School of Accounting, Economics and Finance

Essays Connecting Australian Dwelling Price Growth and Subjective Wellbeing to Within-City Income and Wealth Differentials

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DECLARATION AND ATTRIBUTION

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

Signature:

Date: 16/05/2021

The research essay/paper presented in Chapter 2 was an original work produced for this thesis, but it has subsequently been published in an academic journal. The table below outlines the percentage time contribution each co-author made towards the published paper:

	Concept and Design	**Acquisition of Data and Method**	**Data Conditioning and Manipulation**	**Analysis and Statistical Method**	**Interpretation and Discussion**	**Final Approval**	**Total Time Contribution**
Christopher Phelps	100%	100%	100%	95%	75%	10%	85%
I acknowledge that these represent my time contribution to the above research output. Signed :							
Mark N. Harris	0%	0%	0%	5%	0%	25%	2.5%
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Steven Rowley	0%	0%	0%	0%	2.5%	25%	2.5%
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Rachel Ong	0%	0%	0%	0%	2.5%	25%	2.5%
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Gavin A. Wood	0%	0%	0%	0%	20%	15%	7.5%
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Total %	**100**	**100**	**100**	**100**	**100**	**100**	**100**

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THESIS ABSTRACT

This thesis comprises three independent research essays that address knowledge gaps in the Australian literature surrounding the response of housing prices and individual wellbeing to residential segregation within Australian cities. In the first essay, I observe differences in price dynamics across lower-priced and higher-priced neighbourhoods within Australia's major cities over the period 2001-2016. Neighbourhood dwelling prices within all cities and dwelling types converged during a 2001-2006 sub-period that coincided with strong housing price growth and demand from first homebuyers and investors. Divergence had overtaken convergence in most cities and market segments by the final 2011-2016 sub-period. I argue that falling interest rates are associated with periods of divergence. The findings highlight how price indices based on movements in central measures of the price distribution, can offer a poor guide to housing affordability trends at different points in a city's neighbourhood price distribution. They also suggest that monetary policy is associated with differential effects across market segments. These effects are markedly different in periods when monetary policy is relaxed rather than tightened, and have important implications for first homebuyer accessibility and the ability of existing homeowners to trade up.

In the second essay, hedonic price growth indices for neighbourhoods within five Australian cities is used to investigate the impact of neighbourhood consumption externalities on within-city dwelling price growth heterogeneity. Over the 1996 to 2016 study period, I find a systematic pattern in which less-affluent neighbourhoods in proximity to affluent ones experience higher house and unit price appreciation than similar neighbourhoods that were further away. This outcome suggests that positive neighbourhood consumption externalities are present within Australian cities; households are willing to pay for closer access to the greater quality and variety of endogenous amenities found in nearby wealthy neighbourhoods. Exogenous amenities, production agglomeration effects and initial differences between neighbourhoods are controlled for to ensure this impact is above and beyond other drivers of dwelling values. Additionally, I find that less-affluent neighbourhoods in proximity to affluent ones are more likely to show signs of gentrification. Government intervention may be required to avoid the displacement of lower-income residents from these neighbourhoods.

In the third essay, panel data on the subjective and economic wellbeing of Australian households is used to establish the geographic reference income and subjective wellbeing relationship within Australia. Recent US-based studies suggest that the income of other people in a given area – geographic reference income – differs in impact on one's wellbeing, dependent on geographic scale. The rising incomes of one's local neighbours increases wellbeing, while the income of region-wide neighbours reduces wellbeing. However, these were cross-sectional studies, and their subsequent estimates could be driven by the self-selection of innately happy or unhappy individuals into higher-income areas. In this study measurements are performed at different geographic scales concurrently and take advantage of panel-data modelling to limit time-invariant heterogeneity. I find that, controlling for own household income and the inclusion of fixed-effects, there is still a positive relationship between reference income and wellbeing at the neighbourhood level and a negative relationship at the region-wide level. Importantly, there is no asymmetry between households in these effects; the wellbeing relationship is the same no matter one's rank in the distribution of incomes within an area. The positive wellbeing relationship at the neighbourhood level suggests there is merit in social mixing policies. The negative region-wide relationship suggests that policies to redistribute economic resources and opportunities to lower-income Australians will improve wellbeing.

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1 CHAPTER 1: GENERAL INTRODUCTION

1.1 RESEARCH THEME AND OVERALL MOTIVATION

This thesis presents three independent research essays related by a theme of residential segregation and its implications within Australian cities. Residential segregation is the spatial manifestation of the inequality of household incomes and wealth interacting with variation in household preferences (Cheshire et al., 2014). In the neighbourhood sorting process, households with the most means outbid other households for dwellings in neighbourhoods containing desirable amenities and/or better access to income earning opportunities, resulting in clusters of advantage and disadvantage across urban areas (Cheshire et al., 2014). These clusters are the source of the within-city income and wealth differentials referred to in the title of this thesis. Wealth inequality trends over the last two decades show the average wealth of the top 20% of Australians to have grown ten times faster than that of the bottom 20% (Davidson et al., 2020). If household economic resources are becoming more unequal over time, residential segregation should then be more obvious. Recent research by Azpitarte et al. (2021) supports this notion, they found that residential segregation of high and low socio-economic groups is intensifying across the neighbourhoods of Australia's main capital cities. Those of low education and occupational status became increasingly overrepresented in outer areas of these cities, while high-skilled groups became more concentrated in desirable inner-city neighbourhoods.

But what are the implications of this increasing intensity of residential segregation for households within Australian cities? Some illustrations of the negative effects of residential segregation exist in the Australian urban literature. For example, Nouwelant et al. (2016) finds that for lower income workers within job rich central city locations, a lack of affordable housing nearby increases commuting distance and encourages housing related compromises, such as renting instead of owning, or sharing with unrelated adults. Additionally, Pawson et al. (2015) suggest that employment opportunities and access to services are reduced for individuals located inside clusters of socioeconomic disadvantage. However, other than those for employment and mobility outcomes, Australian empirical evidence on the implications of residential segregation is sparse. In the International literature, studies such as Guerrieri et al. (2013) and Ifcher et al. (2019) demonstrate that neighbourhood sorting and residential segregation also impact upon neighbourhood dwelling price movements and individual subjective wellbeing. The motivation of this thesis is to fill a selection of these outcome knowledge gaps, specifically those related to price and wellbeing outcomes within Australian cities. This will assist Australian urban policy makers in forming the appropriate policy responses to residential segregation.

The residential segregation research to be presented is also of interest Internationally. Australian is distinctive because its population is relatively small, yet it is one of the most highly urbanised countries in the world. In 2018, 86% of Australia's population resided in urban areas, compared to 81% in OECD countries and 55% worldwide (World Bank, 2019). Most of its population is concentrated in just five major cities – Sydney, Melbourne, Brisbane, Perth, and Adelaide – some of which are regularly ranked amongst the most expensive cities in the world (Demographia, 2019). The interaction of price dynamics and residential segregation in these cities is of relevance to other highly urbanised countries with Australian style housing markets, such as the USA and UK. The research framework presented in this thesis can then be applied to comparable countries with similar data availability.

In the following section, I explain the specific research questions and knowledge gaps addressed by the three essays of this thesis.

1.2 ESSAY QUESTIONS, MOTIVATIONS, AND OUTLINES

The specific research questions examined in this thesis are:

- Is there heterogeneity in neighbourhood dwelling price movements, specifically that between lower-priced and higher-priced neighbourhoods?
- Is the price growth of less-affluent neighbourhoods influenced by proximity to nearby affluent neighbourhoods?
- What is the impact of the incomes of one's neighbours on the subjective wellbeing of individual Australians?

In the first essay (Chapter 2), now published in the *International Journal of Housing Policy* (Phelps et al., 2020), I address the question of heterogeneity in neighbourhood dwelling price movements, specifically that between lower-priced and higher-priced neighbourhoods within Australian cities. For most home owning Australians, their home is their largest financial asset

(Pawson et al., 2019). Heterogeneity in price growth between residentially segregated neighbourhoods will subsequently lead to differing growth in the balance sheets of low and high socio-economic groups. This has important implications for housing-related policies across three domains – intra- and inter-generational housing wealth inequality, housing asset-based welfare and access to homeownership. I clarify these implications within Chapter 2.

Heterogeneity between initially lower- and higher-priced neighbourhoods can be described by measures of unconditional convergence or divergence. In the case of convergence (divergence), initially lower-priced neighbourhoods experience higher (lower) rates of price growth than higher-priced neighbourhoods, and the dispersion of prices across neighbourhoods within a city decreases (increases). My empirical investigation observes patterns of convergence/divergence within the five main capital cities of Australia over the observation period 2001-2016. Prior literature from Wood et al. (2016) suggests that divergence is dominant in urban areas. However, that study was limited to the neighbourhoods of one Australian city, and did not explore interesting sub-periods contained within its study timeframe, as characterised by changing economic conditions. My study expands this analysis to five capital cities, as well as three sub-periods corresponding to changing economic conditions. The findings will reveal whether patterns of convergence/divergence are uniform across cities and/or time, and hence, whether policy responses should also be uniform. Additionally, I differentiate between dwelling types in my analysis. As opposed to houses, Australian units are generally located in inner-city areas and rates of ownership are evenly split between investors and owner-occupiers (CoreLogic, 2016). The findings will reveal whether patterns of convergence/divergence are uniform across dwelling types.

