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Spatial Price Differences and Inequality in China:

Housing Market Evidence

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Abstract

The large literature on regional inequality in China is hampered by incomplete evidence on price dispersion across space, making it hard to distinguish real and nominal inequality. The two main methods used to calculate spatial deflators have been to price a national basket of goods and services across China's different regions or else to estimate a food Engel curve and define the deflator as that needed for nominally similar households to have the same food budget shares in all regions. Neither approach is convincing with the data available in China. Moreover, a focus on tradable goods like food may be misplaced because of the emerging literature on the rapid convergence of traded goods prices within China that contrasts with earlier claims of fragmented internal markets. In a setting where traded goods prices converge rapidly, the main source of price dispersion across space should come from non-traded items, and especially from housing given the fixity of land. In this paper we use newly available data on dwelling sales in urban China to develop spatially-disaggregated indices of house prices, which are then used as spatial deflators for both provinces and core urban districts. These new deflators complement existing approaches that have relied more on traded goods prices, and are used to re-examine the evidence on the level of regional inequality. Around one-quarter of the apparent spatial inequality disappears once account is taken of cost-of-living differences.

1. INTRODUCTION

The large literature on regional inequality in China is hampered by the limited evidence on price dispersion across space, which makes it is difficult to distinguish real inequality from nominal inequality. In common with statistical agencies in most countries, China's National Bureau of Statistics (NBS) does not publish a spatial price index that allows cost-of-living comparisons over space. Instead, the focus is on the temporal Consumer Price Index (CPI), which is reported at both national and provincial level, and there are also separate CPIs for rural and urban areas at both the national and the provincial level. These CPIs allow rates of change in the consumer price level to be compared across different locations but do not allow comparisons of absolute price levels or of the cost-of-living between locations.

Yet there are good reasons to suspect that price levels and the cost-of-living vary over space. A higher price level is expected in more productive, richer, economies (Balassa 1964; Samuelson 1964). The same pattern likely holds within countries because typically productivity growth is stronger in the traded sector than the non-traded sector. If wages in the traded sector rise with productivity while non-traded sector wages are pegged to those in the traded sector (both sectors compete for workers in the same labor market) then prices of non-traded items will grow faster than productivity and will rise in real terms. The overall price level is an average of traded and non-traded prices, so in the context of China's regions, this implies a higher overall price level in export-oriented, coastal provinces in which nominal income is higher, such as Guangdong, than in poorer, inland, provinces, such as Yunnan.

The implications of this pattern are worth emphasizing in China where there is substantial debate about the impacts of economic reform on inequality. A common claim in the literature is that spatial inequality rose in the reform era, especially when policy neglected the rural sector (Fan, Kanbur and Zhang 2011). This claim has fuelled initiatives by China's leaders to help seemingly laggard regions catch up to seemingly advanced regions, including the West China Development Project (Lai 2002), the Northeast China Revitalization Campaign (Zhang 2008) and the Rise of Central China Plan (Lai 2007). Just a subset of these initiatives saw more than one trillion Yuan (US$180 billion) of state-led infrastructural investment directed to western China (Yao 2009). But without reliable measures of spatial price differences, it is not clear how much of the reported spatial inequality, and its claimed increase, is just due to regional price variation versus how much reflects differences in real incomes.

In this paper we use newly available data on dwelling sales in urban China to develop spatially-disaggregated indices of house prices, which are used as spatial deflators for provinces, urban prefectures, and urban core districts. Since we account for only one source of cost-of-living variation over space, the impacts on inequality that we find when using these deflators should be considered a conservative, lower bound. Our approach contrasts with the

two main methods previously used to calculate spatial deflators in China, where either a national basket of goods and services has been priced in different regions or else a food Engel curve has been estimated and a deflator derived as that which is needed for nominally similar households to have the same food budget shares in all regions. Neither approach is convincing with the data available in China, as we explain below. Moreover, a focus on traded goods like food may be misplaced because of the emerging literature on the rapid convergence of prices within China that contrasts with earlier claims of fragmented internal markets.

It is increasingly reasonable to expect integrated goods markets in China, and for goods prices to obey the law-of-one-price (net of transport costs) but the same is not true of housing services. Because of the fixity of the land supply, accounting for regional differences in housing service prices is fundamental to the calculation of spatial differences in the cost-of-living. While other services also are considered non-tradable, for many of these the long-run supply of the dominant factor of production can spatially adjust to reduce inter-regional price differences. For example, if haircuts are relatively more expensive in urban areas of the Pearl River Delta, hairdressers might be expected to migrate to that region to increase the supply and reduce the regional price premium. There is no similar migration possibility for land – the presence of abundant land (relative to population) in Western China and consequently relatively low house prices in that region can do nothing to moderate the high cost of housing in Beijing.

Our focus on housing costs as the main driver of spatial cost-of-living differences is supported by previous studies in other countries. According to Moulton (1995, p.181): 'the cost of shelter is the single most important component of interarea differences in the cost-of-living.' Similarly, Massari *et al.* (2010) find housing prices account for almost 70 percent of cost-of-living differences between Northern and Southern Italy. Our approach is perhaps most closely related to Jolliffe (2006), who examines how adjusting for cost-of-living differences between metropolitan and nonmetropolitan areas in the United States causes a complete reversal of the poverty ranking of these areas. In order to measure poverty using spatially deflated data, Jolliffe uses the Fair Market Rent (FMR) index, which consists of just two components: housing expenses (with a weight of 0.44), and all other goods and services (weight of 0.56). This FMR index assumes that cost-of-living variation over space reflects variation in housing prices only, and that there is no variation over space in the prices of all other goods and services.[1]

The remainder of the paper is structured as follows. Section 2 reviews the literature in three areas that help to inform this study: spatial deflation studies; market integration studies;

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[1] Specifically, the FMR is based on housing prices for the poor, defined as the cost of gross rent (including utilities) at the 40th percentile for standard quality housing.

and, housing market studies. Section 3 describes the data that we use to create housing-related spatial deflators for China. One concern with using dwelling prices as an indicator of cost-of-living differences is that dwelling quality may vary systematically across space, so in Section 4 we discuss the nature of real estate development in China and provide some empirical evidence on the importance of location effects relative to dwelling characteristics in determining housing prices. The calculation of the deflators is described in Section 5 and the results are contrasted with other spatial deflators for China. The impact of using the deflators when measuring spatial inequality is discussed in Section 6, while the conclusions are in Section 7.

2. PREVIOUS LITERATURE

The approach we use here, of constructing spatially real income by deflating only for housing costs, relies on literature for China that is drawn from three distinct areas: spatial deflation studies; market integration studies; and, housing market studies. Our overall goal is to contribute to the literature on China's spatial inequality, by examining the impact of using various deflators on estimates of spatial inequality. But there is no need to here review the spatial inequality literature, since we have recently done so in Li and Gibson (2013). The focus of our previous study was on the misunderstanding that results from ignoring the fact that for most of the reform era, China's statistical authorities denominated local GDP by the number of people with *hukou* household registration from each place rather than the number of people actually residing in each place (so measured inequality mechanically increased as the number of non-*hukou* migrants rose). In the current study we use the adjustments to the population denominators created by Li and Gibson (2013) but otherwise do not address population issues and instead pay attention to the impact of adjusting for spatial cost-of-living differences.

