# CITY SIZES, HOUSING COSTS, AND WEALTH

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# Abstract

Australia's household sector appears to hold a greater proportion of its wealth in dwellings than do households in other countries. Average dwelling prices in Australia also appear to be high relative to household income, but dwellings in Australia are not noticeably higher in quality than those in comparable countries. This concentration of wealth in housing also does not seem attributable to government policies that encourage dwelling investment in Australia to a greater extent than is true overseas. A possible reconciliation of this pattern may be the unusual concentration of Australia's population in two large cities. Average housing prices tend to be higher in larger cities than smaller ones. Therefore, the expensive cities in Australia drag up the average level of dwelling prices more than in other countries, resulting in a higher share of wealth concentrated in housing. The increasing importance of dwelling wealth in Australia over recent years largely reflects the consequences of disinflation and financial deregulation. This is most likely a transitional effect, and the ratio of dwelling wealth to income should stabilise, or begin to grow more slowly, in the future.



JEL Classification Numbers: G12, R11, R31

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## 1. Introduction

Australia's household sector appears to hold a greater proportion of its wealth in dwellings than do households in other countries. This does not appear to be due to greater quality of the housing stock in Australia than in other comparable countries. Since the measure of dwelling wealth used in household wealth calculations includes all private dwellings, this difference similarly cannot be due to differences in home ownership rates. Alternatively, this pattern in the composition of wealth could be a consequence of public-policy decisions that make the purchase of dwellings relatively more attractive in Australia than in comparable countries.

In this paper, we present evidence against this explanation. We focus instead on an alternative explanation which relies on the observation that housing costs are high in Australia's two largest cities, Sydney and Melbourne. Housing is usually more expensive in large cities than in smaller cities, particularly those cities that dominate other urban regions. The two largest cities in Australia account for a much larger proportion of the total urban population in Australia than is the case in most other developed countries. Therefore, the expensive cities in Australia raise the average *level* of dwelling prices more than in other countries, resulting in a higher share of wealth concentrated in housing.

This concentration of population in the two largest cities is a result of the unusual structure of Australia's urban population. To a first approximation, the populations of cities in many countries are in inverse proportion to their ranking by population size; that is, the second-largest city is roughly half the size of the largest, the third-largest one-third the size and so on. This empirical regularity is an example of a power law, and is known as the rank-size rule or Zipf's Law. Australia's large towns and cities follow an approximate rank-size power law, but with a flatter distribution than other countries. Sydney and Melbourne together therefore account for 'too much' of the urban population of Australia, raising the national average price of dwellings and the share of dwellings in household wealth.

Although this geographic explanation for the structure of Australian households' balance sheets is not the only plausible one, it is consistent with the data and does not rely on presumed differences in preferences. The available data do not suggest that Australians have a greater preference for housing than residents of other developed economies, or that government policy encourages dwelling investment to a greater extent than does policy elsewhere.

The characteristics of housing also support a geographical explanation. Housing differs from the standard neoclassical good; it is heterogenous and its spatial fixity means that the location of the housing stock matters to households (Smith, Rosen and Fallis 1988). Housing is thus imperfectly substitutable across locations (Maclean 1994). These factors, combined with construction lags make housing supply inelastic in the short run, so the housing market is prone to rapid increases in dwelling prices (housing price booms). The relative dominance of the larger cities may therefore also help explain Australia's susceptibility to housing-price booms. In countries with less concentrated urban populations, price booms in one city have less effect on national average prices.

To the extent that average dwelling prices are higher in Australia, some households might respond by reducing their demand for housing services. At the margin, renters would shift their consumption away from housing and downgrade to lower-quality dwellings. However, owner-occupiers' housing demand is both a consumption and investment decision, so their response is less clear (Henderson and Ioannides 1983). It seems likely that any demand substitution would only partially offset the initial increase in dwelling prices.

The question of why Australia's population structure is different remains. The broad similarity with Canada suggests that our federal structure has resulted in state capital cities acting as primate cities dominating the surrounding regions. This will tend to flatten out the rank-size relationship. It is also possible that large countries with small populations – like Canada but unlike the United Kingdom – have flatter rank-size relationships because the large distances between population centres increase transport costs. If so, the structure of the household balance sheet in Australia would not require a policy response, but rather would be partly a necessary implication of our geography and political history.

The paper proceeds as follows. In the next section, we document the importance of dwelling wealth in the household sector's balance sheet in Australia and other developed countries, and critically examine some possible explanations of the high level in Australia. Section 3 provides a brief overview of the literature and empirical evidence about the distribution of city sizes. The data confirm that Zipf's Law is a reasonable first approximation to the distribution of city sizes. We also show that Australia's urban structure accounts for around one-third of the difference between the wealth-income ratios in Australia and the United States.

Section 4 shows that the effects of urban structure on national average housing prices might only occur if households' financial behaviour is not constrained by either financial regulation or the interaction between capital market imperfections and inflation. Section 5 develops a simple model of city sizes with housing costs consistent with the observation that larger cities have more expensive housing. Therefore, the more important are the large cities in the total population, the higher will be the national average level of dwelling costs. The conclusion in Section 6 draws out some of the macroeconomic implications of Australia's relatively large share of dwellings in household wealth, and in particular, argues that a dramatic fall in dwelling prices is unlikely.

## 2. Dwellings and Household Wealth

### 2.1 Measuring Dwelling Wealth

Measurement of the value of the stock of dwelling wealth is in principle as simple as counting the number of dwellings, and multiplying by an appropriately weighted estimate of the average prices of those dwellings. The first part can be generated in a straightforward way using national census data, and interpolated between census dates using information on dwelling completions. The second part, which must be available in local currency values rather than as an index number (as is the case with the ABS House Price Index), is more difficult to obtain.

Some statistical agencies publish estimates of the value of the dwelling stock as part of the country's national accounts. However, national accounting principles do not capture the market price of dwellings, including land value, which is what matters for household wealth. Similarly, implicit price deflators for dwelling investment from national accounts do not correspond to market prices of the existing dwelling stock because they generally exclude land and are based on the composition of new dwellings, not the stock of existing dwellings. Price deflators also exclude the effects of increasing dwelling quality, for example where new houses are larger on average than those built previously. However, these effects clearly add to households' dwelling wealth.

The most appropriate sources for data on the market value of dwellings are those based on prices of existing dwellings sold. These series are sometimes collected by national statistical agencies but are more likely to be published by financial institutions or real estate associations. Dwelling prices are frequently used as an indicator of more general price pressures (Girouard and Blöndal 2001). Therefore many published series on sale prices abstract from compositional effects, or relate only to specific markets or types of housing – for example, detached houses in major urban areas, houses for which past sale prices are known, or dwellings of a standardised size. These adjustments ensure that the series are close to a pure price signal, but are unhelpful when trying to determine the market value of the total dwelling stock.

Appropriate measures of the market price of dwellings must include all regions of the country, and apartments and townhouses as well as detached houses. For this reason, the Reserve Bank uses data from the Housing Industry Association's *Housing Report*, based on prices paid by customers of the Commonwealth Bank. Unlike the other dwelling price series available in Australia such as those from the Real Estate Institute of Australia (REIA) and the ABS, these data include all dwellings, not just detached houses, and cover non-metropolitan regions. However, we are therefore implicitly assuming that Commonwealth Bank customers are representative of all home-buyers. The CBA/HIA prices tend to be higher than those reported by the REIA; it is difficult to say which is correct, given that the CBA/HIA series is otherwise conceptually superior. However, if the CBA/HIA data did overstate the true level of housing prices in Australia, we would have a smaller distance from the dwelling wealth levels of other countries to explain.

Even when conceptually correct measures of sale prices are available, some aspects of their construction can still create biases in estimates of dwelling stock values. Measured values can be biased down by the use of median rather than average prices, for what is likely to be a left-skewed distribution. There is also a potential bias in average dwelling-price measures if different types of dwellings turn over at different rates: the composition of dwellings *sold* would therefore differ from that of dwellings *standing*. Countries with large public-housing sectors could have overstated dwelling wealth unless these dwellings are excluded.[1] Similarly, if privately rented dwellings are owned by corporations, not other households, their exclusion could reduce measures of dwelling wealth, especially in countries with low owner-occupation rates.[2]

**Table 1: Non-financial Assets as a Share of Total Assets**
Per cent

| | 1987 | 1990 | 1993 | 1996 | 1999 |
|---|---|---|---|---|---|
| Australia | 55 | 68 | 63 | 63 | 64 |
| Canada | 47 | 46 | 45 | 43 | 42 |
| France | 61 | 57 | 51 | 50 | na |
| Germany | na | 67 | 65 | 64 | 60 |
| Italy | 53 | 51 | 50 | 48 | na |
| Japan | 65 | 63 | 57 | 51 | na |
| UK | 55 | 55 | 45 | 42 | 42 |
| US | 39 | 38 | 35 | 32 | 28 |
| Sweden[(a)] | 49 | 53 | 51 | 47 | 45 |
| New Zealand | 58 | 61 | 57 | 61 | 60 |

Note: (a) 1999 data refer to 1998.
Sources: Mylonas, Schich and Wehinger (2000); RBA; RBNZ

With these data caveats in mind, Table 1 shows the shares of non-financial assets in total household wealth for countries for which we have sufficient data. Although these data include consumer durables for all countries except New Zealand, non-financial assets are dominated by the dwelling stock. A decade and a half ago, Australia's household balance sheet contained a non-financial asset share around the international average. Since then, the share in most other countries has fallen or stayed fairly constant, while in Australia the share has risen by almost 10 percentage points. This divergence is not due to differences in the relative importance of financial assets: household holdings of financial assets in Australia

1 The measure of dwelling wealth in household wealth calculations is based upon private dwellings. Since this measure is expressed as a percentage of household disposable income, the inclusion of public housing would inflate this estimate because households do not own them.

2 Whilst this effect is likely to be small in most countries, it will be more important in Continental Europe (especially France, Germany and Italy) where some rental housing is financed by large businesses.

are not particularly low relative to those in other developed countries. Rather, housing is expensive relative to income in Australia.

The ratio of aggregate dwelling wealth to disposable income is roughly equivalent to the ratio of average dwelling prices to average disposable income; the ratios will only differ to the extent that there is a difference between the number of private-sector *dwellings* and the number of *households* (this difference is marginal in Australia).[3] Table 2 shows this measure of dwelling prices is relatively high in Australia, and grew fairly steadily through the 1990s, reaching 378 per cent by late 2000. While some nations (Japan, UK, Sweden) experienced rapid run-ups in dwelling prices, these booms ultimately led to busts, and price-income ratios in those countries returned to levels closer to those in other countries (Henley 1998). Of this group of countries, only New Zealand has followed Australia in experiencing sustained growth in relative housing prices.

