human capital tied up in that industry. If the industry undergoes an economic downturn (potentially exhibited both through a commodity price downturn and an activity downturn—and possibly also through a population decline) the value of their human capital is likely to reduce (through a decline in their real wage rate, and a greater likelihood of a spell of unemployment). If their main form of non-human wealth is a house in the same TLA, they may suffer an additional capital loss if the real value of their house declines in response to the same shock.

Economic shocks also affect the tax base of local authorities. TLAs in New Zealand are reliant on property taxation for funding nearly 60% of local services such as water supply and sewerage systems. Kerr et al (2004) find that there is significant variability in per capita tax bases across TLAs. Our results indicate that the income and hence the ability of local authorities to provide services is affected by external economic shocks over which they have little or no control.

Naturally, people within communities can partially adjust to external shocks by altering their exposure to different commodities, but comparative advantage constrains the degree to which this can and should occur. A community that is ideally suited to raising beef cattle may not change commodity base if there is a moderate relative price fall for beef. Its incomes will, however, decline and this will be reflected in house prices in that locality. The community may have a beef with the resulting house price developments, but there may be little it can do to avoid the shock or its effects.

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