Spatial Deflation Studies

The most widely used spatial deflators for China appears to be those of Brandt and Holz (2006), whose paper has 152 *Google Scholar* citations as at March, 2013. These authors use provincial price data from 1990 to calculate the cost of national rural and urban expenditure baskets (containing 40-60 items) and a population-weighted combined basket. The prices had originally been collected by the statistical authorities for the purpose of calculating a temporal index (the CPI) for each province, so they do not necessarily refer to the same quality of items across provinces. Rural prices were not available for all products consumed in rural areas, so provincial capital city prices were used for items constituting just over 40 percent of the average rural household budget. Since there were no prices for non-traded services, average labourer wages in township and village enterprises (TVE) were used as a proxy for these. Finally, the analysis lacked data on either rent, land prices or real estate prices, so instead the construction costs per square meter of rural household buildings was

used as a proxy, with the 'quantity' of housing services in the basket set as 0.5625 square meters – chosen to give an expenditure that was equivalent to nationwide per capita rural household living expenditures on housing.

Brandt and Holz (2006) then use the annual rate of change in the CPI for each province to extend from the base year, back and forth in time to form annual spatial deflators for each province from 1984 to 2004. This time series also is used by other researchers studying inequality (for example, Sicular *et al.* 2007 and Li and Gibson 2013) since it allows easy updating by just using published data on the annual rate of change in each province's CPI. Despite this simplicity, there are potential problems in using a temporal index to update a spatial index so as to create a panel of deflators. An example of such bias comes from Russia; Gluschenko (2006) compares a spatial price index calculated for period t using spatial prices for the same period, with an index for period t that is extrapolated from a spatial price index for period t_0 using local CPIs to update prices from t_0 to t. The direct method gives a spatial price index for each province whose range is 44 percent of the national mean price level, but the indirect method gives a much wider range, of 72 percent.

The example from Russia shows that CPI-updated price levels may not adequately proxy for cross-spatial price levels. More generally, it may not be possible to construct panel price indexes that are unbiased across both space and time (Hill 2004). The problem is that bilateral index formulae, such as for the Laspeyres index used by Brandt and Holz (2006), are unlikely to give transitive results when extended to a multilateral situation. For example, consider a price index calculated for three regions: Beijing, P_B, other urban areas, P_U, and rural areas, P_R with base weights that differ in each region. A direct comparison between the rural price level in period t_2 and Beijing prices in period t_0 will not give the same result as constructing an indirect comparison via the third region in an intermediate time period, t_1:

$$P_{R2,B0} \neq P_{R2,U1} \times P_{U1,B0} \tag{1}$$

Instead, transitivity requires use of a multilateral index method, such as the Geary-Khamis (GK) method that underlies the Penn World Table or EKS (Eltetö, Köves and Szulc) type methods.[2]

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[2] These methods compare each country (or region) with an artificially constructed average country (or region). Typically they use the Paasche price index formula to make each of these bilateral comparisons, with the artificial country as the base, and tend to suffer from substitution bias because the price vector of the base artificial country (region) is not equally representative of the prices faced by all of the countries (regions) in the comparison. EKS methods impose transitivity in the following way: first, make bilateral comparisons between all possible pairs of countries and then take the nth root of the product of all possible Fisher indices between n countries. Deaton and Dupriez (2011, p.4) note that multilateral price indexes required for spatial work are typically not consistent with the inflation rates in local CPIs, and so need to be calculated regularly, not just once and updated by the local CPIs.

Another issue with the deflator formed by Brandt and Holz is the use of a national basket rather than letting consumer responses to relative prices and other differences induce regional variation in the structure of consumption. While sensitivity to consumer responses is a claimed feature of the 'no-price' Engel curve method described below (Gong and Meng, 2008), it is not required that methods using disaggregated price data ignore variation in the structure of consumption. For example, Deaton and Dupriez (2011) use unit values from household surveys to calculate spatial price differences in two other large countries – India and Brazil, using multilateral Törnqvist indexes that are the geometric average of price relativities between each region and the base region, weighted by the arithmetic average of the budget shares for the two regions. Hence, variation in the structure of consumption, as captured in budget shares for each region, is accounted for by this type of spatial price index. The results for these two countries show a 20 percent range in average food prices between the cheapest and most expensive regions in India, while in Brazil there is almost no price gradient; reflecting the higher incomes in Brazil and hence greater importance of processed foods which likely have much smaller price margins between regions than do unprocessed foods.[3]

Gong and Meng (2008) use an Engel curve approach to estimate spatial price deflators for each province, using data from the Urban Household Income and Expenditure Survey from 1986 to 2001.[4] Their deflator is defined by what is needed for nominally similar households to have the same food budget shares in all regions, following an idea first proposed by Hamilton (2001) for measuring bias in a temporal CPI. These authors find implied regional cost-of-living differences from the Engel curve that are considerably larger than those calculated from pricing a fixed basket, using either provincial average prices or household-level unit values. The difference from fixed basket results was most apparent during the mid- to late-1990s when social welfare reforms altered coverage and subsidies for public health, education and housing. In terms of inequality, when no adjustment was made for spatial price differences, Gong and Meng (2008) find that the mid 1990s saw the most significant increase in regional income inequality, but after using the deflator derived from their Engel curve results, they find regional income inequality to actually increase the most in the late 1980s.

Almås and Johnsen (2012) use a similar Engel curve approach, with data from just two years (1995 and 2002), for rural areas in 19 (of 31) provinces and urban areas in 11

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[3] Relatedly, supermarkets are more important in Brazil (and also China) than in India and the growth in the importance of supermarkets assists with spatial convergence in food prices (Reardon *et al*. 2003).

[4] In contrast to the later work of Almås and Johnsen (2012), Gong and Meng do not create a panel price index of time-space deflators, and instead the food Engel curves are estimated separately for each year.

provinces. Rather than estimating a spatial cost-of-living index year-by-year, they attempt to make incomes comparable over both time and space using a single set of Engel curve estimates. They claim that the CPI understates price changes in rural areas and overstates in urban areas; the deflator derived from the Engel curve suggests a 44 percent rise in the rural cost-of-living from 1995 to 2002 and zero change in the urban cost-of-living, versus CPI increases of eight and 11 percent. This closes the rural-urban gap in price levels, with the rural cost-of-living rising from 60 percent of the urban level in 1995 to 87 percent of the urban level by 2002. Thus, the real income figures calculated with their deflator show a greater rise in inequality and a more modest fall in poverty than is implied by making no spatial adjustment and using the CPI for temporal deflation.