**Table 2: Housing Wealth as Per Cent to Household Disposable Income**

| | 1980 | 1985 | 1990 | 1995 | 1998 |
|---|---|---|---|---|---|
| Australia | 248 | 239 | 281 | 303 | 355 |
| Canada | 123 | – | 118 | 129 | 129 |
| France[(a)] | 172 | – | 218 | 218 | 227 |
| Germany[(a)] | – | – | 331 | 302 | 301 |
| Italy | 133 | – | 170 | 172 | 166 |
| Japan[(b)] | 380 | 397 | 641 | 429 | 381 |
| UK | 343 | 357 | 361 | 252 | 293 |
| US | 169 | 170 | 173 | 155 | 163 |
| Sweden[(b)] | 208 | 184 | 245 | 182 | 198 |
| New Zealand | 185 | 237 | 243 | 278 | 283 |

Notes: (a) 1998 data refer to 1997.
(b) Figures refer to non-financial assets which include consumer durables as well as dwellings.
Sources: Bundesbank; Mylonas *et al* (2000); OECD; RBA; RBNZ

Some increase in dwelling prices should have been expected through the 1990s in Australia. Following financial deregulation, households now enjoy greater access to loan finance for the purchase of dwellings. Reinforcing this trend, the move to low inflation over that period enabled households to service larger mortgages and therefore purchase more expensive homes (Stevens 1997). These factors

3 Holiday homes and vacant rental properties can result in the number of private-sector dwellings exceeding the number of households.

would be expected to increase demand for dwellings and put upward pressure on dwelling prices. Household indebtedness also increased substantially during this period, reflecting these changes, bringing Australia to around the average level of indebtedness seen in other comparable countries; we discuss these issues in more detail in Section 4. However, these changes do not explain why the increase in dwelling prices since the 1990s has resulted in Australia having relatively more expensive housing than other low-inflation countries. These changes explain the *increase* in dwelling prices and indebtedness, but not why the price *level* has increased from around the average to well above international averages.

This divergence in the dwelling wealth-income ratio, if sustained, implies that different countries have different relative prices of housing in the long run. We consider an explanation for this based on unobservable and unexplained differences in preferences for housing to be unsatisfactory, and inconsistent with the evidence on housing quality presented in Table 4. The ranking of countries by dwelling wealth-income ratio does not obviously follow differences in average income, so these variations in the relative price of housing are also not obviously attributable to housing services being either a superior or inferior good.

### 2.2 The Relative Attractiveness of Dwelling Wealth

Despite the limitations of the data presented in the previous section, they clearly suggest that Australians have concentrated a larger portion of their wealth in housing than their counterparts in other developed economies, and spend a larger proportion of their incomes to purchase a home. The first step in finding the reasons for this result is to establish whether there are government policies or other factors that could have contributed to it. Tax policies such as exclusion from capital gains tax can make owner-occupied dwellings relatively more attractive than other forms of investment, and thus cause over-investment in dwellings. It is also important to assess whether there is a greater revealed preference for dwellings in the sense of their being larger or higher-quality in Australia than elsewhere. Tables 3 and 4 present indicators for these factors for Australia and the other countries for which we have dwelling wealth data.

**Table 3: Policies Affecting the Relative Attractiveness of Housing Wealth**

| | **Mortgage interest deductibility** | **Capital gains exemption on family home** | **Share of public housing** Per cent | **Memo item: home ownership rates** |
|---|---|---|---|---|
| Australia | No | Yes | 5.1 | 70.1 |
| Canada | No | Yes | 1.7 | 63.7 |
| France | Yes[(a)] | Yes | 17.0 | 56.0 |
| Germany | Yes | Yes | 26.0 | 43.0[(b)] |
| Italy | Yes[(c)] | Yes | 6.0 | 68.0 |
| Japan | No | No[(d)] | 7.0 | 60.3 |
| UK | Yes[(e)] | Yes | 24.0 | 69.0 |
| US | Yes | Yes[(f)] | 1.2 | 67.4 |
| Sweden | Yes | No | 22.0[(g)] | 56.0 |
| New Zealand | No | Yes | 6.4 | 71.2 |

Notes: Data are latest available. See Appendix B for detailed information on sources and reference periods. There are other more targeted policies that encourage homeownership across countries (Miron 2001). Although these policies can vary across countries, their net effect seems less significant because their coverage is generally limited.

(a) Interest is deductible for the first five years. The deduction is equivalent to 25 per cent of the total interest bill, subject to a ceiling based on the date of the contract and age of the building.

(b) West Germany only.

(c) A tax credit of 27 per cent of interest payments is allowed up to a ceiling.

(d) A special deduction of ¥30 000 000 can be claimed for the principal residence.

(e) Mortgage interest deductible only on the first £30 000 of a mortgage.

(f) Capital gains is theoretically subject to tax. However, any capital gains from the sale of the family home when another dwelling costing at least as much is purchased within two years of the sale is exempt from taxation. A once-in-a-lifetime exclusion of US $125 000 also exists for people over 55 years.

(g) Excludes co-operative sector.

Owner-occupied housing is tax-advantaged in Australia, but some developed countries apply an even greater range of tax incentives toward home ownership, including deductibility of mortgage interest payments (Table 3). Past theoretical work suggests that deductibility of mortgage interest represents a greater distortion than capital gains tax exemption (Britten-Jones and McKibbin 1989).[4] On this

4 One policy encouraging home ownership in Australia that is not seen elsewhere is the exclusion of owner-occupied dwellings from means and assets tests that can restrict access to government pensions. This encourages pensioners to hold onto larger homes rather than trade down to something smaller, thus restricting the supply of family-sized homes available to larger households. This tax advantage to owner-occupied housing is not applicable in other countries because their welfare systems are not means tested in the same way.

basis, we would expect that if anything, Australia's housing stock is less affected by over-investment than those of some other developed countries.

The quality of the Australian dwelling stock is comparable with that in some other countries. However, Australia has a greater proportion of detached houses, suggesting somewhat more land-intensive housing patterns, and the share of relatively new homes built in the past 20 years is somewhat higher, due to Australia's relatively high population growth (Table 4). Dwellings in Australia appear to be similar in size to those in other non-European developed countries. Although dwellings are larger on average here than in Europe, this is partly because households are larger; the number of persons per room is around the average for developed countries.

**Table 4: Indicators of Housing Quality**

| | Persons per room | Average existing dwelling size | Average new dwelling size | Houses | Detached houses | Dwellings with six or more rooms | Dwellings built since 1980 |
|---|---|---|---|---|---|---|---|
| | | m$^2$ | | Per cent of stock | | | |
| Australia | 0.6 | 131.8[c] | 185.5 | 87.6 | 78.8 | 63.5 | 33.7 |
| Canada | 0.5 | 114.0 | na | 66.4 | 55.9 | 75.0[d] | na |
| France | 0.7 | 88.0 | 102.5 | 56.2 | na | 16.6 | 32.0[e] |
| Germany[a] | 0.5 | 86.7 | 101.9 | 45.6 | 31.0 | 11.5 | 22.0 |
| Italy | 0.8 | 92.3 | 88.7 | na | na | na | na |
| Japan | 0.7 | 89.6 | 94.3 | na | 59.2 | na | 51.8 |
| UK | 0.6 | 84.0[f] | 76.0 | 80.7[f] | 25.6 | 36.8 | 13.3 |
| US | 0.5 | 156.5 | 199.7 | 66.7 | 60.6 | 45.2 | 25.4 |
| Sweden | 0.5 | 89.8 | 86.0 | 45.7 | na | na | 12.0 |
| New Zealand[b] | 0.5 | 132.0 | na | 83.0 | 73.0 | 56.1 | na |

Notes: Data are latest available. Proportion of houses in dwellings refers to all single-family dwellings including townhouses and terraces. See Appendix B for detailed information on sources and reference periods.
(a) West Germany only. Dwellings built column refers to dwellings built since 1979, not 1980.
(b) Existing dwelling size and detached house data refer to Auckland.
(c) Excludes public housing.
(d) Refers to five or more rooms. The average number of rooms in Canada is six.
(e) Since 1975.
(f) England only.

The rate of home ownership in Australia is higher than a number of the countries shown in Table 3, but there are many other countries with similar ownership rates, including New Zealand, Finland, Ireland, Greece and Spain

(European Parliament 1996). Home ownership tends to increase average housing prices because owner-occupiers internalise the cost of the wear and tear they create in their home, while renters might not fully bear such costs (Henderson and Ioannides 1983). Owner-occupiers therefore require a lower gross return than landlords, and are thus in theory willing to pay more for a given dwelling in the absence of differences in tax treatment.

On the other hand, ownership of private rental properties also attracts favourable tax treatment in many OECD countries (Miron 2001). Negative gearing tax provisions in many countries allow landlords to deduct interest payments against income from other sources if they exceed rental income net of expenses, while tax credits and loan subsidies apply in France (Cardew, Parnell and Randolph 2000). These tax provisions generally ensure that owners of rented dwellings receive the same tax treatment as owners of other commercial properties (Weicher 2000). Since they are common across developed countries, Australia's negative gearing provisions do not represent a relatively greater incentive to invest in rental properties. In the UK by contrast, mortgage interest cannot be deducted against rental or other income (Miron 2001). This may be discouraging the expansion of the existing small private rental sector there.

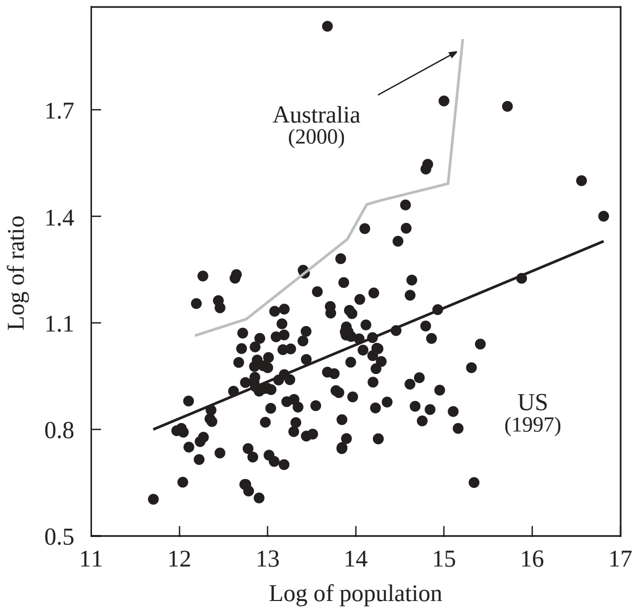
Although previous studies have found evidence of over-investment in housing in Australia, the evidence that this over-investment is greater than in other countries is weak (Bourassa and Hendershott 1992). Therefore tax policies do not appear to explain the divergence in the stock of housing wealth between Australia and other developed countries; to do so, the incentives for over-investment would have to be stronger here than elsewhere. The concern about over-investment is probably better directed at countries that allow tax deductibility of interest payments on owner-occupiers' mortgages (Mills 1987).