In the second essay (Chapter 3), I address whether the dwelling price growth of less-affluent neighbourhoods is influenced by proximity to more-affluent neighbourhoods. US-based literature by Guerrieri et al. (2013) has found a systematic pattern in which less-affluent neighbourhoods in proximity to affluent ones experience higher house price appreciation than similar neighbourhoods that are further away. This suggests that positive neighbourhood consumption externalities are present within urban areas; wealthier households are willing to pay higher prices for closer access to the greater quality and variety of endogenous amenities found in nearby affluent neighbourhoods. Evidence of neighbourhood consumption externalities is yet to be established within the Australian literature, and the concept is sparsely mentioned in international literature. The presence of neighbourhood consumption externalities would suggest that less-affluent neighbourhoods in proximity to affluent neighbourhoods are a useful target for urban renewal projects; proximity provides the opportunity to deliver diversity and affordability in the housing stock, by tapping into spillover demand from affluent neighbourhoods, avoiding the inflated land and construction costs of development inside those affluent neighbourhoods. However, the evidence from Guerrieri et al. (2013) also suggests that this neighbourhood sorting process results in the gentrification of less-affluent neighbourhoods. Government intervention may then be required to avoid the displacement of low-income residents into further segregated lower-income neighbourhoods.

Over a 1996 to 2016 study timeframe, within Australia’s five main cities, I empirically investigate neighbourhood consumption externalities and its impact on the dwelling price growth of nearby less-affluent neighbourhoods. The finding will better inform Australian urban policy makers on how neighbourhood sorting decisions impact upon less-affluent households, and the subsequent potential for gentrification and displacement, contributing to Australia’s relatively sparse literature in this area (Atkinson et al., 2011). As in Chapter 2, I differentiate between dwelling types in my analysis. The hedonic price indices used in my study allow for separation between dwelling types (houses or units), revealing whether houses or units experience a higher rate of price appreciation in response to neighbourhood consumption externalities.

In the third essay (Chapter 4), I address the impact of the incomes of one’s neighbours on the subjective wellbeing of individual Australians. The US-based findings of Luttmer (2005) suggest that wellbeing is decreased by the incomes of others within one’s neighbourhood, which is attributed to negative comparisons between one’s own income and the incomes of others. The incomes of others in a given area, to which one compares their income, is known as geographic reference income. The direction of the relationship between geographic reference income and subjective wellbeing is yet to be established in Australia, leaving two unanswered questions relevant to residential segregation policy responses. First, for lower-income Australians, does segregation into neighbourhoods with other lower-income households reduce wellbeing? Second, will sorting into a higher-income neighbourhood than current improve wellbeing? In Australia, it is often assumed that there are negative consequences on individuals from clusters of social disadvantage, and that these consequences can be reduced through social mixing policies; policies that encourage diversity of income, tenure and class within neighbourhoods (Parkinson et al., 2014). However, as argued by Cheshire et al. (2014), if the negative externalities for the poor from living among the rich outweigh the positive externalities, polices to encourage social mixing would then be a cost-ineffective use of societal resources. Instead, it would be better to redistribute resources and opportunities from the richer to the poorer, given it is this inequality that manifests spatially as residential segregation in the first place.

Within Chapter 4, I use panel data on the subjective and economic wellbeing of households to establish the geographic reference income and subjective wellbeing relationship within Australia. This relationship will help inform the appropriate policy responses to residential segregation. Recent US-based studies (Brodeur & Flèche, 2019; Ifcher et al., 2019) suggest that geographic reference income differs in impact on one’s wellbeing, dependent on geographic scale. The rising incomes of one’s local neighbours increases wellbeing, while the income of region-wide neighbours reduces wellbeing. However, these were cross-sectional studies, and their subsequent estimates could be driven by the self-selection of innately happy or unhappy individuals into higher-income areas. Therefore, in my study measurements are performed at different geographic scales concurrently and take advantage of panel-data modelling to limit time-invariant heterogeneity. My chosen panel-data model is novel to the geographic reference income literature; it allows us to control for time-invariant endogeneity issues, while also acknowledging the ordinal nature of measurements of subjective wellbeing, a combination ignored by the prior literature.

1.3 KEY DATA SOURCES

As a researcher at the beginning of my research career, an additional motivation behind the studies in this thesis was to build up my knowledge and skills concerning datasets relevant to Australian urban research. The three essays of the thesis increase in methodological complexity and data intensity in the order they are presented. The first essay followed the simplest methodology, its measures of convergence only required the use of Australian housing price datasets for small areas, specifically neighbourhood-level median prices and hedonic price growth indices. Hedonic estimates of price growth are useful as they control for the time-varying quality and composition of the transacted dwelling stock that is a source of error in other measures of price growth (Hansen, 2009). The accuracy of analysis in the first two essays are enhanced by the use of this hedonic measure of price growth. Median price data at various geographic scales is readily available to Australian researchers through the Australian Urban Research Infrastructure Network (AURIN) data portal (Australian Property Monitors, 2018), but, due to their complexity and large data requirements, the hedonic price indices had to be licensed from a private property data and analytics company, CoreLogic.

The linear regression model of neighbourhood consumption externalities in the second essay also required the aforementioned housing price data sets, in addition to socioeconomic and geographic data. Neighbourhood-level socioeconomic data was licensed or attained freely from the Australian Bureau of Statistics (ABS). The geographic data, such as elevation and distance to natural amenities, was generated in the *ArcGIS* geographic software package, using spatial data files from Geoscience Australia.[1] The study timeframe of the second essay extends from 1996 to 2016, while the first and third essays extend from 2001 to 2016. The borders of some Australian neighbourhoods have shifted over the these timeframes, meaning much of the price and socioeconomic data acquired for this thesis was defined by incompatible versions of the Australian Statistical Geography Standard (ASGS) (ABS, 2020). Therefore, the data was corresponded so that all years of data share consistent border structures compliant to the 2011 ASGS.

The third essay required the use of longitudinal data on the subjective and economic wellbeing of individuals from the nationally representative Household, Income and Labour Dynamics in Australia (HILDA) Survey.[2] The first wave of HILDA in 2001 surveyed 19,194 individuals in 7,682 households, and the survey has grown each year to now include 23,237 individuals in 9,639 households as at the latest wave available, wave 19. Besides its breadth of participants and interview topics, a distinct advantage of HILDA over many other Australian surveys is that participants are re-interviewed each subsequent wave of the survey. Repeat observations of the same individual over time allows for the employment of a panel-data model, instead of the cross-sectional models employed in the first and second essay. The panel-data model employed in the third essay exploits the longitudinal nature of the HILDA sample, by capturing variations within the same individual over time, limiting concerns of endogeneity and endogenous self-selection that may be applicable to cross-sectional models of subjective wellbeing (Luttmer, 2005).

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1 For example, to calculate distance to oceans or rivers from each neighbourhood, I required the 'Surface Hydrology Polygons (National)' from Geoscience Australia. https://www.data.gov.au/dataset/surface-hydrology-polygons-national.

2 The survey is managed by the Melbourne Institute of Applied Economic and Social Research at the University of Melbourne. See Watson & Wooden (2012) for a discussion on the design and implementation of the HILDA survey.

1.4 THESIS STRUCTURE

The structure of this thesis is as follows. Chapter 2 presents the first research essay of this thesis, entitled ‘Within-city dwelling price growth and convergence: trends from Australia’s large cities’, in which I address heterogeneity in neighbourhood dwelling price movements. Following this, Chapter 3 presents the second essay, entitled ‘Neighbourhood consumption externalities and heterogeneity in Australian within-city dwelling price growth’, in which I address whether the dwelling price growth of less-affluent neighbourhoods is influenced by proximity to more-affluent neighbourhoods. Next, Chapter 4 presents the third and final essay, entitled ‘Geographic reference income and the subjective wellbeing of Australians’, in which I address the impact of the incomes of one’s neighbours on the subjective wellbeing of individual Australians. In the final Chapter, I present a general conclusion; I first summarise the main findings, and subsequent policy implications, of each essay, I then restate the theoretical and methodological contributions of my thesis to the literature, and conclude by discussing my future research intentions.

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2 CHAPTER 2: WITHIN-CITY DWELLING PRICE GROWTH AND CONVERGENCE: TRENDS FROM AUSTRALIA'S LARGE CITIES

2.1 INTRODUCTION

This essay documents recent trends in neighbourhood price dynamics within Australian cities. Real house prices in Australia have trebled in the last three decades while real incomes have grown by 50% over the same period (Pawson et al., 2019). The widening divide separating real dwelling prices from real incomes is one of the key trends driving falling rates of homeownership, most notably for young and low-income households struggling to break into the Australian housing market (Burke et al., 2020).

The growing housing affordability burden is not equally spread across Australia's cities, with some cities experiencing greater increases in housing costs than others (Duncan et al., 2019). However, a neglected facet of the housing affordability problem is differential dwelling price growth across cheaper and more expensive neighbourhoods *within* a city, that cause subsequent convergence or divergence in neighbourhood prices. *Within-city* dwelling price convergence or divergence has two dimensions. The first dimension can be described by either dwelling prices appreciating faster in lower-priced neighbourhoods than in higher-priced neighbourhoods (beta-convergence), or alternatively dwelling prices appreciating slower in lower-priced neighbourhoods than in higher-priced neighbourhoods (beta-divergence). A second dimension is represented by measures of dispersion across neighbourhood dwelling prices that describe sigma-convergence when dispersion falls, and sigma-divergence when dispersion increases.

There are important implications for housing-related policies across three domains – intra- and inter-generational housing wealth inequality, housing asset-based welfare and access to homeownership. Intra-city price dynamics can affect the distribution of wealth across income groups and between generations (Mayer, 1993). When dwelling prices diverge because of more rapid appreciation in expensive neighbourhoods, intergenerational disparities widen, since older households are more likely to own properties in these neighbourhoods;[3] and within an

[3] In 2015-16, 40.3% of Australian household heads aged 25-34 possessed owner occupied dwellings with a mean total value of $211200, as compared 79.4% of households aged 55-64 and a mean value of $573000. Authors'

age cohort there will be a growing wealth divide separating those owning housing in higher-priced compared to lower-priced neighbourhoods. Such differential growth in wealth also affects household mobility, potentially impacting upon labour market efficiency (Wood et al., 2016).