The studies that use a food Engel curve to back out regional differences in the cost-of-living (or more generally the bias in any spatial or temporal deflator) are one strand in a broad literature that relies on observable proxies for well-being to calculate implicit compensation for people living in different circumstances (such as family size and structure, or location). Timmins (2006), for example, uses internal migration data from Brazil, under the logic that moves reveal preferences over locations that differ in terms of nominal incomes and the cost-of-living, and can thereby reveal spatial differences in the cost-of-living. Lanjouw and Ravallion (1995) use child anthropometric indicators (stunting and wasting) in addition to the food share, to indicate well-being when anchoring their calculation of allowances for household size economies (effectively, the inverse of the compensation needed by people living in smaller households to be as well off as those in larger ones at the same per capita consumption). Subjective data on self-rated welfare can also be used; Krueger and Siskind (1998) and Gibson, Stillman and Le (2008) use survey questions that compare feelings of being better off in the present or the past to adjust for possible biases in the CPI and the same method could be used to make spatial comparisons.

The problem with all of these approaches is that it is simply an assertion that the welfare indicator – whether food budget shares, anthropometrics, and so forth – does indeed identify people who are equally well off. But at least since Nicholson (1976), a long literature has argued that the food share is not a good indicator of well-being. Consider the example of using the food share to calculate the exact amount of money needed for parents to maintain their consumption while providing for a child; since child consumption is concentrated more on food than is adult consumption, the food share would be higher even if exact compensation had been given, and this higher food share would wrongly indicate the need for further (over)compensation. In the context of the food Engel curve estimates for China, there is a substantial difference between provinces and urban and rural areas in the proportion of household members who are children. The data from the latest wave of the China Health and Nutrition Survey (CHNS) show 0-15 year old children comprise just three percent of the average household in urban areas of Liaoning province but are 16 percent of the average rural

household in Guangxi. Food shares will thus be higher in Guangxi, even if there were no differences in the cost-of-living, but the Engel method will not necessarily recognize this.[5] Consequently there are reasons to doubt the reliability of spatial deflators produced by this method.

Market Integration Studies

Many authors consider China an example of a developing country with segmented markets and much less integration than developed countries (Gong and Meng, 2008; Xu, 2002). In the early reform period this description may have been apt since economic interaction between provinces had been minimized during the planned economy era, making China more like a cluster of independent economies rather than a large, spatially integrated economy. But the surprising claim of some influential studies is that market integration declined even more during the reform period. According to Young (2000, p.1128)

> '…twenty years of economic reform … resulted in a fragmented internal market with fiefdoms controlled by local officials whose economic and political ties to protected industry resemble those of the Latin American economies of past decades.'

The claimed reason for the seemingly perverse fragmentation of the internal market while China opened up internationally is that devolution of powers saw local government revenue linked to local industry protection, leading to inter-regional trade wars. Apparent confirmation comes from Poncet (2005) who examined 'border effects' between China's provinces by comparing volumes of intra-provincial and inter-provincial trade. The trade-reducing impact of provincial borders appeared to increase between 1992 and 1997, from which Poncet concluded that the Chinese domestic economy fragmented and that '[R]ather than a single market, China appears as a collection of separate regional economies protected by barriers' (Poncet, 2005, p. 426).

A critical reappraisal shows the evidence from Young (2000) is not robust and also shows that China is comparable to the United States in terms of being a relatively integrated, large economy (Holz 2009). For example, Young showed a rise in the (ln of the) inter-provincial standard deviation of (the ln of) prices of various consumer and agricultural goods, which was taken as evidence of trade barriers segmenting markets. But this calculation was neither robust to inflation nor to the growth in product variety in the reform period. Once Holz (2009) accounts for these factors there is no trend in inter-provincial price dispersion,

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[5] Adding demographic variables to the Engel curve regression may not help, since there is no reason for these effects to operate just as intercept-shifters. The literature using food Engel curves to study bias in temporal deflators is more credible since it typically restricts attention to a particular household type (say, two adults with two children) and the change in household structure over a decade or so is much less than the differences over space, yet all of the regional differences are rolled into a catch-all term that is assumed to be due just to cost-of-living differences.

and the range of variation matches that in inter-city data for products in the United States. Similarly, Young found a convergence in the output structure of each province during the reform period, which was taken as evidence of provinces duplicating each other's industries rather than allowing regional specialization. Yet the degree of convergence in the composition of value added across U.S. states in the same period was approximately the same as for provinces in China but there were no claims of rising inter-state trade barriers in the United States at that time.

In keeping with the reappraisal by Holz (2009), a number of more recent studies find China to be a relatively well integrated market economy. Fan and Wei (2006) apply panel unit root tests to data on monthly prices for a group of 93 industrial products, agricultural goods, other consumer goods, and services in 36 major Chinese cities, finding that prices do converge to the law of one price. Similarly, Ma, Oxley and Gibson (2009) use spot energy prices in 35 major cities in China to test for convergence, with their panel unit root tests indicating that the energy market is integrated in China. Huang, Rozelle and Chang (2004) examine prices for rice, maize and soybeans from almost 50 locations in 15 provinces, on the eve of China's accession to the WTO. These authors find most market pairs to be integrated (and this integration to extend down to village level), and market integration to be substantially higher than even five years earlier.[6] A longer term perspective on grain prices found that on the eve of the industrial revolution, market integration in China was as high as it was in most of the advanced areas of Western Europe (Keller and Shiue 2007a), while contemporary markets are even more integrated. Keller and Shuie (2007b, p. 107) conclude that for China 'in the late twentieth century local and national prices essentially move one-to-one.' Thus, it is mainly the central planning era that deviated from the pattern of China being a normal, relatively integrated, large economy.

Another way to examine market integration is to test how long it takes prices to converge following idiosyncratic shocks. For example, Parsley and Wei (1996) find convergence rates to purchasing power parity of five quarters for tradable goods and fifteen quarters for services, for a sample of 48 cities in the United States. When the comparable approach is used in China, convergence rates appear to be much faster. Lan and Sylwester (2010) study the prices of 44 products in 36 Chinese cities and estimate half-live divergences from the law-of-one-price that average just 2.4 months. This is approximately twice the speed of adjustment found in the United States, leading these authors to conclude: '[O]ur findings suggest that prices within China converge to relative parity extremely quickly' (Lan and Sylwester, 2010, p. 231).

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[6] Rising integration is also apparent in the labor market; since 1997, urban wages in China's interior provinces have risen at a faster rate than in coastal regions – although the absolute wage gap continues to grow (Li *et al.* 2012).