### 2.3 Dwelling Prices in Different Cities

Figure 1 indicates that city sizes and city-level house prices are related. Although city-specific factors also matter, larger cities usually have higher average housing prices than smaller cities in the same country, even after allowing for variation in incomes, which are also usually higher in larger cities. Then if large cities make up a relatively large share of the population, the national average dwelling price will be higher than if the same population was spread over a larger number of smaller cities.[5]

**Figure 1: US and Australian House Prices by City**

Per cent to median gross household income




Sources: CBA/HIA for Australia; National Association of Realtors for US

There are a number of possible reasons for this relationship between city size and dwelling prices. Income differentials are clearly important for explaining the high level of dwelling prices in big cities. Mori and Turrini (2000) argue that transport and communication costs encourage higher-skilled workers to concentrate into large urban centres, while Glaeser and Maré (2001) suggest that the observed wage premium paid in larger cities reflects endogenous improvements to human

5 This assumes that there is no systematic negative relationship between house prices in large cities and the share of large cities in the national population. The trend line for US data was estimated by OLS. The coefficient on population is clearly significant using White's correction for heteroskedasticity. If we regress (log) house prices on log income and population, instead of the price-income ratio on population, the coefficient on population remains significant, while the coefficient on income is not significantly different from 1.

capital arising from lower search costs and greater specialisation. However, this cannot be the whole story, as dwelling prices are high relative to income in larger cities, as well as in absolute terms (Figure 1; Table 5).[6] This may be because housing demand represents an increasing share of expenditure as income increases: preferences may not be homothetic or wealth may increase faster than income.[7] Other reasons include that larger cities offer more amenities and a greater range of job opportunities. In equilibrium, these benefits will be balanced against greater costs, such as congestion, crime and higher housing costs (Gabaix 1999b).

**Table 5: Dwelling Prices by City Relative to Disposable Income, 1998/99**

| City | Population | Average income | Dwelling price-income ratio | |
|---|---|---|---|---|
| | '000 | Per cent of national average | Disposable income | Gross income |
| Sydney | 4 041.4 | 113.1 | 8.06 | 5.64 |
| Melbourne | 3 417.2 | 113.2 | 4.69 | 3.51 |
| Brisbane | 1 601.4 | 97.1 | 5.16 | 3.92 |
| Perth | 1 364.2 | 100.4 | 4.87 | 3.76 |
| Adelaide | 1 092.9 | 91.4 | 4.21 | 3.47 |
| Canberra | 348.6 | 124.7 | 3.83 | 2.94 |
| Hobart | 194.2 | 93.3 | 3.38 | 2.58 |

Notes: These price-income ratios are not strictly comparable with the national data in Table 2. Survey data understate national accounts disposable income, and number of households does not equal the number of dwellings.

Sources: See Appendix B

6 As shown in Figure 1, the divergence increased between 1998 and 2000. Canadian housing prices also show a roughly rising relationship, but this is dominated by unusually high housing prices in British Columbia and low prices in Quebec.

7 It might also be because large cities are space-constrained, limiting supply and putting upward pressure on dwelling prices.

# 3. The Distribution of City Sizes

## 3.1 Zipf's Law

Australia's apparently more expensive housing does not seem to be due to differences in government policy or household preferences. An alternative candidate explanation for the importance of housing wealth in Australia is that the urban population is concentrated in two large cities with relatively high housing costs. In most developed and many developing countries, the population size and population ranks of cities are distributed approximately according to a *power law*. This means that if a country's urban centres are ordered by population size, the rank of city $S$ (largest = 1, second-largest = 2, and so on) has an inverse relationship with its population $p(S)$:

$$S = \frac{a}{p(S)^{\zeta}} \tag{1}$$

where $a$ and $\zeta$ are positive constants. This empirical regularity can be demonstrated graphically by plotting the natural logarithm of the rank of each city against the natural logarithm of its population size. Figures 2–4 show this relationship for a range of developed and developing countries. When the exponent $\zeta$ equals 1, this empirical regularity is known as Zipf's Law (Zipf 1949), corresponding to a slope of $-1$ for the lines in these figures.[8]

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[8] Gabaix (1999b) showed that cities with populations that grew randomly would converge to a distribution matching Zipf's Law ($\zeta = 1$) in its upper tail, provided that the growth rates for all cities were drawn from a statistical distribution with the same mean and variance, and that the cities were bounded to be above some minimum size. The existence of such a common distribution is called Gibrat's Law. If this is not true, then Zipf's Law does not hold; Zipf's Law should therefore be seen as a diagnostic for the underlying growth process, rather than a law that must hold in all cases and at all times. Earlier work on explaining Zipf's Law centred on variations of this requirement for random growth from a common distribution. Simon (1955) developed a simple model with additions to the population attaching to existing cities with probability equal to its share of total population. Hill (1974) formalised this proportionality of probability to population as a Bose-Einstein occupancy problem. Gibrat's Law has also been used to study the size distributions of firms, income distributions and other economic variables; see Sutton (1997) for a review.

**Figure 2: Rank-size Relationship – G7 Countries**

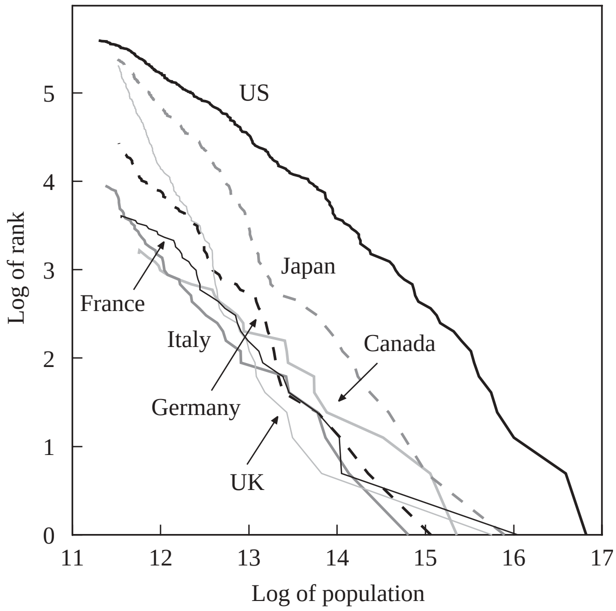
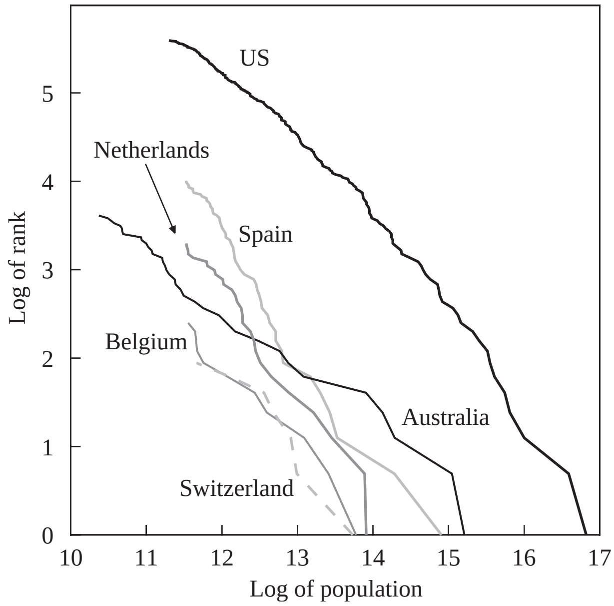
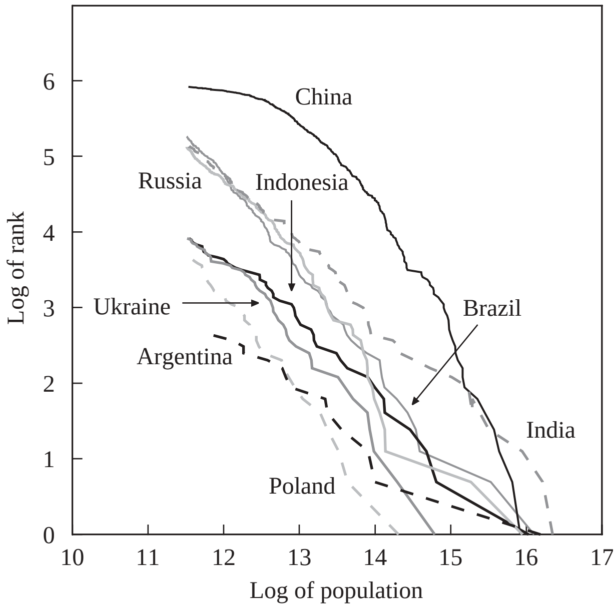



**Figure 3: Rank-size Relationship – Other Developed Countries**




Some empirical support for Zipf's Law has been shown for US cities through time (Krugman 1996; Ioannides and Dobkins 2000), while international evidence has been more mixed (Kamecke 1990). Recent literature on this power law has presented OLS estimates of the slope of this 'Zipf curve' as evidence of the exponent $\zeta$ being 1. Although OLS is not an ideal estimation method when the

**Figure 4: Rank-size Relationship – Developing Countries**




left-hand side variable is the log of an integer, maximum-likelihood estimates give similar results (Kamecke 1990; Urzúa 2000).[9]

Although the evidence is mixed, a power law seems to be a reasonable first approximation of the data for many countries. In contrast, models of city formation based on economic first principles such as the location decisions of workers and owners of capital have generally failed to capture the size distribution seen in the data. For example, Henderson's (1974) model could only generate city sizes that varied at all by introducing different traded-goods industries facing (unexplained) differences in production-function parameters; there was no mechanism for generating the observed power law except by assumption. It would be equally misguided, however, to develop a theory that could only generate a Zipf-type power law distribution.

As indicated in the figures above, the rank-size relationship of Australian cities differs noticeably from the predictions of Zipf's Law, and the relationships seen in other countries. This is confirmed by estimates of the power law exponent ($\zeta$)

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9 The OLS estimates are based on an inappropriate specification of the errors, so their standard errors and *t*-statistics are not meaningful and we have not reported them here. The residuals for both sets of estimates have a cyclical pattern; similar-sized cities tend to have residuals of the same sign. Explaining this is beyond the scope of the paper, but it suggests that there is more to the city-size distribution than a simple power law.