Asset-based welfare strategies are impacted because they encourage households to accumulate private wealth that can be drawn down to replace public assistance (especially government pensions) in retirement. Owner occupied housing is commonly a household's most important store of wealth. Differential housing price growth across regions (Searle & McCollum, 2014) or city neighbourhoods will then result in asset welfare strategies that have uneven social and spatial effects.

When there is convergence of inter-neighbourhood housing prices there can be negative implications for aspiring first homebuyers. Convergence during the upswing of a market cycle makes saving to meet deposit requirements tougher as entry-level prices increase faster than other housing market segments.[4] Deposits are the biggest barrier to first home ownership in Australia (Duncan et al., 2019) and deposit constraints are then more likely to bind in these circumstances. This can prompt the introduction of expensive policy interventions designed to ease deposit constraints.

There are also threats to first homeownership from the financialisation of the housing market and the associated rise of private landlordism (Arundel, 2017). Rental investors are prominent in Australian housing markets with private rental housing accounting for around 25% of the nation's housing stock (Rowley & James, 2018). Capital gains tax reform in 1999 introduced a 50% discount on rental investors' realised capital gains (Shi et al. 2016), an especially attractive tax concession for high tax bracket landlords. Investors are therefore encouraged to invest in market segments where capital appreciation is relatively strong (Wood & Tu, 2004). Divergence or convergence in neighbourhood price dynamics will then signal market segments in which tax advantaged capital gains are relatively strong. Convergence will favour acquisitions by high bracket investors in low value segments with the outbidding and displacement of prospective first homebuyers a concern.

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own calculations from summary data made available in the 2015–16 Survey of Income and Housing (ABS catalogue 6523.0 - Household Income and Wealth, Australia, 2015-16).

[4] If inter-neighbourhood dwelling prices were to instead diverge, entry level prices would decrease relative to the market, benefiting first homebuyers.

The majority of Australia’s population is concentrated in five mainland state capital cities – Sydney, Melbourne, Brisbane, Perth and Adelaide. Wood et al. (2016) examined intra-city price dynamics in Australia and reported evidence of house price divergence, but the analysis was limited to a single Australian city (Melbourne) and time period (1990-2009). The empirics reported below document price dynamics within each of the five major cities and the study timeframe bridges both pre- and post-GFC eras. My convergence measures are computed across the entire timeframe as well as shorter sub-periods that span the pre-GFC housing market boom, the GFC years, and post-GFC recovery, during which there were important shifts in macroeconomic conditions and macroeconomic policy.

As another contribution I differentiate between houses and units. As opposed to houses, Australian units are generally located in inner-city areas and rates of ownership are evenly split between investors and owner-occupiers (CoreLogic, 2016). I explore whether neighbourhood price dynamics differ across these segments. This is especially relevant given the rising importance of units in State Government strategies to meet affordability pressures and infill housing targets (National Housing Supply Council, 2010).

I begin by describing demand-side and supply-side mechanisms that can drive price convergence or divergence across the neighbourhoods of a city. This is followed by discussion of suitable convergence/divergence measures and a detailed explanation of methods and data. The findings from analyses of price dynamics are then presented, with a focus on the potential causes of heterogeneous price patterns that are found across cities and sub-periods of the study timeframe.

2.2 BACKGROUND LITERATURE

2.2.1 Mechanisms for convergence or divergence in price dynamics

In the early neoclassical urban economics literature, cities are monocentric with rents (and hence dwelling prices) that are predicted to decline with distance from the central business district as households trade-off accessibility, transport costs and space (Alonso, 1964). More recently, urban housing markets are viewed through a polycentric lens, with price dynamics reflecting various drivers in addition to access-space considerations. Potential drivers of inter-neighbourhood price dynamics can be classified into supply-side and demand-side factors.

Among supply side drivers there is the home-voter hypothesis (Fischel, 2009). It proposes that affluent homeowners can influence local governments and planning authorities by gaming planning and zoning decisions to the betterment of their own property values and amenity. This regulatory capture restricts new dwelling supply but improves amenities in affluent homeowners’ (typically higher-priced) neighbourhoods. Dwelling prices in these neighbourhoods diverge from those occupied by less influential lower-income households.

Relevant evidence is presented in McLaughlin et al.'s (2016) local government area supply elasticity estimates for Adelaide, Australia, that find a negative correlation between new supply and areas’ average household incomes. Rowley et al. (2020) report relatively high housing supply in local government areas with below average house prices, which is attributed to a lack of site availability and pushback from local owners in higher-priced areas.

He & La Cava (2020) link limitations on new dwelling supply to the interaction between Australian monetary policy and dwelling prices. They find that prices in higher-priced neighbourhoods are more sensitive to shifts in the stance of monetary policy, and suggest that limitations on new supply in these areas impede a response to monetary policy induced demand. This notion is supported by Glaeser et al., (2013), who find there to be a larger impact on prices from interest rates movements in supply-constrained American cities. He & La Cava (2020) also argue that sensitivity to interest rate movements is due to greater indebtedness among homebuyers in higher-priced neighbourhoods.

On the demand-side, Guerrieri et al.'s (2013) endogenous gentrification hypothesis proposes that a higher quality and variety of consumption amenities shape a neighbourhood’s appeal with spill over benefits to adjacent but cheaper neighbourhoods. These neighbourhood consumption externalities can act as a catalyst for gentrification in adjacent neighbourhoods during favourable market conditions. Neighbourhood price differentials will narrow as a result of this process and convergence in neighbourhood price dynamics can be expected.

Studies analysing the dynamics of intra-city dwelling price differentials and housing market cycles typically find that prices diverge during upturns and converge during downturns. Mayer (1993) and Stein (1995) postulate that when housing market conditions weaken, “locked in” homeowners are unable to realize sufficient equity from sale of their existing home to trade up into higher-priced neighbourhoods, and prices therefore stagnate in these neighbourhoods. Meanwhile the weaker market conditions incentivise aspiring owners to enter the market in typically lower-priced neighbourhoods. These differential demand effects combine to promote price convergence. But when housing market conditions are strong, differential demand effects are reversed, and price divergence is anticipated.

Deregulation of the Australian financial sector is potentially relevant. Since the 1970s Australia has, like much of the western world, embraced the neo-liberal paradigm (Pawson et al., 2019). It invigorated competition in both domestic and international financial market, and stimulated new mortgage products, securitization, more relaxed loan eligibility criteria, and reductions in the cost of borrowing, all of which increased homeowners and investors borrowing capacity. Pawson et al., (2019) explains that this benefited higher-income Australian households because of a shift away from conservative lending rules which limited repayments to 30% of a household's gross income. Instead, the 'net income surplus' rule assumes that household income above a minimum subsistence level is available to meet mortgage repayments, allowing higher-income households to borrow much higher percentages of their gross income. This increase in their relative borrowing power has raised the demand for higher-priced property, driving divergence, while concurrent increases in income inequality exacerbate the impact of this change (Wood et al., 2016).

Bradbury (1990) links growing income inequality to property price divergence in the US. In Australia there has been a rise in income inequality since market liberalisation in the 80's, though it has slowed as income growth has stagnated in recent times (Burke et al., 2020). Wealth inequality trends, on the other hand, are more pronounced with the average wealth of the top 20% of Australians growing ten times faster than that of the bottom 20% (Davidson et al., 2020). Higher-priced segments of the housing market benefit due to increasing demand from income rich and wealth rich households. Pawson & Martin (2020) surveyed property investors who had invested in the most disadvantaged suburbs of Sydney, and found investors to be typically high income, better educated, and resident in more advantaged Sydney suburbs. This suggests that some of the income and wealth accumulated by high-income households leaks into lower-priced neighbourhoods through their property investments, and is therefore also a potential driver of price convergence.

2.2.2 Measurement of convergence and divergence

Convergence diagnostics came to prominence in the economic growth literature of the 1980's and 1990's. Baumol (1986) estimated a 'growth-initial level' regression model using a country sample of growth rates that was regressed on national income levels at the start of the study timeframe. The sign and significance of the estimated beta-coefficient on the initial national income level variable indicates either beta-convergence (negative sign) or beta-divergence (positive sign) (see Islam (2003) for a literature review).

Housing price dynamics is commonly studied across regions or cities belonging to the same country (see Cook (2012) or Kim & Rous (2012)), rather than across intra-city neighbourhoods. Much of this literature is US or UK focused and many examine 'ripple effects' in housing prices through complex econometric measures of stochastic convergence. This essay's principal motivation is the impacts of different price dynamics on access to homeownership and housing wealth inequality. The convergence measures I employ are simpler and readily interpretable tools for this purpose.

Friedman (1992) and Quah (1993) argue that it is important to test for both sigma- and beta-convergence. Sigma-convergence is evident when the cross-section distribution of a variable narrows over time. Use of both measures is recommended because a negative beta-coefficient from 'growth-initial level' regressions does not ensure sigma-convergence (Sala-i-Martin, 1996).[5]

Hill et al. (2009) find both sigma-convergence and sigma-divergence across the neighbourhoods of Sydney, Australia, over a six-year period from 2000 to 2006. The authors suggest that dwelling price convergence is related to the dwelling price cycle. Using a longer timeframe of 19 years (1990-2009), Wood et al. (2016) document both beta- and sigma-divergence across 108 submarkets in Melbourne. The findings in these two papers suggest that the spatial dynamics of neighbourhood prices vary across Australian cities, a question that helps motivate this study.