A recent review of product, labor and capital market integration in China summarizes the evidence as showing: '[P]roduct markets became more integrated over time, as regional trade increased and product prices were increasingly similar throughout the country' (Chen, Goh, Sun and Xu, 2011, p.73). Given this similarity over space of the prices of tradable goods, the focus of many of the previous spatial deflation studies summarised above may be misplaced. In an environment where traded goods prices converge rapidly, the main source of price dispersion across space should come from the non-traded components of consumption, and especially from housing, given the fixity of land. We therefore briefly review the literature on spatial variation in house prices in China before turning to the data that we use to develop housing-related deflators.

Housing Market Studies

In the planned economy era, government agencies such as work units provided all urban housing. Rents were low and the dwelling one was allocated depended on administrative criteria, for example, job rank (Bian *et al.* 1997). Housing reform was launched in 1988 (State Council, 1988), with privatization and creation of an urban housing market as the aim. Thereafter, commodity houses built by private developers could be bought on the housing market (Huang and Clark, 2002). For the first decade of reform a dual track system developed, with large numbers of commodity houses bought by work units and then distributed to workers at discounted prices (Huang 2003). In 1998, the State Council abolished the old housing system completely (State Council, 1998) and thereafter any provision of subsidized housing by work units was strictly banned (Huang 2003). Since then, the urban housing system has become totally market-oriented.

In contrast to the urban sector, rural houses were (and remain now) self-funded, self-built and self-renovated by residents (Liu, 2010). The right to use rural residential land (*Nongcun Zhaijidi Shiyongquan*) is evenly distributed and free of charge for village collective members. Land is collectively owned by the village and the occupant is not allowed to mortgage or trade the land, although transfers within the village collective community are permitted. The occupant may build new houses or renovate old houses with their own funds for all kinds of needs e.g. marriage, tourism (*Nongjiale*, akin to a motel, for urban tourists to taste rural life), family workshop, and handicraft production, etc. (Liu, 2010). Thus, the rural housing system enables rural residents to satisfy their housing needs at much lower cost than is incurred by urban residents in the current era. Though rural self-built houses are generally large and cheap, they are poor in quality relative to urban housing in terms of housing attributes such as the energy source for cooking, bath facilities and individual toilets (Logan *et al.* 2009).

The reforms have led to a large literature on urban housing in China, with early studies on determinants of home-ownership (Huang 2003, Pan 2004). But after the full marketization of urban housing in 1998, the focus shifts to affordability due to the sharp increases in house prices. For example, the Shanghai Housing Price Index (SHHPI) of the

China Real Estate Index System (CREIS) rose by 63 percent within two years from January 2001 (Hui and Yue, 2006). Liu *et al.* (2008) document poor housing affordability in Beijing during the 2000s using the house price to income ratio (PIR) and the home affordability index (HAI). The PIR is defined as the ratio of the average market value of a typical dwelling to the average annual household income and the HAI measures the ability of a household with an average income to pay back a mortgage on a typical home. In a more comprehensive study, Xiang and Long (2007) calculate PIR and HAI indices for 34 major Chinese cities and find Beijing, Shanghai, Shenyang, Xiamen and Haikou to have poor housing affordability while inland cities of Hohhot, Changsha, Chongqing and Urumqi are relatively better.

In addition to affordability, the other focus of recent literature on the urban housing market is price determination. Zhang and Tian (2010) study sales of new dwellings in 35 major cities between 1995 and 2006, finding stable long-run inter-city price relativities, which implies that the urban housing market in China is segmented and specific local economic characteristics matter. Deng *et al.* (2012) examine land auctions for 35 major cities from 2003 to 2011 to construct a model of land supply and also for use in a hedonic model of dwelling prices, finding that house prices are driven by the land market rather than by construction costs. Zheng *et al.* (2009) estimate a hedonic house price regression for 35 major cities, and find significant location effects in determining prices and Wu *et al.* (2012) use a similar model but examine the role of intra-city locational factors (for example, distance to city centre). Overall, this research indicates the importance of location in determining dwelling prices in urban China, with the most plausible source of inter-area variation coming from land prices.

3. DATA

For our main analyses we use administrative data on the average selling price for new residential dwellings that real estate developers are required to report to the NBS. Specifically, every transaction for new housing sales is meant to be reported (both monthly and annually, directly to the NBS through an electronic portal) and these are the most commonly used data in China for studies of the urban housing market (Zheng *et al.* 2009). Since most of the housing market is new construction rather than repeat sales (Deng et al, 2012) an index derived from prices of new units is broadly representative. The average selling price is given for each province in the China Real Estate Statistics Yearbook (NBS, 2011a), for urban prefectures it is shown in the China Statistical Yearbook for Regional Economy (NBS, 2011c), and for urban core districts (which are more consistently urban than the prefecture they belong to) they are reported for 2009 (but not 2010) in the China Urban Life and Price Yearbook (NBS, 2010).[7]

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[7] Subsequent editions of the China Urban Life and Price Yearbook after 2010 do not report house price data for urban core districts, so we use the 2009 values, as reported in 2010.

We obtain data on average GDP for every province, every urban prefecture and every urban core district from the China Statistical Yearbook for Regional Economy (NBS, 2011c) and the China City Statistical Yearbook (2011b). These same two sources provide information on the value of total urban real estate investments on residential assets (IRA). The data on the resident population, which are needed for correct calculation of per capita values (rather than using the misleading registered population figures), are year-end 2010 figures for provinces from NBS (2011c) and are 1st November, 2010 figures for prefectures and districts as reported in the county-level tabulations of the 2010 Census of Population (NBS, 2012).

In addition to these data provided by the NBS we gathered our own data on sales prices and attributes of new apartment units from www.Soufun.com, which is the largest real estate listing site in China. In conjunction with the China Real Estate Index System (CREIS), Soufun.com co-publish the China Real Estate Statistical Yearbook. For the primary data collection we only considered the dominant type of urban residence, which is a private apartment in a complex. We did not consider subsidized public rental housing, economically affordable housing, and high-grade apartments and villas, which are just minor components of the urban housing system. According to the China Real Estate Yearbook 2011, of 8.82 million new urban housing units sold in 2010, just 2.5 percent were high-grade apartments or villas and 3.7 percent were economically affordable housing. The other 94 percent were standard private apartments, so our primary data collection concentrated on this dominant form of urban housing.

4.   CHINA'S URBAN HOUSING MARKET AND PRICE DETERMINANTS

If dwelling quality varies systematically over space it may interfere with using published average new dwelling selling prices as an indicator of standardized housing costs for urban areas. The way that real estate development is organized in China makes systematic quality differences between cities unlikely, since many apartment complexes in different cities are developed by the same national-level real estate development companies (sometimes even using the same names for their complexes in each city). While each complex may have dozens of multi-story towers, each containing more than 50 individual housing units, within a complex there are only a few (typically less than 10) floor plans available and the selling price in terms of yuan per square metre varies little across the individual units. But there is considerable variation in selling price between complexes in different areas, including between different districts of the same city (for example, Beijing has 16 city districts and complexes in different Beijing districts may have prices that vary by up to 30,000 yuan (US$4,800) per square metre). This variation is consistent with the finding of Deng *et al.* (2012) that variation in new dwelling prices is driven by the land market.