**Table 6: Indicators of City Population Structure**

| | Zipf curve exponent estimates | | Share of urban population in two largest cities | Primacy ratio[(a)] |
|---|---|---|---|---|
| | OLS | MLE | | |
| Argentina | 0.68 | 0.80 | 68.7 | 8.92 |
| Australia | 0.62 | 0.71 | 54.2 | 1.18 |
| Belgium | 0.92 | 1.28 | 47.7 | 1.44 |
| Brazil | 1.22 | 1.19 | 26.8 | 1.77 |
| Canada | 0.82 | 0.82 | 42.6 | 1.35 |
| China | 1.08 | 0.56*** | 4.6 | 1.11 |
| France | 0.98 | 0.92 | 48.8 | 7.38 |
| Germany | 1.28 | 1.31 | 20.0 | 2.04 |
| Indonesia | 0.89 | 0.82 | 35.1 | 3.39 |
| Italy | 1.14 | 1.31 | 27.1 | 1.96 |
| Japan | 1.32 | 1.21 | 15.2 | 2.43 |
| Netherlands | 1.24 | 1.28 | 28.0 | 1.02 |
| New Zealand | 0.74 | – | 59.1 | 2.97 |
| Poland | 1.31 | 1.39 | 21.4 | 1.97 |
| Russia | 1.18 | 1.06 | 19.0 | 1.97 |
| Spain | 1.32 | 1.36 | 28.0 | 1.86 |
| Ukraine | 1.11 | 0.96 | 20.9 | 1.64 |
| United Kingdom | 1.83 | 2.23*** | 19.0 | 6.90 |
| United States | 1.01 | 0.76** | 15.7 | 2.04 |

Notes: MLE estimates exclude New Zealand due to insufficient number of cities. **,*** indicates related Lagrange multiplier test of $\zeta = 1$ rejected at 5 per cent and 1 per cent significance levels.
(a) Ratio of largest city to second-largest. If Zipf's Law is true, this ratio should be 2.

Sources: See Appendix B

for different countries (Table 6). The point estimates for Australia using either estimation method are below that for all the other countries except China, which has a city-size structure completely different from a power law. The plot of log rank against log size for China is nowhere near linear, for reasons we can only speculate about.

Australia's low $\zeta$ implies that city populations are lower further down the rank ordering than Zipf's Law predicts. Indeed, Australia has no middle-sized cities according to the UN definition of between 500 000 and 1 million inhabitants. In 1999, Newcastle, the sixth-largest had around 480 000 residents and Adelaide, the fifth-largest city had 1.09 million. By contrast, Australia's small towns follow

Zipf's Law very closely: estimates of ζ for the set of towns with populations between 5 000 and about 80 000 are very close to 1. This suggests that population growth behaves in roughly the same way across Australia's small towns, but that small towns as a group behave differently from large towns and cities. The result is surprising, given that the literature finds that Zipf's Law usually holds in the *upper* tail of the city-size distribution (Gabaix 1999b).

Why does Australia have so few middle-sized cities, resulting in such a low ζ in the upper tail of the city-size distribution? One circumstance where the estimated Zipf coefficient could be lower than 1 is where smaller cities had lower average growth rates or higher variances of their growth rates than the larger cities. A lower mean growth rate could occur if natural population increase is roughly the same nationwide, but larger cities systematically attract residents away from smaller cities. Similarly, smaller cities might have narrower industrial bases and thus be more susceptible to industrial shocks, leading to population growth having a higher variance than in larger cities (Gabaix 1999b).

### 3.2 The Primate City and Deviations from Zipf's Law

Models of the development of city sizes based on random growth from a common distribution can explain the rank-size rule observed in the population structures of many countries. However, other countries have only one significant city, or a city that is much larger than would be expected based on the Zipf power law. In the geography literature, these are referred to as *primate cities* (Jefferson 1939).[10] Zipf's Law predicts that the largest city in a country should be double the size of the next largest – a good approximation for many countries. In countries with primate cities, however, it can be six to eight times as large as the next-largest city, and well out of line with the power law describing the relative sizes of the smaller cities in that country. The *primacy ratio* is the ratio of the largest to the second-largest city. If Zipf's Law holds, this primacy ratio should be around 2; if it is above 3, the largest city is considered a primate city.[11]

10 Countries with obvious primate cities include Argentina, Denmark, Finland, France, Greece Indonesia, Norway and the United Kingdom.

11 Thresholds for defining primate cities have evolved over time. Jefferson's (1939) original definition of a primate city was one that was more than twice as large as the next-largest city, that is, any upward deviation from Zipf's Law.

Australia is often considered to be a country with no primate city. It is certainly true that Sydney's population is substantially less than twice that of Melbourne. Even if Newcastle, Wollongong and the Central Coast are included in Sydney's population as a single conurbation, Sydney's population is well below what would be predicted from the rank-size relationship of the other cities.

One plausible view of Australia's urban structure is that each state capital is a primate city for its state, and that its population size relative to other state capitals is less relevant. Hill (1974) demonstrated that if the cities in each region of a country follow Zipf's Law, then the rank-size relationship for the whole country will also be approximately consistent with Zipf's Law. As mentioned earlier, the rank-size distribution for Australian towns with fewer than 80 000 inhabitants – that is, smaller than Hobart, the smallest of the state capitals – is close to that predicted by Zipf's Law, but larger cities have a flatter rank-size relationship. This is consistent with Australia's nationwide rank-size relationship being a combination of several state rank-size relations where the largest city is a primate, while all the others follow Zipf's Law. It also clearly suggests that smaller towns are subject to random growth of a common nature, while the state and national capitals evolve according to different forces.

Canada also has a relatively flat rank-size curve and a federal political system. Provincial capitals tend to attract residents from other parts of the province because their positions as the seat of government results in these cities offering employment opportunities in administration and policy that are not available elsewhere.[12] Unlike Australia, the provincial capitals in Canada are not usually the largest cities in the provinces. This may help explain both why Canada's Zipf curve is not as flat as Australia's, and why dwelling prices are lower there; demand pressures on housing from internal migration will be spread over two cities in each province – the economic centre and the political centre. The difference may reflect the history of colonisation by European settlers, and this may help explain the current urban structure.

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12 These opportunities are in addition to the normal range of private-sector occupations seen in a city of that size, rather than a substitute for them. By contrast, manufactured political capitals such as Brasilia, Canberra or Islamabad have narrower employment bases focused on the public sector. This may explain why these capitals do not become primate cities.

Because both these countries have relatively small populations spread over a large area, transport costs and political institutions may have induced multiple centres of economic activity, resulting in the formation of a primate city for each region. In more densely populated countries such as the United Kingdom, transport costs are less important. A single primate city may arise in those countries, but there may be little impetus for others to form, as centralised administrative functions can cover the entire country, without subsidiary regional centres to cover some areas. Ades and Glaeser (1995) found that a relative lack of transport infrastructure tended to foster centralisation into large cities. Sparsely populated countries such as Australia and Canada have fairly sparse transport infrastructure relative to more densely populated developed countries. This may be encouraging the relatively high concentration of these countries' populations into a few cities, albeit on a regional rather than national basis.

### 3.3 Implications of the Urban Structure for Dwelling Wealth

As a rule, primate cities account for a greater fraction of the total population than would a largest city that followed Zipf's Law. Larger cities tend to have more expensive housing than smaller cities, so the national average housing price will be higher as the primacy ratio rises, even if housing prices in individual cities are unaffected by this change. Holding national population fixed, an increase in the primacy ratio (or the concentration of population in the largest city) reduces both the absolute population and relative share of the other cities, which may be expected to reduce their average housing prices. Nonetheless, the national average housing price will rise if the population share of the largest city rises, given reasonable assumptions about the functional form of the relationship between population and housing prices at the city level.[13] This implies that if a primate city exists, or more generally, the population is concentrated in a few large cities, national average housing costs tend to be higher than would be true if Zipf's Law held.

How important is this urban structure effect? Our best guess is that it accounts for about one-third of the difference between the dwelling wealth-income ratios of

13 In particular, this will hold if house prices in individual cities are a rising function of population with a second derivative that is always non-zero; a proof of this is available on request. The result also holds for some cases where $h'' = 0$ at some point.

Australia and the United States. Although this estimate is necessarily rough, we believe it conveys the correct order of magnitude, if not the exact figure.

Recall Figure 1 in Section 2.3, which showed housing price-income ratios for individual cities in Australia and the United States. Other than Sydney, the ratios for Australian cities are only somewhat above the average value for US cities of comparable size, and just above the bounds of US experience. We estimated a line of best fit for housing price-income ratios in US cities, given their populations (this is the trend line shown on Figure 1). We used the fitted values to derive the price-income ratios they implied for cities equal in size to each of Australia's major cities. Multiplying these ratios by a measure of income for each city, comparable to those used in the disaggregated US data, gives a counterfactual price for Australian housing (Table 7). These are the prices that would prevail in Australia if the US relationship between city size and price-income ratios also applied to Australia.

**Table 7: Actual and Counterfactual Australian Dwelling Prices by City**

Per cent to city-level median household gross income, June quarter 1998

| City | Actual house prices | Counterfactual house prices |
|---|---|---|
| Sydney | 6.68 | 3.21 |
| Melbourne | 4.24 | 3.15 |
| Brisbane | 4.75 | 2.92 |
| Perth | 4.72 | 2.87 |
| Adelaide | 4.27 | 2.80 |
| Canberra | 3.35 | 2.49 |
| Hobart | 3.31 | 2.34 |

Sources: See Appendix B

The counterfactual prices can be aggregated along with actual data for non-metropolitan housing prices, to derive a national average dwelling price and thus a counterfactual ratio to disposable income comparable to the figures in Table 2.[14] The difference between this counterfactual price-income ratio and the US figure in Table 2 represents the urban structure effect – the part of the difference

14 To be consistent with the data in Table 2, the weights used to aggregate the city data are slightly different from the population data used in Section 3.1. We also use 1998/99 data for Australia, not the 2000 data shown in Figure 1.

between the two countries' ratios attributable to the greater concentration of Australia's population in larger, more expensive cities. As shown in Table 8, the counterfactual ratio of price to disposable income for Australia is 2.29, implying that the urban structure effect accounts for around one-third of the gap between the US and Australian ratios.

**Table 8: Actual and Counterfactual Dwelling Prices**

| Data | Ratio to survey-based median gross household income | Ratio to national accounts average household disposable income |
|---|---|---|
| US actual data (Flow of funds housing prices, 1997) | 2.76 | 1.63[(a)] |
| US actual data (Realtors housing prices, 1997) | 2.93 | 1.72 |
| Australian actual data | 5.01 | 3.55[(a)] |
| Australian counterfactual data | 3.48 | 2.29 |

Note: (a) These figures are also reported in Table 2
Sources: See Appendix B.