2.3 METHODS AND DATA

Beta-convergence or beta-divergence is detected using a 'growth-initial level' regression model adapted to within-city neighbourhood-level dwelling prices, as in Wood et al. (2016). The specification is;

$$r_i = \alpha + \beta y_i + \varepsilon_i, \ \varepsilon \sim \mathrm{N}(0, \sigma^2) \quad (1)$$

where r_i is the annual growth rate of dwelling prices in neighbourhood i of a city, and y_i is the natural log of real median price in neighbourhood i at the start of the observation period. The size of the beta-coefficient (β) is the key estimate; a larger value indicates faster convergence

[5] For example, the negative beta-coefficient from 'growth-initial level' regressions could be so large that initially expensive (cheap) neighbourhoods end-up being the low-priced (high priced) neighbourhoods, and the resulting neighbourhood price distribution has a higher standard deviation than the initial distribution.

when negative and faster divergence when positive. The model was estimated by ordinary least squares and separately for Sydney, Melbourne, Brisbane, Perth and Adelaide over the full-period (2001-2016), and three sub-periods (2001-2006, 2006-2011, 2011-2016), as well as by dwelling type (houses and units).[6]

I also test for sigma-convergence and sigma-divergence. Sigma-convergence is evidenced by a declining standard deviation of real median dwelling prices over time, as described in equation (2):

$$\sigma_{t+1} < \sigma_t, \qquad (2)$$

Where σ_t is the time t standard deviation of the natural log of real median dwelling prices. I calculate σ_t over each city's neighbourhoods, in each year from 2001 to 2016 and separately for houses and units. If the standard deviation falls over time, the distribution of dwelling prices across neighbourhoods narrows, and there is sigma-convergence. Conversely, a declining standard deviation over time defines sigma-divergence.

My chosen spatial unit is the Statistical Area Level 2 (SA2). Each SA2 conforms to the 2011 Australian Statistical Geography Standard (ASGS), and is designed to represent communities within which there are strong social and economic interactions (ABS, 2020). 1067 SA2s are defined within the Greater Capital City Statistical Areas (GCCSA) of my five cities, and 1009 have usable price data. Each SA2 contains a mean 4030 dwellings.

Two house and unit price data sets are employed. The first was obtained from property data provider Australian Property Monitors, and contains yearly median prices for each SA2.[7] This median price data was used to calculate y_i in equation (1) as well as σ_t in equation (2). The second was purchased from property data provider CoreLogic and contains hedonic price growth indices for each SA2. These indices were used to calculate r_i in equation (1). The growth indices are obtained by estimating a hedonic regression; the estimated coefficients are used to 'price' a representative bundle of housing characteristics in each region and year of the sample period (Green & Malpezzi, 2003).[8] Hedonic estimates of price growth are useful as

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[6] All years referred to in this analysis are financial years.

[7] This research used the NCRIS-enabled Australian Urban Research Infrastructure Network (AURIN) Portal e-Infrastructure to access the dataset 'APM - Timeseries Property Data (SA2 - ASGS 2011) 01/01/1986 - 31/12/2017' on 14/08/2018 (Australian Property Monitors, 2018).

[8] The exact methodology used to create the SA2 hedonic indices used in my analysis are explained in CoreLogic (2018).

they control for the time-varying quality and composition of the transacted dwelling stock that is a source of error in measures of price growth (Hansen, 2009). The accuracy of the beta-convergence results are enhanced by the use of this hedonic measure of price growth.

Houses in my price data sets are defined as any dwelling situated on a single title, while units share a title with any number of other dwellings. I inflated the house and unit hedonic indexes and median prices for each SA2 to 2019 prices, using the Consumer Price Index (CPI) of the SA2's relevant city.[9] The inflation adjusted hedonic index was used to calculate real annual price growth.[10]

Table 1 provides descriptive data on real price levels and their growth in each city, as well as across the all city sample. In the latter annual real price growth 2001-2016 was 4.8% for houses and 3.5% for units. Property owners therefore enjoyed large real increases in dwelling values and increases in wealth provided they have not leveraged against these gains. Melbourne has the largest SA2 sample with complete dwelling price data - 273 SA2s for houses and 218 SA2s for units. Adelaide has the smallest sample - 101 SA2s for houses and 75 SA2s for units. Sydney SA2s feature the highest initial median price for both houses ($577,491) and units ($404,309). Median prices reach a low in Adelaide at $241,493 for houses and $148,009 for units.

Given housing market cycle theories of neighbourhood price dynamics (Guerrieri et al., 2013; He & La Cava, 2020; Mayer, 1993), it is prudent to test for convergence over the entire observation period, as well as sub-periods corresponding to different market cycle segments (Cook, 2012) and shifts in monetary policy. The chosen sub-periods are 2001-2006, 2006-2011, and 2011-2016.

In the first sub-period all cities enjoyed buoyant market conditions leading up to the GFC; all SA2 real price growth reached annual rates of 9.0% for houses and 7.9% for units. Unusually, Australian cities did not suffer a crash in dwelling prices during or immediately post GFC (Murphy, 2011). Indeed, Melbourne and Adelaide still enjoyed annual price growth over the second sub-period. But Brisbane and Sydney prices stagnated, while Perth house and unit prices declined by roughly 2.0% per annum. Price trends in the third recovery sub-period are

[9] CPI obtained from ABS catalogue 6401.0 – Consumer Price Index, Australia.

[10] Price growth for each SA2 was annualised by calculating the SA2's percentage change in the inflation adjusted hedonic index over the sample period, and then dividing by the number of years comprising the sample period.

heterogeneous. Annual price growth was a substantial 7.1% for Sydney houses, 3.9% for Melbourne houses, while house prices were relatively stable in the other cities. But unit prices were either stagnant or declined in all cities bar Sydney (4.3%).

2.4 PRICE DYNAMICS: CONVERGENCE OR DIVERGENCE?

Table 2 lists beta-convergence estimates using the 'growth-initial level' model (see equation (1)), for houses and units in each individual city, across the entire study-period as well as 3 sub-periods. Table 3 presents the standard deviation of the log of SA2 median dwelling prices for houses and units in each city at the initial and terminal year of each sub-period.

2.4.1 Convergence and divergence across the full period 2001 to 2016

Over the full period Table 2 confirms beta-convergence for *units* in all cities. But the evidence is mixed across the *house* segments of cities' dwelling stocks. House price beta-convergence was evident in Brisbane and Perth, while Sydney and Adelaide's house price dynamics are uncertain. In contrast Melbourne displays house price beta-divergence over the full period, confirming the findings in Wood et al. (2016) using a different data source and an earlier time period. Melbourne's price dynamics were therefore distinctive; house prices in relatively high-priced neighbourhoods grew faster than those in relatively low-priced neighbourhoods.

For units, Adelaide exhibited the strongest beta-convergence. Rates of price appreciation fell by 0.039 percentage points for every one per cent increase in an Adelaide SA2's initial median unit price. This compares to 0.005 percentage points in Sydney, the city with the slowest unit price beta-convergence.

Table 3 confirms that all cities with *beta*-convergence of house or unit prices also display *sigma*-convergence. I can therefore conclude that price rises in cheaper neighbourhoods were sufficient to narrow the price divide between neighbourhoods at extremes of the price distribution. In some cities and dwelling type segments the price gap has been substantially cut. For example, in the units segment of Brisbane, standard deviations fell from 0.398 (2001) to 0.256 (2016) – a decrease in dispersion of 36%.

In the house segments of the Melbourne and (to a lesser extent) Sydney markets, the sigma measure suggests divergence in price dynamics, and confirms a positive and significant Melbourne beta coefficient. It is noticeable that the Melbourne house market experienced the highest annual real price growth of 6.1% (see Table 1). The large real capital gains offered in

Melbourne's market is especially attractive to high tax bracket homebuyers and investors, and so price divergence could reflect the income bias in capital gains tax concessions. While annual real price growth is lower in the house segments of other cities' housing stocks, they nevertheless reach very attractive rates. It seems likely that the conspicuous difference between Melbourne and other cities' house price dynamics is driven by other factors.

In the *Background Literature* section of this essay, it was established that limitations on new supply can drive intra-city convergence or divergence. Table 4 offers a supply-side explanation for the differing price dynamics between dwelling types, as well as Melbourne's distinctive house price divergence. All SA2 house or unit approvals have been assigned to the house or unit price quartile a SA2 belongs to at the beginning of the measurement period. The pattern of supply across these price quartiles is then described by the percentage of city-wide house or unit approvals in each house or unit price quartile. The measurement periods are the three sub-periods, as well as the full period.

Building approvals over the full period reveal a clear differentiation in patterns of supply between dwelling types; house approvals favoured lower-priced quartiles (Q1 and Q2) at the expense of higher-priced quartiles (Q3 and Q4), while unit approvals were the inverse. This reflects the role of each dwelling type in the Australian market and the generally declining price gradient with distance from the city centre. A near majority (48%) of units are investor-owned, and predominately located in inner city areas to meet the demand for housing services in already developed areas (CoreLogic, 2016). Metropolitan planning efforts in the 2000's saw all five cities introduce infill targets of at least 50% of new supply, for which new unit supply plays a key role (National Housing Supply Council, 2010). Houses, on the hand, are mostly owner occupied, and new supply is predominately constructed on the urban fringe where developable land is more abundant.

In the five cities combined, 63% of house approvals were contained in the lower-priced quartiles, as compared to only 38% of unit approvals. The weaker evidence on price convergence in the house segment might reflect the stronger bias in house supply towards lower-priced quartiles, which puts downward pressure on prices in lower-priced neighbourhoods. Computing correlation coefficients between convergence estimates and patterns of supply supports this notion; over the full period, there is a strong positive relationship (0.78) between house beta-coefficients estimated in Table 2 and the percentage of house approvals in the bottom two quartiles of each city, signalling that beta-divergence is more likely as lower-priced supply increases.