In order to verify if dwelling quality varies systematically over space, in February 2013 we gathered data on sales prices for 150 new apartments in three cities. Each city is from a different level of China's administrative hierarchy: Beijing is a municipality-level city with an equivalent status to a province; Nanjing is the capital of Jiangsu province and is one of 15 sub-provincial cities in China, which have much greater autonomy and higher status than prefecture-level cities; while Changsha is a prefecture-level city and the capital of Hunan province. The data collection was restricted to these three cities because advertisements from most of the 323 cities in Soufun.com lack data on key attributes (both unit and complex characteristics). The majority of advertisements just list the average selling price of all units in a complex but for the three selected cities the unique price (per square metre) for every apartment in a complex is consistently listed. Furthermore, only for these three cities do the advertisements always list the complex opening date, completion date, and the sales ratio, while for other cities these data are missing. Previous research has found that these factors play a significant role in determining new apartment prices because they represent changing pricing behaviour of the real estate developer at the different stages to completion of an apartment complex (Wu *et al*. 2012). We sampled prices from 3-5 complexes for each of the 13 districts of Beijing, 5-8 complexes from each of the nine districts of Nanjing, and 5-12 complexes from each of the five districts of Changsha.

The data used for the hedonic apartment price regression are described in Appendix A. For some characteristics, apartments in Nanjing and Changsha appear to have more desirable qualities than those in Beijing, with more green space and a higher proportion of the complex area being green space (despite the complexes in Nanjing and Changsha rising higher, on average, than those in Beijing). Also, the listings for Changsha are for slightly newer complexes than for Beijing, as seen from the fewer months elapsed since the complex was opened for sale and the greater number of months to completion of the complex. On the other hand, the apartments in Beijing in the sample are larger than those in Changsha, which is likely to be a desirable characteristic showing up in higher prices, even when we concentrate on the price per square metre. The apartment complexes from Beijing also have a higher car park ratio (the number of car parks per dwelling) – note that these are rented or sold separately, while most observations for Nanjing and Changsha leave this attribute blank so it is unclear if car parking is bundled with the price of the apartment in those cities. Overall, there is no clear sign that Beijing apartments have better quality relative to those in the other two cities; for example, the new trend in the real estate market in urban China of developers selling decorated new houses rather than unfinished ones is just as apparent in all three cities. The results of the hedonic house price regressions are shown in Table 1.

Table 1. Effect of Location and Dwelling Characteristics on House Prices in Urban China

	ln(price of apartment unit in 1,000 yuan/square metre)		
	(1)	(2)	(3)
Beijing=1, otherwise=0	1.270		1.190
	(15.28)***		(13.85)***
Nanjing =1, otherwise=0	0.610		0.716
	(7.34)***		(9.59)***
Unit characteristics			
Apartment area (sq metres)		0.005	0.002
		(4.75)***	(2.60)**
Number of bedrooms		-0.432	-0.191
		(5.80)***	(3.82)***
Number of bathrooms		0.348	0.283
		(4.38)***	(5.50)***
Number of living rooms		0.030	0.127
		(0.29)	(1.89)*
Decorated=1, otherwise=0		0.337	0.256
		(3.93)***	(4.71)***
Level (floor) in complex		-0.011	-0.005
		(1.44)	(0.97)
Complex characteristics			
Land area (1,000 sq metres)		-0.002	-0.001
		(2.13)**	(1.62)
Total number of floors		-0.002	0.003
		(0.34)	(0.83)
Floor area ratio		-0.104	0.072
		(2.57)**	(2.51)**
Green area (1,000 sq metres)		0.005	0.003
		(2.07)**	(1.56)
Green area / total area		-3.035	-0.466
		(4.18)***	(0.95)
Car park ratio		0.006	0.018
		(0.06)	(0.29)
Months after opening		-0.008	-0.012
		(1.09)	(2.48)**
Months to completion		-0.017	-0.019
		(2.79)***	(4.79)***
Sale ratio		0.043	0.060
		(0.39)	(0.70)
Constant	1.945	4.039	1.584
	(33.08)***	(11.04)***	(5.48)***
R-squared	0.61	0.59	0.84

Notes: Absolute value of t statistics in parentheses, * significant at 10%; ** at 5%; *** at 1%. *N*=150. The omitted location is Changsa.

The dependent variable is the logarithm of the price (in thousands of yuan) per square metre, so the relative difference in prices is not directly shown by the regression coefficients on the dummy variables for each city. Instead, the coefficients must be transformed into percentage differences using: $percentage\ difference = (e^{\hat{\beta}} - 1) \times 100$, which shows that the price per square metre is 84 percent higher in Nanjing than in Changsha, and 256 percent higher in Beijing, without controlling for any attributes of the apartment (Column (1) of

Table 1). The results in column (2) use the attributes of each apartment but do not consider the location; despite having 15 characteristics that are potentially related to selling prices, these explain slightly less of the variation in prices than just using location dummy variables.

When the location effects and characteristics are put together, the hedonic regression explains 84 percent of price variation and after controlling for all of the characteristics of the particular apartment and its complex, the relative price differences are fairly similar to what they were without the controls. Specifically, the (conditional) price per square metre is 105 percent higher in Nanjing than in Changsha, and 229 percent higher in Beijing. While the price premium is slightly smaller for Beijing than when using the raw data, it is somewhat larger for Nanjing and this reflects the fact that, at least for these three cities, there is no systematic quality gradient whereby apartments in cities with higher priced real estate have more desirable attributes of either the unit or the apartment complex. In the absence of the sort of apartment-specific data that we used in the regression, we proceed to use raw data on average selling prices for all cities and we treat the spatial variation in these raw prices as mainly reflecting the fixity of land supply rather than systematic variation in quality.

5. HOUSING PRICES AND ESTIMATED DEFLATORS

Since there is tentative evidence that apartment quality does not vary systematically between cities, we go ahead and use data from the China Real Estate Statistics Yearbook (NBS 2011a), China Statistical Yearbook for Regional Economy (NBS, 2011c) and the China Urban Life and Price Yearbook (NBS 2010) on the average selling price in 2010 (provinces and urban prefectures) and 2009 (urban core districts) of new residential dwellings. We note that these data are for the urban sector, and our expectation is that these prices vary over space most especially because of inter-city land price variation. For this reason we do not consider rural housing, since rural residential land use rights are not determined by market forces and also because the data available for rural households are just the construction costs (building materials) which we consider to be traded goods and therefore less likely to vary over space than do urban house prices. The distinction between the urban and rural housing sectors is clearly seen in the way that China's statistical system reports the relevant data; rural household expenditure on new dwelling construction is defined as consumption expenditure in the China Rural Statistical Yearbook 2011 (NBS 2011d) while urban household expenditure on house purchases are defined as a separate category apart from consumption expenditure in the China Urban Life and Price Yearbook 2010 (NBS 2010).