We have made a number of assumptions on the way to obtaining this estimate. Firstly, we used data on prices for detached houses, not all dwellings, in individual US cities from the National Association of Realtors (NAR). Although these seem roughly comparable with the data underlying the flow of funds wealth estimates, we cannot be sure how different they are. However, the difference between average detached house prices and total dwelling prices in Australia is not large, so this probably does not make much difference to the estimated urban structure effect.

Secondly, the non-metropolitan house price data for the US and Australia are not strictly comparable. The NAR does not publish data for non-metropolitan homes (those located in cities with less than 100 000 inhabitants), so we assume a ratio of price to gross income of 1.5 for non-metropolitan areas to derive the national averages shown in the second row of Table 8. This figure seems reasonable: it is roughly comparable with the price-income ratios of the smallest cities in the NAR data and the national accounts estimate in Table 2. However, we cannot make this assumption for non-metropolitan houses in Australia. The non-metropolitan Australian price data (the CBA/HIA's 'Rest of State' series) is highly aggregated and does not distinguish between regional centres (with populations over 100 000) and small towns. Consequently, we use the actual data for the non-metropolitan prices, making the counterfactual a statement about capital-city dwelling prices.[15]

Thirdly, US data on household income by city is from the Current Population Survey which, like Australia's Household Expenditure Survey, reports lower income than the national accounts. The data are also only available as median gross income, not average disposable income. Cross-country differences in the gap between survey measures of income and the national accounts are therefore built into our estimate of the urban structure effect, perhaps inflating it.

Of course, this estimate assumes that the average price-income ratio for cities of the same absolute size is the appropriate basis for cross-country comparison, and that the level of dwelling prices in the US is at an equilibrium. Relative city sizes clearly matter for housing costs within countries, but without city-level dwelling price and income data for a wider range of countries, we cannot say whether dwelling prices vary with absolute population or relative rank. If cities in different countries with the same *rank* should have the same price-income ratio, given preferences and other factors, then we should compare Sydney with New York or Los Angeles, not Houston or Atlanta, as we have effectively done in this paper. In that case, the counterfactual price-income ratio for Sydney would be much closer to the actual value, and our estimate of the urban structure effect would be closer to half the gap between the US and Australian data.

## 4. Deregulation, Disinflation and Housing Wealth Dynamics

The previous sections set out what we believe to be a plausible partial explanation of the current distribution of relative housing prices across countries. If Australia had always had relatively high housing wealth, our story would end there. However, in the early 1980s, Australia's ratio of dwelling prices to income was not obviously different from those in other countries, and Australia's households had much lower debt than households in many other countries. As mentioned earlier, we attribute this to constraints imposed on dwelling prices by high inflation and financial regulation. However, the extent to which housing was tax-advantaged was also important, because that tended to dampen the effects of high inflation

15 This might introduce some upward bias to our counterfactual national average if actual prices are higher than the average US income ratios would suggest. However, we do not have separate price series for these cities, so we cannot tell how important this is.

and regulation. In countries such as Australia, where government intervention in the housing market did not offset the effects of inflation very much, actual dwelling wealth was further from its desired ratio to income prior to deregulation. Therefore, after deregulation and disinflation, these countries had further to travel to reach their desired level of dwelling wealth. The market adjustment in Australia was particularly prolonged, as dwelling prices in the larger cities had to converge to a higher long-run equilibrium, as determined by Australia's urban structure.

When the financial sector is regulated, credit is rationed and households cannot borrow as much as they would like at the current interest rate.[16] Once these constraints are removed, household indebtedness usually rises, as shown in Figures 5 and 6 for eight countries; the period where deregulation took place, marked by a grey band, is frequently followed by a rapid increase in indebtedness.[17] By contrast, Canada has always had a fairly deregulated home loan market (Edey and Hviding 1995; Freedman 1998), and never experienced the rapid run-up in debt seen in Australia, New Zealand, Sweden or the UK, which reflected pent-up demand following the removal of restrictions.

Some of the increase in indebtedness may have been due to existing home owners withdrawing housing equity, for example by refinancing and increasing their mortgages or by taking out a home equity loan. Households could also withdraw equity indirectly, for example if a household that inherits a house that was owned outright sells it to a household that took out a mortgage to make the purchase, and either consumes the proceeds or channels them into non-housing assets. This would result in higher consumption but not necessarily higher dwelling prices. Still, the removal of credit constraints on mortgage borrowers enables some households who previously did not own a home to purchase one, and some existing home owners to upgrade to a better home. This should be expected to result in increased effective demand for owner-occupied housing and therefore upward pressure on dwelling prices.

The rapid build-up in household indebtedness, however, appears to be more closely associated with a reduction in inflation to low levels. Figures 5 and 6 show

[16] Duca and Rosenthal (1994) found that borrowing constraints lowered the US owner-occupation rate by around 8 percentage points, disproportionately affecting young households.

[17] Appendix B contains the sources we used to construct the dates of the period of financial deregulation in each country.

**Figure 5: Deregulation, Inflation and Household Debt**

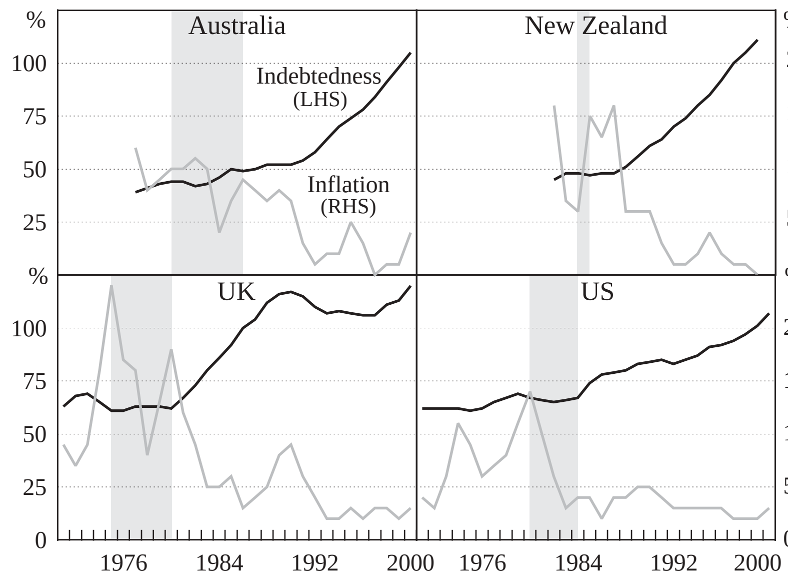
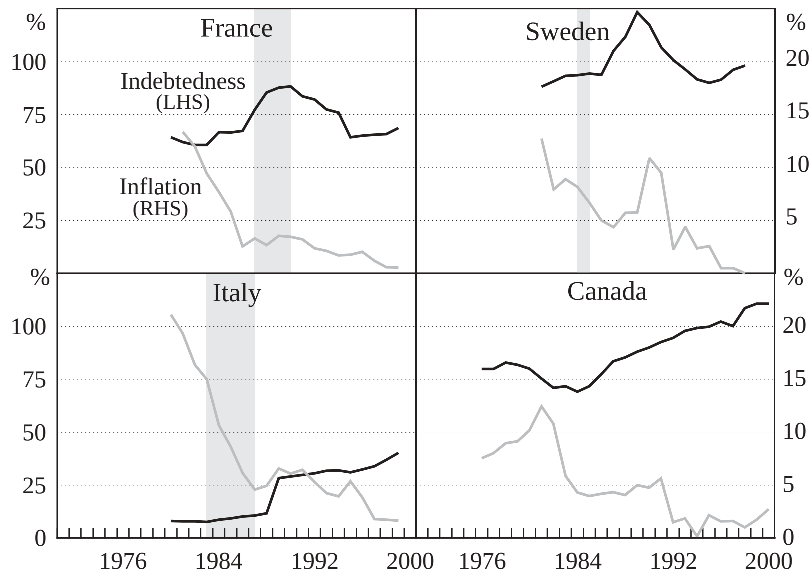



**Figure 6: Deregulation, Inflation and Household Debt**




that the most rapid increases in debt have occurred in Australia, New Zealand and the UK, where disinflation has followed financial deregulation. This suggests that disinflation dominates deregulation as a precondition for rising household debt. It is also worth noting that in Australia, the full benefits of financial deregulation did not accrue to households until the 1990s, with financial intermediaries mainly directing their lending toward businesses in the 1980s (Stevens 1997).

Even with a deregulated financial sector, *high inflation will still constrain household debt* because some imperfections and information asymmetries remain. Mortgage contracts are usually based on regular repayments fixed in nominal terms. Given this, financial institutions will only lend to households as much as they can reasonably service on their current incomes; in Australia, most financial intermediaries impose a maximum loan size corresponding to a repayment-to-income ratio of around 30 per cent. It is the nominal interest rate, not the real rate, that determines this repayment ratio. Therefore the higher is inflation, and thus the higher are nominal rates, the more households are affected by this market imperfection and excluded from the home loan market (Lessard and Modigliani 1975; Stevens 1997). Disinflation will therefore unambiguously increase demand for owner-occupied housing, although this effect may have been dampened in countries such as the United States, where mortgage interest is deductible. Existing home owners will be able to upgrade, current renters will be more likely to be able to move into home ownership, and new households may form as an endogenous response to the reduced costs of mortgage finance.[18] This increased the effective demand for housing, resulting in higher housing prices and a relatively static home-ownership rate.

Deregulation and disinflation certainly affected household debt, but it did not necessarily follow that dwelling wealth-income ratios increased in all countries. Growth in dwelling wealth after deregulation and disinflation largely reflects the difference between its actual level in the regulated period and its putative desired level. The relationship between the actual and desired level was determined by the extent to which distortions in the housing market offset the effects of high inflation and financial regulation. We have already seen that these policies were not uniform across countries (see Table 3). In the presence of credit constraints, mortgage interest deductibility and capital gains exemptions on the family home in the UK and US made dwellings very attractive relative to other investments. This may have worked to offset the effects of regulation and thus closer align actual dwelling

18 Poterba (1984) suggests that the interaction between inflation and mortgage interest deductibility could have explained the strong growth in US house prices during the 1970s. However, demographic factors such as the entry of the baby-boom generation into its house-buying years have also been cited as a potential cause (Mankiw and Weil 1989).

wealth with its desired level. Furthermore, mortgage interest deductibility in the UK and US would have ameliorated the burden that high inflation placed on mortgage borrowers; Britten-Jones and McKibbin (1989) found that changes in mortgage interest deductibility have a much larger effect on the housing market than changes in income taxes. These factors combined to mean that the actual level of dwelling wealth under regulation was possibly closer to its desired level than was the case in Australia.[19] That dwelling wealth-income ratios in the US and UK are currently around their 1980 level is consistent with this point (see Table 2).