In Melbourne new house supply favoured lower-priced quartiles more than in the other cities. Consider, for example, the lowest price quartile where a little over one third of Melbourne's new house supply was approved back in 2001, somewhat higher than in all cities (30%); by 2016 that share of Melbourne's house approvals had approached one half, 13 percentage points higher than the all cities share (35%). Meanwhile the share of all house approvals in the top two price quartiles contracted. This supply side shift reflects the abundance of greenfield sites to the north and west of Melbourne that are relatively close to the city centre (Daley et al., 2018). Development of these sites have helped Melbourne respond to growing population pressures over the study timeframe, suppressing house price growth on the lower-priced fringe and contributing to Melbourne's distinctive divergent house price dynamics. In contrast, Sydney faced the same population pressures, but was burdened by greater geographical constraints, due to national parks to the north and south, ocean to the east, and the Blue Mountains to the west (Daley et al., 2018) leading to a greater reliance on unit development. I now examine price dynamics in each sub-period.

2.4.2 2001 to 2006 sub-period

Convergence is a strong feature of price dynamics in both house and unit segments across all cities in this first sub-period. The beta-coefficients suggest that convergence in unit prices occurred at a faster rate than for house prices (see Table 2). Table 3 reveals falls in the sigma measure in every city and across both dwelling types. There is then strong relative real price gains in initially inexpensive neighbourhoods in mainland state capital cities that narrows price gaps between relatively expensive and inexpensive neighbourhoods. In the house segment of Brisbane's dwelling stock and the unit segment of Sydney's dwelling stock there is a 24% reduction in dispersion in only 5 years.

The period 2001-2006 represents the run up to the GFC when market-wide house and unit price growth was very strong. Brisbane and Perth reach double digit annual inflation rates for real house prices (12.4% and 19.8% respectively), but rates are also robust in the other cities and dwelling types (see Table 1). Brisbane and Perth also had the strongest beta-convergence estimates in both house and unit segments. Past studies typically find that prices diverge during upturns and converge during downturns (Mayer, 1993; Stein, 1995). Pre-GFC price convergence contradicts this hypothesis, and I instead turn to supply and policy explanations.

The exceptionally strong convergence results in Brisbane and Perth in this first sub-period could be related to the commodities boom of the 2000's. Perth and Brisbane are the state capitals of Western Australia and Queensland, states that contribute by far the largest proportion of Australia's mining output, and therefore benefited most from the commodities boom (Garnett, 2012). Western Australia was the most impacted, with big increases in housing demand as investment and employment in the mining sector soared, attracting migrants to the state, and driving incomes higher for workers inside and outside of the mining sector (Garnett, 2012). Strong population growth and income gains lifted demand for dwellings, especially in Perth's lower-priced and land abundant middle and outer ring neighbourhoods. Despite several commodity price downturns, mining continues to be an important sector in the Western Australian economy. Perth is conspicuous as the only city that did not experience house price beta-divergence in any subsequent sub-period.

Table 4 confirms the correlation between the five cities' beta- and sigma-convergence estimates and supply patterns across housing price distributions. For units, approvals in the top two price quartiles are 63% of all cities' approvals, and are especially strong in Melbourne (71%) and Brisbane (69%). The surge in unit approvals in these two price quartiles is likely to have depressed price growth at the upper end of the price distribution. These patterns are also evident in the house segment of cities' dwelling stocks where a strong negative correlation coefficient (-0.85) between beta coefficients and the top two price quartiles share of approvals suggests that convergence is more likely when house supply increases in higher price quartiles.

Trends in interest rates could also play a role in driving these patterns. He & La Cava (2020) have shown that in the expensive segments of Australia's housing market, prices are more sensitive to changes in interest rates. Convergence in price dynamics is then more likely following interest rate rises, while divergence is more probable following interest rate cuts. The 2001-2006 sub-period confirms this prediction because it is the only one of my three sub-periods in which interest rates predominately increased; the Reserve Bank of Australia's cash rate was 4.25% at the end of 2001, and then steadily increased to 5.75% by the end of 2006 (RBA, 2020b).

A second potential influence is the $7000 First Home Owners Grant (FHOG) introduced in July 2000 to assist first homebuyers meet deposit constraints. Randolph et al. (2013) found that the $2.5 billion FHOGs approved in Sydney from 2000-2010 was largely spent on existing dwellings in lower-value suburbs. This pattern is also likely in the other Australian cities given that first homebuyers usually purchase towards the lower-end of the price distribution. The resulting pressure on prices in cheaper entry-level segments of housing markets will have encouraged beta and sigma price convergence in that first sub-period, as young homebuyers advanced their planned first transitions into homeownership using FHOGs.

Another relevant policy intervention was the 1999 changes to capital gains tax law that introduced a 50% discount on capital gains realised on asset transactions. Shi et al. (2016) discusses its role in kick starting a housing boom that persisted up until the GFC. This policy change increased the concessions that landlord capital gains benefit from, and encouraged acquisition of properties in neighbourhoods with strong price growth. In this sub-period that price growth was strongest in those neighbourhoods with initially lower prices.

2.4.3 2006 to 2011 and 2011 to 2016 sub-period

The subsequent two sub-periods are grouped together because they offer a marked contrast to the first sub-period. The strong convergence evident over the 2001-2006 sub-period progressively weakens as the rest of the study timeframe unfolds. In the house segments of Melbourne, Brisbane and Adelaide's housing stocks, price dynamics become beta divergent (see Table 2a)[11]. Sigma-divergence is also apparent in these cities, with increases in the sigma measure evident in Brisbane as well as Adelaide, and across both sub-periods (see Table 3). In the house segment of Sydney's dwelling stock, price dynamics are strongly beta divergent in the 2006-2011 sub-period; while the beta coefficient remains positive in the final sub-period it loses statistical significance. A similar pattern is evident from Sydney's sigma measure. By the final sub-period Perth's house price dynamics are unique in remaining both beta and sigma convergent. Perth is also the only city with falling house and unit prices in both sub-periods.

In the unit segment of cities' housing stocks, the strong convergence detected in the first sub-period's price dynamics also fades over the subsequent two periods. In Brisbane and Melbourne unit price dynamics are significantly beta divergent by the final 2011-2016 sub-period, while Sydney and Adelaide's initial unit beta-convergence weakens such that no discernible pattern is evident by the final sub-period (see Table 2b). In three of these four cities (Sydney is the exception) the sigma measure also increases in the final sub-period. Perth presents a mixed pattern that again contrasts with the other cities.

[11] In Melbourne's case the beta coefficient is positive and statistically significant in both sub-periods and increases in size. In Brisbane and Adelaide statistically significant and positive beta coefficients are eventually achieved in the later sub-period.

The change in price dynamics that is generally witnessed in these later two sub-periods correlates with a relaxation of monetary policy following the GFC. Economic growth resumed at relatively low rates, real wages stagnated and fiscal policy sought to restore a budget balance.[12] Monetary policy was therefore relied on to maintain momentum in the economy. The Reserve Bank of Australia cut its cash rate from 5.75% to 4.75% in the 2006-2011 sub-period, and then more steeply from 4.75% to 1.75% over the 2011-2016 sub-period (RBA, 2020b).[13] These lower cash rates fed through into the variable rate on mortgage loans and thereby provided considerable financial relief to mortgagors, especially those burdened by large loans.[14]

The interest rate cycle offers a convincing explanation of the changing price dynamics. When interest rates fall, supply-constrained higher-priced areas experience greater price increases as supply is less able to respond to monetary policy induced demand (Glaeser et al., 2013; He & La Cava, 2020). Also, when interest rates fall the largest reductions in mortgage payments are experienced by those with the biggest outstanding loans. It is homebuyers positioned toward the upper end of the housing price distribution that secure the biggest mortgages loans, a factor that has been exacerbated by financial deregulation and widening wealth inequality. According to the 2016 release of the Household, Income and Labour Dynamics in Australia Survey, the average and median mortgage loan serviced by homebuyers in the lowest dwelling price decile is A$141,292 and A$139,500 respectively (See Table 5). In the highest housing price decile, where home values exceed A$1.3m, the average (median) mortgage loan is A$602,706 (A$400,000).

The relationships outlined above between monetary policy, new supply and debt in higher-priced neighbourhoods prompt price divergence following interest rate reductions, and price

[12] Annual growth in real GDP slumped from 5.4% pre-GFC (2001-2008) to only 2.1% post-GFC (2008-2016) (Authors own calculations from ABS Cat 5206.0 and ABS Cat 6401). Real wage growth was very low throughout; pre- GFC growth of 0.8% per annum was followed by annual growth of 0.9% post-GFC (total hourly rates of pay excluding bonuses, private and public, seasonally adjusted, ABS Cat 6345.0).

[13] Before the GFC struck rates rose to 7.25% in March 2008 before falling sharply to 3% in April 2009. By June 2009 they had been increased back to 4.75%. But continued weakness in the national economy meant that cash rates decline throughout the later 2011-2016 sub-period.

[14] The indicator standard variable rate on owner-occupied residential mortgages initially increased from 7.6% in June 2006 to peak at 9.6% in August 2008; sharp declines followed with rates bottoming out when they reached 5.8% in September 2009. They then rose but remained below June 2006 levels until November 2010. In the last sub-period rates plummeted from 7.8% in July 2011 to 5.4% in June 2016. Sourced from RBA Statistical Table 'Indicator Lending Rates – F5' (RBA, 2020a)

convergence when interest rates increase. Monetary policy can then be the source of differential impacts across local housing markets. The housing policy implications of this conclusion are developed in the following concluding comments.