The average prices for new urban housing in 2010 are displayed in Figure 1, at provincial scale. The highest prices are found in Beijing (17,150 yuan per square metre – hereafter 'ysm') and Shanghai (14,290 ysm). The next highest category of prices (7,001 to 9,400 ysm) are only one-half as high as those in Beijing, and are found in Tianjin, Zhejiang, Guangdong and Hainan. In general, the highest prices are found in a continuous belt of provinces along

the coast between Jiangsu and Hainan, and in the Gulf of Bohai. All of the remaining provinces fall into the lowest price category, which includes all interior provinces plus the coastal province of Shandong.

Figure 1. Provincial Average Prices for New Urban Housing, 2010
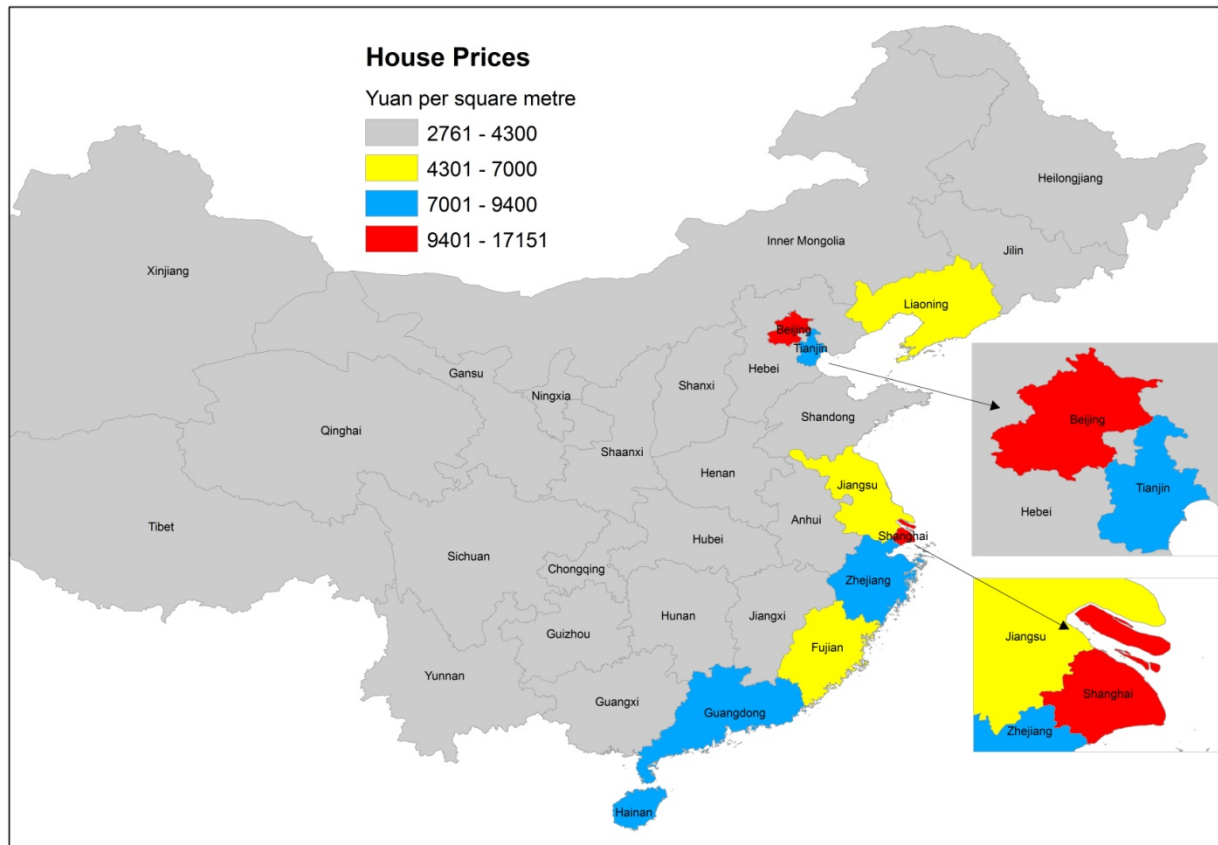
There is considerable heterogeneity within provinces in China, since many of them are as large and as populous as independent countries. So Figure 2 provides a finer-scale view of urban house prices, reporting the average value in 2009 for each of 288 core urban districts. These core districts lie within prefecture-level and sub-provincial cities, but are more consistently urban than the full area of the prefecture, which often includes rural counties. In order to concentrate on the part of China where most core urban districts are located, the map truncates Xinjiang, Tibet and Qinghai in western China; this region contains only two urban districts -- Karamay and Urumqi (both in Xinjiang). It is apparent that there are a number of cities in interior provinces, such as Chengdu, Harbin, Ji'nan, Taiyuan, and Wuhan that have much higher prices than is revealed by a provincial average, and Pu'er in Yunnan even falls into the highest price category that is shared by cities such as Guangzhou, Hangzhou and Shenzhen, in addition to Beijing and Shanghai. Conversely it is also apparent that there are cities in the coastal provinces which have much lower prices than some cities in the interior. Consequently the variation in the cost-of-living will be more accurately portrayed at sub-provincial levels.