Fewer housing market distortions in Australia and New Zealand made the relative constraint placed on dwelling wealth by high inflation and financial regulation more binding. These constraints seem to have disproportionately affected cities that would otherwise have had high housing costs. The suppression of this urban structure effect widened the gap between actual dwelling wealth and its desired level. It took financial deregulation and disinflation to release this effect, and since then dwelling prices have responded accordingly, with the largest increases seen in Sydney and more recently Melbourne. It is therefore possible that national average dwelling wealth has been able to rise to its long-run level, now that housing prices in these cities are no longer constrained by these regulations. This may explain why Australia's dwelling wealth-income ratio has increased relative to other countries, from around the international average to well above it.

On the other hand, if the combined effects of high inflation and financial regulation had kept housing prices artificially low, they may also have had an effect on the current composition of the dwellings stock. These constraints on purchase prices would have affected building costs very little, so most of the effect would have manifested in land prices. Although home buyers may have been constrained from paying as much as they would in a deregulated environment, the artificially low land prices might have allowed inframarginal home buyers to purchase a higher-quality home than they would if prices had been higher. In particular, they might have been able to purchase a home that used more land. This might go some way to explaining the greater prevalence of detached houses in the Australian housing stock which, as alluded to in Section 2.2, might indicate a

[19] In the UK, some of this incentive would have been undermined by the existence of a large public-housing sector. Pent-up demand for dwellings was unleashed in the late 1980s when some public housing was privatised (Henley 1999).

more land-intensive component to past demand for new housing than occurred in other countries.

Because the stock of housing greatly exceeds the flow of new building, it takes a long time for the characteristics of the stock to adjust to structural change such as a new post-deregulation equilibrium price. Therefore although the equilibrium price of housing may have risen following these changes, the aggregate value of the housing stock might be above its long-run level because the composition of the housing stock is yet to adjust fully. Now that land prices are no longer held down by inflation and financial regulation, people will tend to choose less land-intensive housing than in the past, supporting the trend to medium-density housing, especially in the larger cities.

## 5. A Two-factor Model of City Populations

As discussed by Krugman (1996), models generating power laws for their size distributions generally involve the interplay of a *centripedal* force encouraging population into large agglomerations, balanced by a *centrifugal* force such as congestion costs, that limits this tendency to agglomeration. In this section, we outline a simplified model that generates Zipf's Law for some parameter values, primate cities for others, and flat rank-size relationships similar to that in Australia for others.[20] Although this model clearly excludes some important details of the evolution and growth of cities, it captures some essential features that may generate insights about the forces driving both the urban structure and relative housing costs seen in Australia.

The household location decision involves a trade-off in which households compare the employment benefits that large cities offer, against the increased costs of congestion, proxied by high dwelling prices. In our model, two types of firms demand labour: local and national firms. Local firms sell only into the city market they are in, and compete only with other firms in that city. The number of such firms is random but roughly proportional to city populations. National firms on the other hand sell into the entire national market and locate so as to minimise transport and land costs. This creates a tendency for national firms to locate in the largest city and fosters the formation of large agglomerations, although this

[20] The details of the model are provided in Appendix A.

is partly offset by land costs which we proxy by housing costs. However, the size of cities is constrained by housing costs, which rise with population size. Since households prefer to minimise commuting times, they are willing to pay a premium to live close to the city centre. This tends to raise housing prices as the city grows, discouraging the formation of large agglomerations.

The relative importance of these two effects depends upon two key parameters: the share of national firms in the economy (β) and transport costs (θ). Our model assumes the birth rate in city *i* is a random variable that has a common variance across cities and a mean that is scaled by attractiveness of that city relative to the national average of all cities. For each pair of values for the parameters β and θ, we conduct 500 simulations, each of 500 periods for a country of 100 cities. When the share of national firms is small, we can generate rank-size relationships consistent with Zipf's Law. However, as β and θ rise, the Zipf curve tends to flatten as the largest city commands an increasing share of the population and the national average house price rises. This distinguishes our model from previous random growth models which could only generate city size distributions consistent with Zipf's Law, and not deviations from it. Moreover, our model of city formation captures the Australian experience: countries with relatively small populations (high β) spread over large distances (high θ) will have more concentrated populations and higher average housing costs than countries without these characteristics.

## 6. Conclusion

Economic researchers have long recognised the potential for demographic factors to drive medium-term outcomes in the labour market and financial asset returns. This paper argues that *spatial* aspects of demography are important for the level of non-financial wealth and housing costs. We argue that Australia's flat Zipf curve is a result of its federal political system and sparse population, which interact to produce multiple primate cities. The relationship between these primate cities arises because some serve as national centres to a greater extent than others, and therefore attract relatively more population from the small towns than do the smaller primate cities (state capitals).

The link from urban structure to average dwelling prices is more subtle. Given that large cities have higher housing costs, the argument that national average dwelling prices will be higher in countries with a larger share of their population concentrated in large cities would seem to be a matter of arithmetic. However, this cannot be the only explanation of the pattern of Australia's household wealth – otherwise, we would see Canada's wealth having a similar composition and Germany's less similar. Sweden would have had a much higher share of dwelling wealth had it not been for its large public and co-operative sectors holding market dwelling prices down.

If our arguments about the link between urban structure and national average dwelling prices are right, we would expect that dwelling wealth will be higher relative to income in Australia than in other countries, in the long run. This implies that housing debt-income ratios could be higher in equilibrium in Australia than elsewhere, without this being a cause for concern. If so, the rapid build-up of housing indebtedness over the 1990s may still have some way to go. Nonetheless, growth in housing prices and debt will still have to level out at some stage, to match nominal income growth in the long run. As has already occurred in New Zealand, the windfall gains that accrued to home owners over the 1980s and 1990s will ultimately end.

However, our estimate of the effect of urban structure on dwelling wealth accounts for only one-third – or at best, one-half – of the gap between Australian and US dwelling wealth-income ratios. This may suggest that dwelling prices *are* too high in Australia and must ultimately fall relative to household income. Fortunately, the prospect of a sudden crash in dwelling prices similar to that seen in the UK in the early 1990s seems remote. Australia's unusually high dwelling wealth-income ratio has built up over fifteen years, not in a brief period of speculation, and the specific circumstances that contributed to that boom-bust cycle do not apply here (Muellbauer 1992; Henley 1999; Bean 2000). It would seem more likely that such an adjustment would occur through an extended period of slow or zero growth in dwelling prices, and perhaps partly through a shift in the composition of the dwelling stock towards higher-density homes rather than prices of particular dwellings falling. Whether that adjustment caused financial distress in some segments of the household sector would depend on whether households had over-extended themselves, in the erroneous belief that dwelling prices would continue to grow strongly.

Given the urban structure of Australia and the concentration of high-income employment opportunities in just two cities, it seems likely that Australia will continue to have a pattern of household wealth being concentrated in dwellings. This has important implications for macroeconomic factors such as savings-investment balances, provision for retirement and the growth in and distribution of wealth.

Finally, the level shift in residential land values that occurred over the past 15 years must have had implications for intergenerational wealth distribution. Households that owned homes before financial deregulation experienced windfall gains in their dwelling wealth that will not be enjoyed by subsequent generations. While inheritance will even out some of this redistribution in the future, the difference between average age of home purchase and average age of inheritance implies that these changes will still affect wealth holdings and saving behaviour over households' life cycles, with home purchase possibly occurring later in life than is common today.

# Appendix A: A Model of City Formation and Dwelling Prices

## Cities

There are $N$ cities, with city $i$ located at position $l_i$ having population $P_i$ and share of total population $p_i \equiv P_i/P$ where $P \equiv \sum_i P_i$. The cities are randomly placed around a circle, implying $0 \leq l_i < 2\pi$. This simplifies the analysis while at the same time being a reasonable approximation of Australia's geography. The distance between cities is therefore:

$$d(i,j) = \min(|l_i - l_j|, |2\pi + l_i - l_j|) \tag{A1}$$

For the purpose of this paper, we assume that city locations are fixed. However, it may be possible to use models such as Krugman's (1996) to extend our model to allow city locations to be endogenous. We leave this task to future research.

## Firms

There are two types of firm, local and country-wide.[21] Firms are of equal size, with the number and share of local firms in city $i$ denoted $F_i$ and $f_i$, and similarly $C_i$ and $c_i$ for national (country-wide) firms. We denote the share of national firms in total firms as $\beta$.

$$\beta \equiv \frac{C}{F+C} \tag{A2}$$

Local firms ($f$-firms) sell only into the city market they are in, and compete only with other firms in that city. Therefore their location decisions are driven by the relative size (population share) of each city, and also influenced by the number of local firms already in that city. The probability that a new local firm will choose to locate in city $i$ is assumed to be proportional to:

$$\left(\frac{p_i}{f_i}\right)^{\alpha} \cdot p_i, \quad 0 \leq \alpha \leq 1 \tag{A3}$$

where $\alpha$ is an index of the intensity of competition or substitutability of the new firms' output with the output of firms already in city $i$.

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21 This distinction is a variant of the approach taken by the existing literature. For instance, Krugman (1996) assumes two sectors: a geographically immobile sector (agriculture) and an increasing returns, monopolistically competitive, geographically mobile sector (manufacturing).

If $\alpha = 0$ (local firms are monopolists selling differentiated goods), the model reduces to a standard Bose-Einstein occupancy problem where growth in $F_i$ is roughly proportionate to city $i$'s population (Hill 1974). If $\alpha > 0$, growth in $F_i$ is less than proportionate to $P_i$ when $f_i > p_i$ and more than proportionate when $f_i < p_i$. In the limit, $f_i$ will converge to $p_i$ and growth in the number of firms will display the random proportionate growth required for Gibrat's Law to hold. Therefore, $\alpha$ does not affect the limiting behaviour of the model, but will help determine its speed of convergence.

National firms ($c$-firms) sell into the entire national market and are not affected by the location decisions of their competitors. New firms of this type locate so as to minimise transport costs, which are assumed to be proportional to distance, and land rent, which is assumed to be proportional to average dwelling price, $h_i$. The choice for these national firms is to choose city $i$, where $i$ minimises

$$\sum_{j=1}^{N} \theta\, d(i,j) p_j + h_i \tag{A4}$$

The parameter $\theta$ represents transport costs per unit distance. Since $d(i,i) = 0$, (A4) implies that most firms of this type will locate in the largest city, unless the largest city is a long way from the rest of the population or land prices are particularly high. We can interpret local firms as those in service and retail industries such as restaurants, doctors, supermarkets and so on, while national firms are likely to be in industries such as finance or manufacturing.