2.5 CONCLUSION

My empirical investigation of price dynamics in five Australian cities finds that the prices of units converged in these cities over the observation period 2001-2016. The price distribution became more compressed because prices of units in initially cheaper neighbourhoods increased more rapidly than unit prices in initially more expensive neighbourhoods. The evidence is somewhat mixed across the house segments of each city's dwelling stocks, but there is only one city (Melbourne) with price dynamics that could be described as divergent over the observation window 2001-2016. Heterogeneous patterns of new supply across the price distribution of a city offer an explanation for the different outcomes between dwelling types and cities.

The more intriguing findings emerge when I breakdown the observation window into three sub-periods; 2001-2006 in which there is strong market-wide house and unit price growth in the lead up to the GFC; 2006-2011 that straddles the severe economic shock associated with the GFC; and 2011-2016, a period of post-GFC recovery. It turns out that convergence over the entire observation period is primarily driven by very strong price convergence in the pre-GFC 2001-2006 sub-period. An array of macroeconomic, fiscal and housing policy factors combined in these years to stoke price pressures in the cheaper segments. The strong economic growth in these years prompted the monetary authorities to tighten policy by raising interest rates. Heavily indebted households, who typically reside in more expensive neighbourhoods, are hit hardest. At the start of the pre-GFC period the Australian Federal Government introduced a First Home Owner's Grant that eased borrowing constraints for those buying their home for the first time. Those entering homeownership tend to buy in neighbourhoods with relatively low prices. Finally, changes to capital gains tax laws (introduced in 1999) increased the concessions that landlord capital gains benefit from, and encouraged acquisition of properties in neighbourhoods with strong price growth. In this sub-period that price growth was strongest in those neighbourhoods with lower prices.

That unusual combination of government interventions were then (unintentionally) working together to shift patterns of supply and demand in ways that encouraged price convergence.

But in my post-2006 sub-periods this synchronicity broke down in one very important respect. The shock delivered to economic systems by the GFC prompted monetary authorities to relax their stance. A period of rising interest rates 2001-2006 was therefore followed by generally lower interest rates and quantitative easing that sought to maintain flows of credit, and maintain confidence in asset markets, with the housing market being to the forefront of policy makers attention given the importance of house prices as a source of wealth effects. Cuts to cash rates fed through into much lower mortgage interest rates and so the monetary factors that had tended to restrain price growth in expensive neighbourhoods were reversed. When interest rates decline there will be stronger demand for housing throughout the housing market, but because supply is less responsive and mortgage debt levels are higher in more expensive neighbourhoods, demand will receive a bigger boost in these more expensive segments of the housing market.

The strongly convergent price dynamics faded as a result of these shifts in the pattern of demand. In the final sub-period 2011-2016, falls in interest rates were especially steep as Australian fiscal policy sought to balance the national budget, and monetary policy was increasingly relied upon to support economic growth. In this final sub-period price dynamics were divergent in the majority of Australian cities' unit and house submarkets. Prices were growing more rapidly in higher priced neighbourhoods, and the price divide separating expensive from cheaper neighbourhoods widened. Monetary policy has well understood aggregate effects on the housing market, but it also has heterogeneous impacts across local housing markets, and thus on subgroups of households as well.

This narrative poses challenges for housing policy makers. The identification of housing market segments where affordability and accessibility problems are worsening is made more difficult. Policymakers need to be wary of using price indices that track movements in average prices. Price dynamics in the lower-priced or 'starter home' market are not necessarily accurately represented by such indices. First homebuyers typically purchase in these market segments and governments commonly intervene by easing their borrowing constraints, and assisting with recurrent mortgage payments. The design of such measures would benefit from the use of price indices that more precisely reflect price dynamics in 'starter home' markets.

Shifting price dynamics also have implications for existing homeowners at different stages of the life course and policies that impact on them at these different stages. Growing families in the earlier stages of their housing careers are typically trading up to larger homes that can better meet their space needs. Their aspirations are easier to meet in periods of price convergence because the price divide is easier to bridge with a smaller loan than would otherwise be the case. Divergence in price dynamics has very different implications. While the young family seeking to trade up confronts a widening price gap, that growing divide is to the gain of ageing couples and singles that have already climbed the owner occupation housing ladder, as their accumulation of housing wealth is boosted. The security this provides is welcome in old age as it is a store of wealth that can be drawn on in emergencies (Smith & Searle, 2008). It is also more important because of the push towards housing asset-based welfare to fund retirement and age care, as governments grapple with the fiscal costs of supporting an ageing population.

In the years following the GFC economic growth has been weak in Australia and many other high income countries. Central banks have generally maintained a relaxed monetary stance, and as I have documented this has encouraged the emergence of divergence in dwelling price dynamics. This is unlikely to change. COVID-19 poses both a public health and economic crisis that is likely to cause a severe and prolonged economic downturn. Lower interest rates and quantitative easing will be a crucial part of the stimulus measures that governments rely on to promote economic recovery. There will be many challenges ahead for housing policy makers in such an environment. It would be judicious to bear in mind that further relaxation in monetary policy will have uneven impacts across local housing markets and neighbourhoods, and these uneven impacts demand a nuanced approach to the crafting of housing policy interventions.

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2.7 TABLES

Table 1 Summary of house and unit price and price growth, for the SA2s of Australia's five major cities, 2001 to 2016, in Australian Dollars.

City	*SA2: Sample Size 2001*	*Real Median Price of the Average SA2 2001*	*Annual Price Growth of the Average SA2*			
			2001-2006	*2006-2011*	*2011-2016*	*2001-2016*
			Houses			
Sydney	259	$577,491	4.1%	0.3%	7.1%	4.3%
Melbourne	273	$373,229	5.4%	5.1%	3.9%	6.1%
Brisbane	226	$270,875	12.4%	0.6%	0.7%	4.8%
Perth	150	$300,503	19.8%	-2.1%	-0.8%	4.6%
Adelaide	101	$241,493	7.5%	2.2%	-0.6%	3.2%
All Cities	1009	$378,737	9.0%	1.5%	2.8%	4.8%
			Units			
Sydney	198	$404,309	3.2%	0.9%	4.3%	3.1%
Melbourne	218	$289,439	5.4%	4.7%	0.7%	4.2%
Brisbane	90	$227,491	9.9%	0.5%	-2.3%	2.4%
Perth	93	$180,863	17.1%	-1.9%	-2.0%	3.2%
Adelaide	75	$148,009	11.4%	4.4%	0.0%	6.1%
All Cities	674	$284,193	7.9%	1.9%	0.6%	3.5%

Source: Authors own calculations.

Notes: Prices were inflated to real 2019 values using the relevant cities' CPI from ABS catalogue 6401.0 – Consumer Price Index, Australia. SA2s are defined by their ABS ASGS, and only SA2s within the borders of their cities' GCCSA were included. SA2 Median prices were obtained from data provider Australian Property Monitors. Annual price growth was and calculated using SA2 level hedonic indices obtained from data provider CoreLogic and annualised using the simple annual growth method.

Table 2 Beta-convergence results. Growth-initial level regressions, house and unit initial real median prices against annual price growth, for the SA2s of 5 major Australian cities.

a) *Houses*

	2001-2006	***2006-2011***	***2011-2016***	***2001-2016***
		Sydney		
Convergence?	Convergence	Divergence	-	-
β-coefficient	- 0.016***	+ 0.012***	- 0.004	- 0.0012
Std. Err.	0.0021	0.0025	0.0021	0.0016
R-Squared	0.17	0.09	0.01	0.00
		Melbourne		
Convergence?	Convergence	Divergence	Divergence	Divergence
β-coefficient	- 0.013***	+ 0.006*	+ 0.041***	+ 0.018***
Std. Err.	0.0031	0.0035	0.0029	0.0028
R-Squared	0.07	0.02	0.41	0.13
		Brisbane		
Convergence?	Convergence	-	Divergence	Convergence
β-coefficient	- 0.058***	+ 0.002	+ 0.018***	- 0.011***
Std. Err.	0.0034	0.0027	0.0033	0.0023
R-Squared	0.57	0.00	0.12	0.10
		Perth		
Convergence?	Convergence	-	Convergence	Convergence
β-coefficient	- 0.065***	+ 0.006	- 0.009***	- 0.014***
Std. Err.	0.0072	0.0034	0.0017	0.0021
R-Squared	0.35	0.02	0.15	0.23
		Adelaide		
Convergence?	Convergence	Convergence	Divergence	-
β-coefficient	- 0.017***	- 0.012***	+ 0.018***	- 0.0035
Std. Err.	0.0043	0.0028	0.0036	0.0026
R-Squared	0.14	0.17	0.19	0.02

b) Units

	2001-2006	2006-2011	2011-2016	2001-2016
		Sydney		
Convergence?	Convergence	-	-	Convergence
β-coefficient	- 0.033***	- 0.0001	+ 0.004	- 0.005*
Std. Err.	0.0029	0.0047	0.0029	0.0023
R-Squared	0.38	0.00	0.01	0.03
		Melbourne		
Convergence?	Convergence	-	Divergence	Convergence
β-coefficient	- 0.051***	- 0.003	+ 0.019***	- 0.018***
Std. Err.	0.005	0.0046	0.0044	0.0029
R-Squared	0.32	0.00	0.08	0.14
		Brisbane		
Convergence?	Convergence	Convergence	Divergence	Convergence
β-coefficient	- 0.062***	- 0.01***	+ 0.033***	- 0.018***
Std. Err.	0.0074	0.0039	0.0068	0.003
R-Squared	0.45	0.10	0.17	0.30
		Perth		
Convergence?	Convergence	Divergence	-	Convergence
β-coefficient	- 0.109***	+ 0.02**	+ 0.006	- 0.013*
Std. Err.	0.016	0.0068	0.0069	0.0062
R-Squared	0.34	0.10	0.01	0.05
		Adelaide		
Convergence?	Convergence	Convergence	-	Convergence
β-coefficient	- 0.072***	- 0.021*	+ 0.031	- 0.039***
Std. Err.	0.0154	0.0097	0.0171	0.0108
R-Squared	0.23	0.06	0.00	0.15

* P < 0.05, ** p < 0.01, *** p < 0.001.