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Figure 2: Average Prices for New Housing in Urban Core Districts, 2009
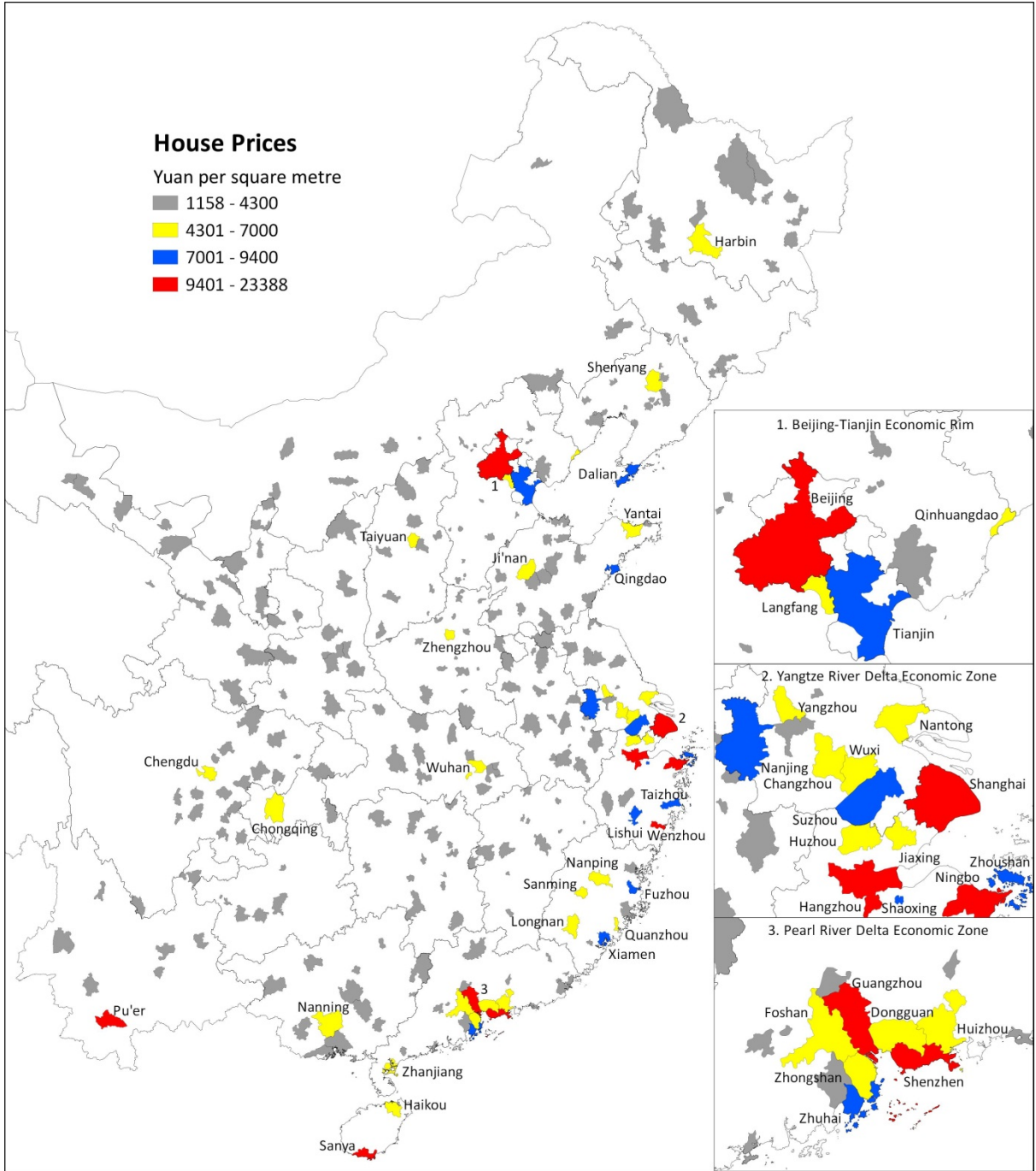
In order to measure cost-of-living differences over space, we calculate a Törnqvist price index for each province (and also for each urban prefecture and urban core district):

$$T = \exp\left[\sum_{j=1}^{J}\left(\frac{S_{kj}+S_{ij}}{2}\right)\ln\left(\frac{P_{ij}}{P_{kj}}\right)\right] \tag{2}$$

where s_{ij} is the average share that item j has in consumption in region i, and s_{kj} is the average budget share in region k, which is the base region, while P_{ij} and P_{kj} are the prices of item j in

region *i* and in the base region. The Törnqvist index uses the arithmetic average of the budget shares in the base region and in region *i* to weight the logarithm of the price relativities between those two regions. These weighted price relativities are then summed over all *J* items that comprise the budget.

Our working assumption is that only house price variation contributes to cost-of-living differences, so as to form a lower bound for the impact of deflation on spatial inequality. Since it is assumed that prices do not vary spatially for all other components of the budget, the index formula reduces to the log house price relativity between Beijing (base region) and region *i*, weighted by the average importance of housing in Beijing and region *i*. There are no micro data on household budget shares on housing that can be disaggregated to sub-provincial levels so we instead use national and regional accounts data. China publishes spatially disaggregated data on annual investments in urban residential assets and since the urban housing market is dominated by new housing stock rather than repeat sales (Deng *et al.* 2012), this annual investment should be a good proxy for the component of regional income set aside for housing provision. However, one further adjustment is needed, because of the famously low share of final consumption in China's GDP, which also varies across provinces because of differing intensities of net exports. We therefore use the ratio of annual investments in urban residential assets to final consumption expenditure as our proxy for the budget shares in the Törnqvist formula.[8]

Table 2 contains the provincial Törnqvist indexes calculated under these assumptions, along with the input data used. The base region is Beijing and the index values are interpreted as the factor by which nominal GDP per capita in region *i* has to be multiplied by to put it into Beijing prices. On average, GDP per capita in provinces outside of Beijing has to be raised by 30 percent to make it comparable to GDP per capita at Beijing prices. The range in the deflator is from 1.03 for Shanghai – whose residents face housing prices almost as high as in Beijing – to 1.42 for Chongqing and 1.43 for Liaoning. It is notable that the lowest average housing prices do not always give the lowest calculated price index because the importance of housing also matters; for example, house prices are low in Gansu but the inflation factor is lower than average because of the relatively low importance of provision for residential housing in regional income.

The last column of Table 2 reports the deflator from Brandt and Holz (2006), using the national basket, which is updated to 2010 using movements in each province's CPI. The Brandt and Holz deflator is more variable than the Törnqvist index, with an unweighted coefficient of variation across provinces more than one-third higher than for the Törnqvist

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8   The share of final consumption expenditure in GDP is not available for prefectures and urban districts, so we use the share for the province that the prefecture or district is part of, as an approximation.

index. This pattern is consistent with Gluschenko (2006), who found that calculating a spatial deflator just once and updating it with the local CPIs can overstate the spatial variation in prices. Nevertheless, the overall level of adjustment needed to put GDP outside of Beijing into Beijing prices is quite similar, with an average inflation factor of 32 percent. The cross-province patterns of the deflators also are quite similar, with a Pearson correlation coefficient of 0.71 and a rank-correlation of 0.63.

Table 2. Residential Investment Fraction in GDP, Final Consumption Expenditure Fraction in GDP, Average New House Price, and Deflation Indices at Province Level (2010)

Province	FIRA	FCON	HP	Tornqvist	DINXB&H
Beijing	0.11	0.56	17151	1.00	1.00
Tianjin	0.06	0.38	7940	1.15	1.19
Hebei	0.09	0.41	3442	1.40	1.52
Shanxi	0.05	0.44	3338	1.29	1.28
Inner Mongolia	0.07	0.39	2983	1.39	1.40
Liaoning	0.13	0.40	4303	1.43	1.40
Jilin	0.08	0.41	3495	1.36	1.42
Heilongjiang	0.06	0.53	3492	1.28	1.38
Shanghai	0.07	0.55	14290	1.03	0.99
Jiangsu	0.08	0.42	5592	1.24	1.30
Zhejiang	0.07	0.46	9332	1.11	1.34
Anhui	0.13	0.50	3899	1.40	1.45
Fujian	0.07	0.43	6077	1.21	1.37
Jiangxi	0.06	0.47	2959	1.33	1.43
Shandong	0.06	0.39	3809	1.30	1.42
Henan	0.07	0.44	2856	1.37	1.50
Hubei	0.07	0.46	3506	1.32	1.35
Hunan	0.07	0.47	3014	1.35	1.24
Guangdong	0.06	0.47	7004	1.16	1.12
Guangxi	0.09	0.51	3382	1.35	1.35
Hainan	0.20	0.46	8800	1.23	1.09
Chongqing	0.14	0.48	4040	1.42	1.64
Sichuan	0.09	0.50	3985	1.32	1.42
Guizhou	0.07	0.63	3142	1.30	1.27
Yunnan	0.09	0.59	2893	1.36	1.20
Tibet	0.01	0.64	2761	1.21	1.22
Shannxi	0.09	0.45	3668	1.36	1.26
Gansu	0.05	0.59	2938	1.28	1.29
Qinghai	0.06	0.53	2894	1.32	1.17
Ningxia	0.11	0.49	3107	1.43	1.31
Xinjiang	0.05	0.53	2872	1.30	1.29