**Housing costs**

Households prefer to minimise commuting time and will therefore pay a premium to live closer to the city centre. Assuming commuting times are linear in distance, and that the premium paid for location is proportional to commuting time, then house prices $h$ vary linearly with distance from the centre, $r$. This is similar to the early models of intra-city housing costs (Mills 1967; Muth 1969), although in those models prices decline at a decreasing rate with distance from the centre.

$$h(r) = \psi(R - r) \tag{A5}$$

In (A5), $R$ is the maximum extent of the city, and the price of housing at the fringe, $H = h(R)$, is set to zero for simplicity. Housing costs that are declining in distance from the centre fit in with the von-Thünen-Mills models of land rent and allocation around a central place (Mills 1967). If the city is circular, its area – equivalently, population or number of dwellings – is $P_i = \pi R^2$. There are $2\pi r$ dwellings at radius $r$. Therefore the city's average housing price, $h_i$ varies with the square root of its population.

$$h_i = \frac{\int_0^R h(r) 2\pi r \, dr}{\pi R^2} = \frac{\psi \int_0^{P_i} \sqrt{P_i - a} \, da}{P_i \sqrt{\pi}} = \frac{\psi \sqrt{P_i}}{3\sqrt{\pi}} \tag{A6}$$

This functional form depends on the assumption of a fixed floor for housing prices; prices at the very fringe of the city do not depend on the size of the city. It is also possible that commuting times will vary more than proportionately with distance from the centre, due to congestion. Alternatively, the development of edge cities and increasing prevalence of employment opportunities in the suburbs could mean that congestion costs rise less than proportionately with population (Krugman 1995). However, this will not reverse the central result that average housing prices are higher in larger cities, and that national average housing prices are higher when the population is concentrated in a few centres. In the simulations below, we define $h_i$ as $\sqrt{P_i}$, effectively setting the scaling factor $\psi$ to $3\sqrt{\pi}$.

**Household location decisions**

We assume a city's attractiveness to households depends on three factors: the availability of jobs, the absolute population of the city and the average level of housing costs. We measure the availability of jobs by $((1-\beta) f_i + \beta c_i)/p_i$. The direct inclusion of city populations is intended to account for the observed wage premium seen in larger cities (Glaeser and Maré 2001). This may reflect either that search costs are lower in larger labour markets, or that larger markets allow for greater specialisation, which raises wages. In addition, larger cities have more diverse industrial structures and thus may be attractive locations to a wider range of workers (Gabaix 1999b).

Housing costs work against these forces encouraging greater agglomeration. Although there may be other disadvantages to living in large cities, such as congestion, pollution and crime, we take housing costs as a proxy for all of these costs, given that they are monotonic in city population. Since the attractiveness of a city, $u(\cdot)$ represents the utility it offers to its residents, we assume that it has a fairly standard functional form, the Cobb-Douglas function. This ensures declining marginal utility of absolute city size.

$$u_i = \left( u\left(\frac{(1-\beta) f_i + \beta c_i}{p_i}, P_i, h_i\right) \right) = \left( \frac{(1-\beta) f_i + \beta c_i}{p_i} \right)^{\lambda} P_i^{1-\lambda} h_i^{-\mu},\ 0 < \lambda, \mu < 1 \qquad \text{(A7)}$$

Following Gabaix (1999a), we assume that in each period $t$, $g_t P$ new households are born and $\delta P$ households die; the death rate $\delta$ is constant across time and across cities.[22] Total births nationwide are random, with the growth rate $g_t$ distributed lognormally with mean $\gamma$ and a variance that depends on $\sigma^2$. The allocation of new households to cities is determined by the attractiveness of that city relative to the national average of all cities. This relative attractiveness is scaled so that their weighted sum equals one. Suppressing the time subscripts, we have:

$$U(i) \equiv u_i / \sum_{j=1}^{N} p_j\ u_j \qquad \text{(A8)}$$

We define the birth rate in city $i$, $g_{it}$ as a lognormal random variable with common variance $\sigma^2$ and a mean that is scaled by the relative attractiveness of that city in that period. The scaling factor used in the definition of relative attractiveness (A8) ensures that the mean growth rate for the total population equals $\gamma$.

$$g_{it} = \gamma U(i)_t \qquad \text{(A9)}$$

Importantly, we do not assume that all (new) households move to whichever is the most attractive city, as this would result in the system having unstable dynamics. Depending on the relative importance of housing costs versus employment opportunities, either the largest city would then increase without limit while the other cities fade away at rate $\delta$, or the smallest, cheapest, city would attract all the new population and become large. If the smallest city attracts the population, it is then no longer the most attractive city, and the city that had previously been the second-smallest attracts all the new population in the following period. The functional forms for the utility and housing-price relations used here result in the net effect of rising population on its relative attractiveness varying with $P_i^{1-\lambda-\mu/2}$. If $1-\lambda$ is very different from $\mu/2$, the (unbounded) city population effect dominates the effect of job availability in the long run. This does not

22 We assume that each household contains one person.

materially distort the simulation results presented below, as the net effect of city population remains fairly small for the range of populations considered.

By contrast, allowing random growth in all cities captures the reality of the process of birth or household formation, while allowing households to respond to economic forces by having some change location. Random growth with a mean depending on economic factors effectively captures moving costs – it is not always advantageous to move to the most attractive city – and unobserved heterogeneity – not everyone will want to move even if it would benefit the median new household. Alternatively, these costs and individual variation could be modelled, but only by adding many free parameters and functional forms without much theoretical guidance to pin them down. In our view, this would add complexity to the model without adding much explanatory power.

One final adjustment is required to prevent city populations from being zero. The actual increase in population in each city is defined as:

$$P_{it} - P_{it-1} = g_{it}P_{it-1} - \delta P_{it-1} + \varepsilon \qquad \text{(A10)}$$

where $\varepsilon$ is a small positive number which we set equal to 1. Gabaix (1999b) showed that random proportionate growth with a lower bound on population, which he termed a *Kesten process*, will generate Zipf's Law in the upper tail of a size distribution.

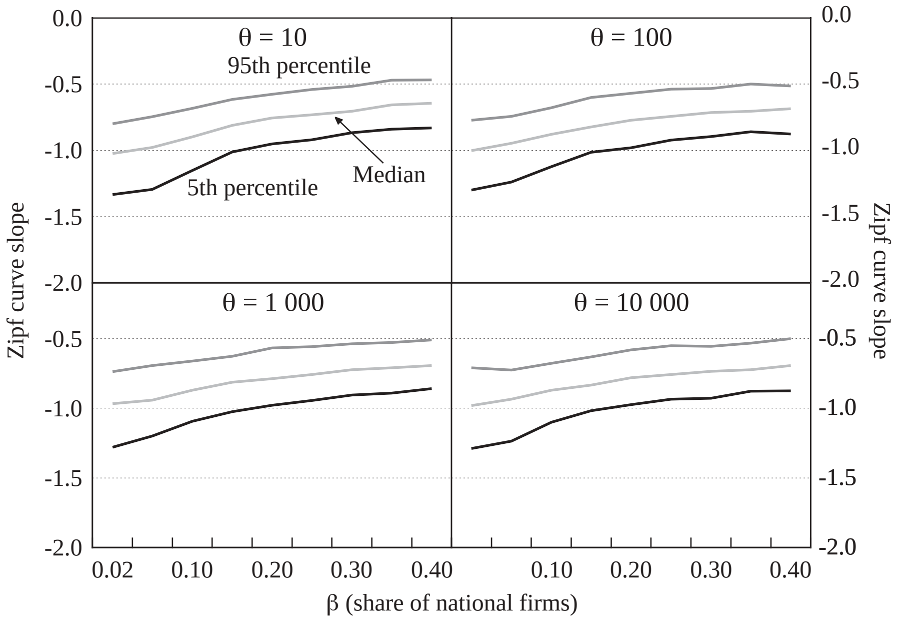
**Simulation results**

The results in this Appendix are based on an extensive exploration of the model for a range of parameters. For each pair of values for the parameters $\beta$ and $\theta$, we conducted 500 simulations, each of 500 periods for a country of 100 cities. The $\alpha$ parameter does not affect the long-run results, so we set it to 0.5 throughout. The mean birth rate $\gamma$ was set to 0.03 and the death rate $\delta$ to 0.02. The parameters in the household utility function are $\lambda = 0.9$ and $\mu = 0.15$, so large cities are on balance more attractive than smaller ones even when the labour market in each city is in equilibrium. Similar results are obtained within a significant neighbourhood of these parameter values. The figures below show the median final-period outcome and the 5th and 95th percentile of those 500 cases, for dwelling prices, the largest city's share of the total population and the slope of the 'Zipf curve', or log rank-log size relationship, for the top 50 cities. We find that the rank-size relationship tends to flatten out after this point. This is in line with the finding that random growth generates Zipf's Law in the upper tail of the distribution, but not necessarily for the whole sample (Gabaix 1999b; Hill 1974); a simple Kesten process as in Equation (A10), where $g_{it}$ is a random variable drawn from a common distribution, will generate a Zipf curve with a linear segment covering about half to two-thirds of the sample.

If the share of national firms in the economy β is small, say, less than about 0.05, our model generates rank-size curves roughly consistent with Zipf's Law (Figure A1). As β rises, the simulations tend to generate flatter Zipf curves, with slopes around 0.5–0.7. With β above about 0.4, a primate city is almost guaranteed (Figure A2).

**Figure A1: Simulation Results – Zipf Curve Slope**

50 largest cities




As expected, increasing importance of national firms (β) and transport costs (θ) both result in the largest city having a larger share of total population. Flatter Zipf curves and large primate cities imply higher national average dwelling prices (Figure A3). This seems in line with Australia's situation: countries with relatively small populations (high β) spread over large distances (high θ) will have more concentrated populations and higher average housing costs than countries without these characteristics.