Source: Authors' own calculations from various SA2 level price data sets.

Notes: Refer to Table 1's notes.

Table 3 Sigma-convergence results. Standard deviation of the natural log of real median prices, for the SA2s of five Australian cities.

	Standard Deviation of SA2 Log Median Prices			
City	***2001***	***2006***	***2011***	***2016***
		Houses		
Sydney	0.463	0.435	0.497	0.486
Melbourne	0.405	0.387	0.383	0.463
Brisbane	0.385	0.291	0.296	0.340
Perth	0.431	0.361	0.375	0.352
Adelaide	0.354	0.295	0.297	0.329
		Units		
Sydney	0.402	0.307	0.340	0.290
Melbourne	0.341	0.253	0.251	0.298
Brisbane	0.398	0.311	0.200	0.256
Perth	0.331	0.246	0.252	0.259
Adelaide	0.259	0.179	0.195	0.220

Source: Authors own calculations.

Notes: See Table 1's notes for further details.

Table 4 Percentage of total building approvals, by dwelling price quartile, Australian city, and dwelling type.

	Percentage of Total House (Unit) Approvals			
SA2 House (Unit) Price Quartile	***2001*-2006***	***2006-2011***	***2011-2016***	***2001*-2016***
Sydney				
Q1	28% (19%)	21% (22%)	32% (12%)	31% (18%)
Q2	32% (22%)	41% (22%)	41% (25%)	35% (22%)
Q3	27% (26%)	19% (27%)	15% (35%)	20% (28%)
Q4	13% (32%)	19% (30%)	11% (27%)	14% (32%)
Melbourne				
Q1	34% (13%)	37% (15%)	48% (11%)	37% (14%)
Q2	33% (16%)	36% (18%)	29% (18%)	28% (18%)
Q3	24% (21%)	18% (35%)	11% (38%)	26% (19%)
Q4	9% (50%)	9% (32%)	10% (30%)	9% (49%)
Brisbane				
Q1	26% (12%)	37% (19%)	30% (12%)	33% (17%)
Q2	28% (19%)	23% (27%)	36% (21%)	26% (19%)
Q3	31% (19%)	28% (23%)	22% (21%)	30% (17%)
Q4	14% (50%)	11% (32%)	11% (44%)	11% (46%)
Perth				
Q1	27% (17%)	22% (20%)	22% (35%)	30% (21%)
Q2	29% (24%)	29% (28%)	44% (22%)	27% (29%)
Q3	26% (25%)	36% (43%)	21% (30%)	24% (20%)
Q4	17% (32%)	12% (9%)	12% (11%)	18% (29%)
Adelaide				
Q1	32% (16%)	36% (24%)	34% (10%)	33% (16%)
Q2	36% (28%)	32% (23%)	32% (22%)	35% (32%)
Q3	21% (21%)	20% (21%)	21% (26%)	22% (21%)
Q4	11% (34%)	12% (30%)	12% (42%)	10% (31%)
All Cities				
Q1	30% (16%)	32% (19%)	35% (13%)	34% (17%)
Q2	32% (21%)	32% (22%)	36% (22%)	29% (21%)
Q3	26% (23%)	24% (31%)	17% (34%)	25% (22%)

Q4	13% (40%)	12% (29%)	11% (31%)	12% (39%)

Source: Authors' own calculations from ABS catalogue 8731.0 - Building Approvals, Australia.

* Building approval data is not available for the first year of this period, so the data is reflective of the patterns of supply from 2002 onwards.

Notes: All house or unit approvals in an SA2 have been assigned to price segments as defined by the house or unit price quartile a SA2 belongs to. To create the price quartiles, SA2s within a city were ranked in ascending order by their median house or unit price at the beginning of the relevant period, and spit into four quartiles. A higher quartile number represents SA2s with higher prices than their peers. The 'All Cities' section combines quartile 1 SA2s from within each city, quartile 2 SA2s within each city, … and so on. Percentages in each city may not add to 100% due to rounding.

Table 5 Mean and median mortgage debt of Australian mortgagor households, by primary home value decile, 2016.

Primary Home Value Decile	***Primary Home Value Thresholds***	***Mortgagors (% of all owners)***	***Mean Mortgage Debt (mortgagors only)***	***Median Mortgage Debt (mortgagors only)***
1	<$300000	47.%	$141,292	$139,500
2	$300000 - $390000	51.3%	$210,320	$209,343
3	$390000 - $450000	53.6%	$254,949	$277,000
4	$450000 - $500000	60.3%	$281,447	$300,000
5	$500000 - $560000	61.7%	$306,262	$291,000
6	$560000 - $650000	57.1%	$331,705	$318,000
7	$650000 - $750000	59.7%	$328,381	$340,000
8	$750000 - $900000	49.5%	$360,638	$330,000
9	$900000 - $1300000	50.2%	$523,279	$400,000
10	>$1300000	54.5%	$602,706	$400,000
All	N/A	34.3%	$329,931	$271,000

Source: Authors own calculations using the 2016 release of the Household, Income and Labour Dynamics in Australia (HILDA) Survey.

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3 CHAPTER 3: NEIGHBOURHOOD CONSUMPTION EXTERNALITIES AND HETEROGENEITY IN AUSTRALIAN WITHIN-CITY DWELLING PRICE GROWTH

3.1 INTRODUCTION AND BACKGROUND

In the classical urban economics literature, cities are seen as monocentric centres of production agglomeration, wherein production and cost economies of scale drive the appeal of cities, while negative consumption agglomeration effects, such as traffic and crime, reduce appeal (Alonso, 1964; Mills, 1967; Muth, 1969). In a seminal paper, Glaeser et al. (2001) advocate that due to innovations in production, transport, and information technologies, cities are instead becoming more important as centres of positive consumption agglomeration, which offer a superior range of amenities to increasingly wealthy households. They refer to this future role of cities as the 'consumer city'. As shown in Phelps et al. (2020), Australia's major cities in recent decades have generally experienced rapid appreciation in dwelling prices. They also show that there is systematic heterogeneity in dwelling price growth between neighbourhoods within these cities. A new wave of urban economics literature suggests that if these major Australian cities conform to the 'consumer city' phenomena, then demand for a higher quality and variety of consumption amenities should be a key driver of the desirability of neighbourhoods and subsequent heterogeneity in within-city dwelling price growth.

Guerrieri et al. (2013) show theoretically and empirically this to be the case for American cities. Using a large number of American cities and neighbourhood level detached-house price data, they present a series of stylised facts about within-city dwelling price growth heterogeneity. A key finding was that poorer neighbourhoods closer to rich neighbourhoods appreciated in price more than other poorer neighbourhoods that were further away during city-wide housing booms. This was true even when controlling for initial differences between neighbourhoods and other factors that drive prices, such as distance to the CBD and fixed natural amenities. A key component of their models were positive spill over effects stemming from wealthy neighbourhoods, which the authors refer to as a neighbourhood consumption externalities.

Neighbourhood consumption externalities occur when households gain utility from having wealthy households nearby, as it allows them to consume amenities that are endogenously determined by the affluence and talents of residents in wealthy neighbourhoods. In the context of dwelling prices, households will then be more willing to pay for proximity to affluent neighbours and bid up prices in neighbourhoods surrounding affluent neighbourhoods. An important component to neighbourhood consumption externalities is that of endogenous amenities. Endogenous amenities are broadly defined as amenities that arise due to the locations, interactions and investments of economic agents (Broxterman et al., 2019). This is as opposed to exogenous or fixed amenities, such as good weather, oceans and rivers, and other natural resources, which household find desirable, but that do not significantly change depending on the mix of economic agents[15].

Guerrieri et al. (2013) provide several examples of desirable amenities that one would expect to be endogenous to wealthy neighbourhoods. First, crime rates are usually lower in richer neighbourhoods, and households' value low crime. Second, the quality of public goods – such as schools – may be correlated with incomes, and therefore are maximised in wealthy neighbourhoods. Thirdly, there are increasing returns to scale in production of desired neighbourhood amenities in richer areas, such as the number and variety of cafés and grocery stores, or easier accesses to services like personal fitness. An empirical example of endogenous amenities in the retail space is given by Handbury (2019), who find that higher-income per capita American cities and neighbourhoods offer a greater variety of high quality groceries than lower-income per capita peers. They also find that wealthy households gain higher utility from each dollar spent on groceries in higher-income per capita cities. Diamond (2016) shows that beyond local labour demand shocks, a key driver of the increased level of skill sorting between high school and college graduates across American cities is demand for the higher levels of endogenous amenity in high-skill cities.

Mentions of neighbourhood consumption externalities are sparse in the urban economics literature. Although not called by name, neighbourhood consumption externalities play a key role in Becker & Murphy's (2001) discussion on neighbourhood sorting and segregation, in which willingness to pay to be closer to rich neighbours lead to an spatial equilibrium of full income segregation in a world with exogenous income groups. Bayer et al. (2007) provides empirical evidence in support of neighbourhood consumption externalities using a heterogeneous residential choice model. They find that – ceteris paribus – individuals are willing to pay more for wealthier and more highly educated neighbours. Autor et al. (2014) exploit the unexpected elimination of rent control on properties in the American city of

[15] The desirability of fixed natural amenities can be enhanced by endogenous lifestyle amenities, such as cycling paths and boardwalks.

Cambridge to find that in addition to directly raising the value of said properties, decontrol also led to large spill over increases in the value of never-controlled properties nearby. They conclude that decontrol led to an unwinding of allocative distortions, changing the attributes of residents and endogenously improving the production of local amenities, making it a more desirable place to live and raising dwelling prices.