Note: FIRA: fraction of investments on urban residential assets in GDP; FCON: fraction of final consumption expenditure in GDP; HP: average selling price of urban commercial new house units (yuan per square metre); Tornqvist: deflation index used by authors; DINXB&H: deflation index of Brandt and Holz (2006) updated to 2010.

6. IMPACTS OF DEFLATION ON SPATIAL INEQUALITY

Our overall goal in carrying out the analysis reported here is to examine how much difference is made to estimates of spatial inequality in China when using deflators derived just from variation in housing costs. The results are summarized in Table 3, which reports three measures of inequality – the Gini coefficient, the Theil index, and the weighted coefficient of variation (CoV) – for three levels of geography – province, urban prefecture, and the urban core districts within urban prefectures.[9] The nominal values that are deflated are GDP per resident in 2010, which takes into account the various corrections to both GDP statistics and population denominators that are summarized in Li and Gibson (2013). We restrict attention to 2010 because of the need for census data to provide correct counts of the resident population (rather than the *hukou* registered population) for sub-provincial spatial units.

Table 3. Inter-Regional Inequality in GDP *per capita* With and Without Spatial Deflation

	THEIL	THEIL(D)	CoV	CoV(D)	GINI	GINI(D)
Province	0.08323	0.06147	0.42332	0.35521	0.22672	0.19790
Prefecture	0.17442	0.14105	0.62303	0.55361	0.33106	0.29865
Districts	0.11026	0.08512	0.46545	0.40836	0.26059	0.22552

Note: Results are for 31 provinces; 288 prefectures; 288 prefecture-merged-districts (prefecture urban cores); (D) is inequality measure on GDP per resident with spatial housing cost deflation. CoV is population weighted coefficient of variation.

If no account is taken of spatial variation in the cost-of-living, the level of spatial inequality is overstated by up to 35 percent (for inter-provincial analysis, using the Theil index). This is two-thirds larger than the impact of spatial deflation found by Li and Gibson (2013) who use the deflator from Brandt and Holz (2006), updated to 2010 with the rise in each province's CPI. Since the current analysis assumes that prices for all goods other than housing are set on perfectly integrated markets, it should provide a lower bound to the impact of spatial deflation if a 'full' deflator was used which considered all components of consumption.

The lowest proportionate over-statement from not deflating comes when studying urban prefectures. This most likely reflects the fact that these spatial units have the highest apparent of inequality amongst the various levels of disaggregation presented in Table 3, due to their heterogeneity. An urban prefecture may contain rural counties and this lack of a consistent defined urbanity gives higher apparent inequality between these 'urban' units, and correcting

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[9] The Theil index is: $T_w = \sum_{j=1}^{m}(p_j/P)(y_{wj}/\mu)\ln(y_{wj}/\mu)$ where m=31 provinces (or 288 prefectures or urban core districts), p_j is the population of the jth province (or prefecture or district), P is overall population, y_{wj} is the GDP *per capita* of the jth province (or prefecture or district), and μ is the overall population-weighted mean of GDP *per capita* for all provinces. The (weighted) coefficient of variation is: $CoV = \sqrt{\sum_{j=1}^{m}(p_j/P)(y_{wj}-\mu)^2}/\mu$. The Gini coefficient is: $G = \left(\sum_{i=1}^{m}\sum_{j=1}^{m}p_i p_j |y_{wi}-y_{wj}|\right)/2\sum p_i^2 \mu$.

for spatial price differences has less impact. The more defensible level of sub-provincial analysis is the urban core district within an urban prefecture, since this excludes rural counties. At this level of geography, spatial inequality is overstated by between 14 percent (using the weighted coefficient of variation) and 30 percent (using the Theil index) if differences in the urban cost-of-living are not taken into account.

7. CONCLUSIONS

In this paper we use newly available data on dwelling sales in urban China to develop spatially-disaggregated indices of house prices, which are used as spatial deflators for provinces, urban prefectures, and urban core districts. Since we account for only one source of cost-of-living variation over space, the impacts on inequality that we find when using these deflators should be considered a conservative, lower bound. Previous approaches to forming spatial deflators for China have focused more on traded goods prices but our interpretation of the recent evidence is that these adjust quickly to parity levels, and so are unlikely to cause long-run cost-of-living differences between areas. In contrast, the fixity of land makes housing the most likely source of price dispersion across space.

It would ideal to generate regional components of house prices that hedonically adjust for all components of dwelling quality, but such data are not available beyond a limited number of cities. Nevertheless, our limited analysis suggests that systematic variation in the quality of new dwellings between cities is unlikely, making the published data on the average price of newly constructed urban dwellings a potentially useful source of information on spatial cost-of-living differences. When we use this information to adjust nominal GDP per resident we find that around one-quarter of the apparent spatial inequality disappears once account is taken of cost-of-living differences. Since there are good theoretical reasons for expecting a higher price level in nominally richer areas, our results provide a caveat to concerns about the degree of spatial inequality experienced in China.

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Appendix A. Comparison of House Prices and Attributes (Means)

	Beijing	Nanjing	Changsha
Unit price (1,000 yuan/construction sq.m)	29.93	13.93***	7.13***
Unit characteristics			
Area (sq.m)	152.69	131.60	115.69***
Number of bedrooms	2.64	2.78	2.74
Number of bathrooms	1.76	1.40**	1.54
Number of living rooms	1.88	1.94	1.94
Decorated=1, otherwise=0	0.36	0.26	0.32
Level (floor) in complex	3.86	7.56***	7.18***
Complex characteristics			
Land area (1,000 sq.m)	149.10	198.65	198.76
Total number of floor	13.74	20.24***	25.78***
Floor area ratio	2.42	2.28	3.51***
Green area (1,000 sq.m)	47.73	84.55	87.15**
Green ratio	0.32	0.39***	0.42***
Car park ratio	1.08	0.88**	0.97
Months after opening	15.14	12.42	11.98**
Months to completion	1.94	4.72	5.50**
Sale ratio	0.23	0.78***	0.45***
Observations	50	50	50

* significant at 10%; ** significant at 5%; *** significant at 1% for testing difference in mean compared with Beijing.