**Figure A2: Simulation Results – Share of Largest City**

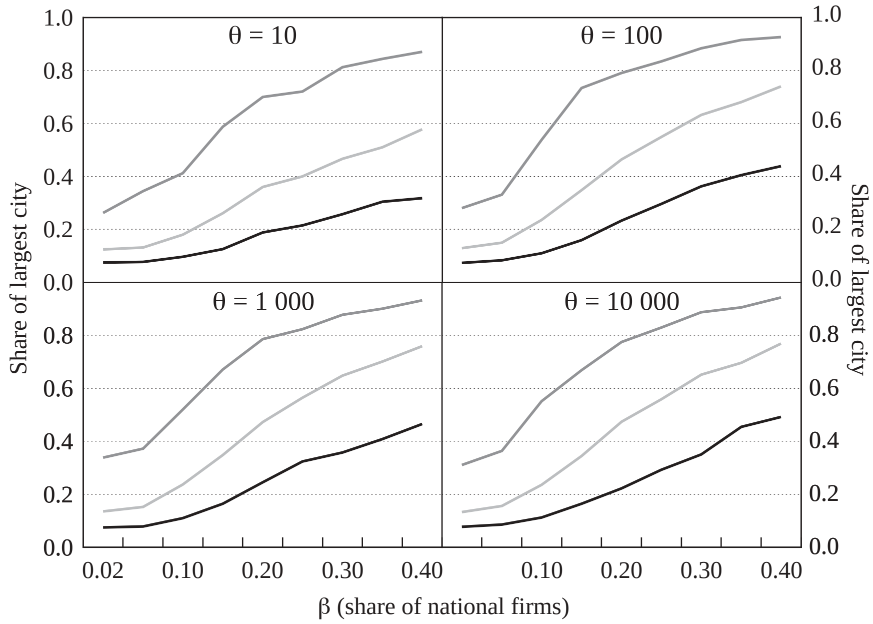
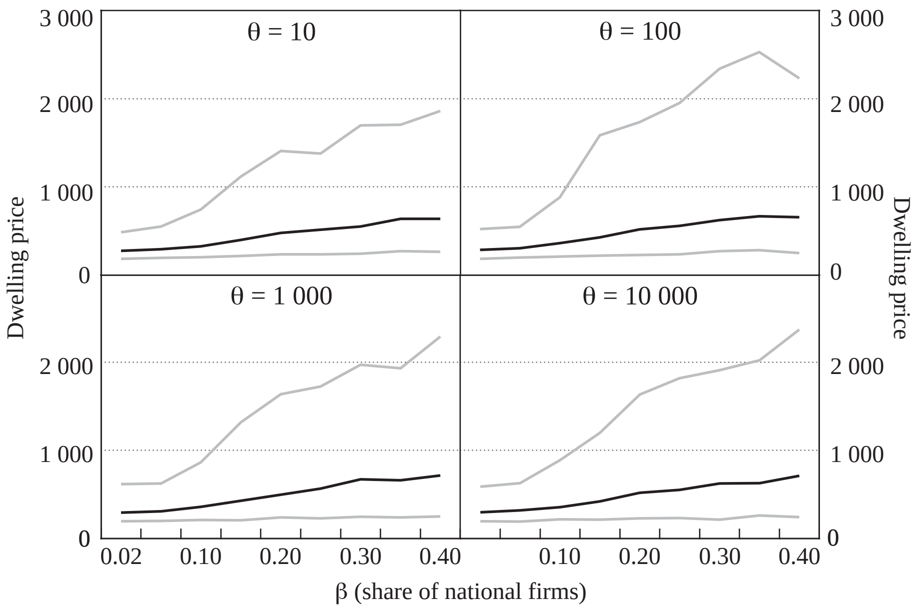



**Figure A3: Simulation Results – National Average Dwelling Prices**




The model we have used is not a complete model of city formation. In particular, we have left many stylised features of the economics of cities as exogenous factors, such as the wage premium paid in large cities. The location decisions of households and firms are assumed to depend only on current-period payoffs. In a more complex model, agents would be forward-looking instead of myopic, but as Neary (2001) argues, and Baldwin (1999) demonstrates for the core-periphery model, this added complexity does not affect the model's comparative-statics predictions. We also generated the higher housing costs in larger cities observed in Section 2.3 by geographic construction; a more sophisticated model would allow residents to respond to housing costs by endogenously adjusting the size and quality of new dwellings. Although random birth of households is biologically justifiable, the random allocation of local firms ($f$-firms) is less justifiable on economic grounds. Recent research has developed models that can explain these features as endogenous outcomes of microeconomic behaviour, at the cost of considerable extra complexity and computational burden (Axtell and Florida 2001). Nonetheless, our model illustrates that a few simple variations on a random-growth model can generate rank-size distributions that match the data for a range of countries reasonably well.

# Appendix B: Data Sources

## Population

For Australia, *Australian Demographic Statistics*, ABS Cat No 3101.0 (March 2000 release). Population of all towns and cities with more than 4 900 inhabitants from the 1996 Census, available at <URL:http://www.abs.gov.au>. For Canada, data are estimates for 1999, taken from the Statistics Canada website, available at <URL:http://www.statcan.ca/english/Pgdb/People/Population/demo05.htm>. For New Zealand, data are from the 1996 Census (Statistics New Zealand). For the United States, MSA and CSMA population data for 1999 were taken from the Bureau of Census website, available at <URL:http://www.census.gov>. For all other countries, city population data from the United Nations Statistics Division Population Database, available at <URL:http://www.un.org/Depts/unsd/demog/ctry.htm>.

## Table 3

***Mortgage interest deductibility:*** OECD (1994).

***Capital gains tax exemption:*** OECD (1994).

***Share of public housing:*** Australia [1999]: *Australian Social Trends*, ABS Cat No 4102.0; Canada: Statistics Canada website; France, Germany, Italy, Sweden, United Kingdom: European Parliament (1996); Japan [1998]: *1998 Housing and Land Survey of Japan*, Statistics Bureau and Statistics Center; New Zealand: Statistics New Zealand [1996 Census] and Ministry of Housing; United States [1997]: authors' calculation based on the number of public housing units reported by the US Department of Housing and Urban Development and the total housing stock from *American Housing Survey 1999*.

***Home ownership rates:*** Australia [1999]: ABS Cat No 4102.0. Canada: Statistics Canada [Census and related data 1999]; France [1996], Germany [1998], Italy [1991], United Kingdom [1998]: Haffner and Dol (2000); Japan [1998]: *Housing of Japan*, Statistics Bureau and Statistics Center; Sweden: Oswald (1999); New Zealand [1996]: Statistics New Zealand [1996 Census]; United States [1999]: US Census Bureau.

**Table 4**

***Persons per room:*** United Nations Statistics Division, available at <URL:http: //www.un.org/Depts/unsd/social/housing.htm>.

***Average existing dwelling size:*** Australia: authors' calculation based on floor space per person for Melbourne from the USAID Housing Indicators Project [1993] and persons per household from ABS Cat No 4102.0; Canada [1985]: Canada Mortgage and Housing Corporation; France [1996], Germany [1998], Italy [1985], Sweden [1997]: Haffner and Dol (2000); Japan [1998]: *1998 Housing and Land Survey of Japan*, Statistics Bureau and Statistics Center; New Zealand [mid 1990s]: Valuation New Zealand Sales Data as cited in Bourassa and Hoesli (1999); United Kingdom: *English House Condition Survey 1996*, Department of Environment, Transport and the Regions; United States [1997]: *American Housing Survey 1999*, Census Bureau.

***Average new dwelling size:*** Australia [1999]: ABS Cat No 4102.0; France [1998], Germany [1999], Italy [1996], Sweden [1998], United Kingdom [average 1980–1996]: Haffner and Dol (2000); Japan [1998]: *1998 Housing and Land Survey of Japan*, Statistics Bureau and Statistics Center; United States [1999]: National Association of Home Builders.

***Proportion of dwellings houses:*** Australia [1998]: ABS Cat No 4102.0; Canada: Statistics Canada [Census and related data 1999]; France [1996], Germany [1998], Sweden [1998]: Haffner and Dol (2000); New Zealand [1996]: Statistics New Zealand; United Kingdom [1996]: *English House Condition Survey*; United States [1997]: *American Housing Survey 1999*.

***Proportion of dwellings detached:*** Australia [1998]: ABS Cat No 4102.0; Canada: Statistics Canada [Census and related data 1999]; Germany [1997]: Miron (2001); Japan [1993]: Building Council of Japan (1998); New Zealand [mid 1990s]: Valuation New Zealand Sales Data as cited in Bourassa and Hoesli (1999); United Kingdom [1996]: *English House Condition Survey*; United States [1997]: *American Housing Survey 1999*.

***Dwellings with six or more rooms:*** Australia [1999]: *Australian Housing Survey*, ABS Cat No 4182.0; Canada [1996], France [1996], Germany [1997], United Kingdom [1996/97], United States [1997], New Zealand [1996]: Miron (2001).

***Dwellings built since 1980:*** Australia: authors' calculation based on Census data and building completions (ABS Cat No 8752.0); France [1996], Germany [1998], Sweden [1990], United Kingdom [1996]: Haffner and Dol (2000); Japan [1998]: *1998 Housing and Land Survey of Japan*, Statistics Bureau and Statistics Center; United States [1997]: *American Housing Survey 1999*.

**Figure 1, Table 5, Table 7 and Table 8: Actual and Counterfactual Dwelling Price-Income Ratios**

***Australian housing prices by city:*** CBA/HIA *Housing Report* and, for Hobart, Real Estate Institute of Australia. The data in Figure 1 are for December 2000. The data in Tables 5, 7 and 8 are for June 1998.

***Australian median household gross income by city:*** *ABS Household Expenditure Survey 1998-1999* (median income provided as a special data service). In Figure 1, income is deflated by national accounts gross household income (ABS Cat No 5206.0).

***Australian average household disposable income:*** *National Income, Expenditure and Product*, (ABS Cat No 5206.0). The number used is an average of quarterly data for 1998.

***US housing prices by city:*** National Association of Realtors, available at <URL: http://nar.realtor.com/databank/ehsmet.htm>.

***US national average housing prices:*** Mylonas *et al* (2000).

***US median household gross income by city:*** Census Bureau Current Population Survey, Small Area Income and Poverty Estimates for 1997, available at <URL:http://www.census.gov/hhes/www/saipe/stcty/estimate.html>.

***US average household disposable income:*** *Survey of Current Business May 2000*, Table 2.1, Bureau of Economic Analysis, Department of Commerce; US Census Bureau Household and Housing Unit Estimates 1998, available at <URL:http://www.census.gov/population/estimates/housing/sthuhh1.txt>.

**Figures 5 and 6: Dates of Financial Deregulation**

The dates of financial deregulation correspond to the period when interest rate ceilings on deposits and loans, and quantitative restrictions on bank lending were lifted in each country.

***Australia:*** Battellino and McMillan (1989).

***Canada:*** Edey and Hviding (1995); Freedman (1998); Germany and Morton (1985); OECD (2000).

***France, Italy and Sweden:*** OECD (2000).

***New Zealand:*** OECD (2000); Margaritis, Hyslop and Rae (1992).

***United Kingdom:*** Germany and Morton (1985); OECD (2000).

***United States:*** Edey and Hviding (1995); Jaffee and Stiglitz (1990); Mehrez and Kaufmann (1999).

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