As suggested by the Autor et al. (2014) example, the existence of neighbourhood consumption externalities implies gentrification. If less-wealthy neighbourhoods become more desirable due to spill overs from wealthy neighbourhoods, and this attracts wealthy households to the neighbourhood who bid up the prices and rents of the existing housing stock, then existing residents risk being displaced. If lower-skilled lower-income households are displaced to the outskirts of the city – as tends to happen in Australian neighbourhoods in the presence of gentrification (Atkinson et al., 2011; Weller & van Hulten, 2012) – then this can cause longer commutes among low-income workers, reduced access to amenities, or prompt housing related compromises in order to access central city job opportunities (Nouwelant et al., 2016). Guerrieri et al. (2013) show empirically for American cities, that in the presence of neighbourhood consumption externalities and labour demand shocks, poorer neighbourhoods closer to rich neighbourhoods show greater signs of gentrification than poorer neighbourhoods that are further away. As noted by Hwang & Lin (2016), if gentrification is primarily caused by increased demand for amenities, then restrictions on housing supply in gentrifying neighbourhoods may amplify dwelling price increases and subsequent displacement effects. Therefore it would be of use to Australian policy makers to know the potential impact neighbourhood consumption externalities are having on Australian within-city dwelling price growth and its subsequent impact on spatial inequality.

This study uses Australian neighbourhood-level hedonic price growth indices to explore the impact of neighbourhood consumption externalities on within-city dwelling price growth heterogeneity. I also test for signs of gentrification. In a linear regression model, I estimate the price growth of less-affluent neighbourhoods, as predicted by distance to affluent neighbourhoods, exogenous amenities, and production agglomeration effects. The effect of distance to affluent neighbourhoods is the key variable. Price dynamics are analysed across neighbourhoods within the mainland state capital cities of Australia – Sydney, Melbourne, Brisbane, Perth and Adelaide – over a 20 year timeframe, 1996 to 2016.

The study makes four contributions to literature. First, it is the first study of the presence of positive neighbourhood consumption externalities within Australian cities. The findings will better inform Australian urban policy makers on how neighbourhood sorting decisions impact upon less-affluent households and neighbourhoods. The findings on gentrification will also contribute to Australia’s relatively sparse literature on the topic of gentrification and displacement (Atkinson et al., 2011). Second, my findings will provide external validity or invalidity to the limited pool of international literature on neighbourhood consumption externalities. My study joins Bayer et al. (2007) and Guerrieri et al. (2013) in analysing the existence of positive neighbourhood consumption externalities, and is the first to do so outside of a US context. Third, I make three methodological extension to the Guerrieri et al. (2013) estimation strategy. The empirics differentiate between houses and units, a potentially important inclusion because dwelling types are not spatially concentrated equally across a city, and usually follow their own market dynamics. One might therefore anticipate different time series properties in rates of price growth calculated in these different segments of the dwelling stock. I include variation in elevation as a natural amenity control variable, as Lee & Lin (2018) suggest it is an important aspect of neighbourhood desirability. Finally, I use an index of economic resources to rank neighbourhoods, instead of neighbourhood dwelling prices, to more accurately represent levels of endogenous amenity within neighbourhoods.

I begin by describing in detail the spatial unit of analysis and the hedonic price growth data used in this study. I then conduct regression analysis, in the style of Guerrieri et al. (2013), to explore the impact of spatial spill overs from wealthy neighbourhoods on price movements among lower-income neighbourhoods. I then search for signs of gentrification in spill over affected lower-income neighbourhoods. Implications for housing policy are discussed in the conclusion.

3.2 SPATIAL UNIT AND PRICE DATA

My spatial unit of analysis is the Statistical Area Level 2 (SA2), which is an area structure specifically designed by the Australian Bureau of Statistics (ABS) for outputting statistics (ABS, 2020).[16] It is a part of the Australian Statistical Geography Standard (ASGS) and

[16] This differs from non-ABS structures, such as suburbs or zip codes, which represent arbitrary or administrative areas not defined by the ABS, which are prone to regular border changes.

represents a community that interacts socially or economically, usually made up of a limited number of suburbs or rural localities.[17] It is the finest level of spatial aggregation for which my price data is available, and is a reasonable proxy to represent 'neighbourhoods' within Australian cities. In this analysis I observe all applicable SA2s that are contained within the Greater Capital City Statistical Areas (GCCSA) of Australia's major cities; Sydney, Melbourne, Brisbane, Adelaide and Perth. GCCSAs are also part of the ASGS, and represent the functional extent of Australia's eight state and territory capital cities. It includes populations that live in built-up areas of capital cities, as well as populations in the smaller towns and areas surrounding those cities, that regularly work, socialise or consume within those cities (ABS, 2020). There are 1,067 SA2s contained within the five cities, and on average one of these SA2s contains 4,030 dwellings, giving us a robust sample from which to test within-city price movements. A small number of these SA2s are industrial or other limited residential areas, and therefore will not necessarily contain price data.

Two house and unit price data sets are employed in my analysis. The first was obtained from property data provider Australian Property Monitors, and contains yearly median prices for each SA2.[18] The median price data is used to control for initial price differences between neighbourhoods in my models. The second was purchased from a private property data and analytics company, CoreLogic, and contains hedonic price growth indices for each SA2. These hedonic price growth indices were used to calculate the dependant variable of my main model – annual real house or unit price growth – over the relevant periods of my study timeframe.[19] Hedonic growth indices are created by estimating a hedonic regression; the estimated coefficients are used to 'price' a representative bundle of housing characteristics in each region and year of the sample period (Green & Malpezzi, 2003).[20] Hedonic estimates of price growth are useful as they control for the time-varying quality and composition of the transacted

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[17] Note that I use SA2 structures from the 2011 ASGS, as opposed to the more recent 2016 ASGS, as the price data used was collected under the former. The borders of all data sets used in this analysis were corresponded to be compliant with the 2011 ASGS.

[18] This research used the NCRIS-enabled Australian Urban Research Infrastructure Network (AURIN) Portal e-Infrastructure to access the dataset 'APM - Timeseries Property Data (SA2 - ASGS 2011) 01/01/1986 - 31/12/2017' on 14/08/2018 (Australian Property Monitors, 2018).

[19] Price growth for each SA2 was annualised by calculating the SA2's percentage change in the inflation adjusted hedonic index over the sample period, and then dividing by the number of years comprising the sample period.

[20] The exact methodology used to create the SA2 hedonic indices used in my analysis are explained in CoreLogic (2018).

dwelling stock that is a source of error in measures of price growth (Hansen, 2009). The accuracy of the results are enhanced by the use of this hedonic measure of price growth.

All price data referred to in this study was inflation adjusted to real 2020 values using the Consumer Price Index (CPI) of the SA2s relevant State. As both price datasets differentiate between houses and units, this allows us to test if patterns of heterogeneity in dwelling price growth and the neighbourhood consumption externality are agnostic to dwelling type differences. Houses in the price datasets are generally defined as any dwelling situated on a single title, while units share a title with any number of other dwellings.

Table 6 provides a descriptive summary of the SA2 median price data by city and by dwelling type. Across the five cities there are 992 SA2s that have median house prices available and 600 that have median unit prices available, at the start of the study period, 1996. The SA2s of Sydney, Australia's most populated city, had the highest average real starting house price in 1996 ($398,551), while Australia's least populated major city, Adelaide, had the lowest ($199,189). To the end of the study period (2016), among all SA2s in the sample, there has been significant hedonic annual price growth of 9.3% and 7.4%, in real terms, across houses and units respectively. To give perspective, the annual increase in the CPI for the five cities over the same period was 2.7%, meaning households in my SA2 sample have on average achieved large real increases in their dwelling wealth.[21]

If I limit the period of annual growth to 1996-2006, real price growth for houses and units in an average SA2 was a considerable 10.5% and 9.2% respectively, with all cities growing significantly in price. This make this sub-period of key interest, as Guerrieri et al. (2013) propagate that heterogeneity in patterns of within-city price movement are most prevalent during housing booms. Outside of Melbourne and Sydney, real median house and unit price growth was considerably slower on average from 2006 onwards (1.8% and 1.7%), and it will therefore be of interest to test whether evidence of a neighbourhood consumption externality is still present when dwelling price growth is not as uniform. I will therefore conduct my analysis over the full period (1996 to 2016), and two sub periods with differing intensities of dwelling price appreciation (1996-2006 and 2006-2016).

Before using my SA2 price data to test for the neighbourhood consumption externality, a type of spatial spill over, it is prudent to use both visual and numerical techniques to check for

[21] Authors' own calculation from ABS catalogue 6401.0 – Consumer Price Index, Australia).

spatial dependence among SA2s. If there are spatial spill overs from wealthy neighbourhoods in to nearby neighbourhoods, then I would expect to see evidence of clustering when SA2 prices are mapped. If spatial dependence was absent, prices would appear to be more randomly distributed than clustered. Using Greater Melbourne as an example, Figure 1 suggests that real median house prices in 1996 exhibit some amount of spatial dependence with clear clustering around certain areas of the city. This clustering becomes even more apparent over time when observing the 2016 map. I can also use a Moran test to numerically test for spatial dependence in cross-sectional data (Moran, 1950). It is a post estimation test of residual correlation with nearby residuals. In performing the Moran test on a regression of my SA2 real median house prices with no independent variables, I was able to reject the null hypothesis that the SA2 prices are independent and identically distributed (not spatially dependant). Therefore it is possible that positive neighbourhood consumption externalities are at play in Australian cities.

3.3 MODEL 1 AND RESULTS

I begin the formal analysis by building a regression model in the style of Guerrieri et al. (2013), wherein neighbourhood consumption externalities from wealthy neighbourhoods drive heterogeneity in dwelling price growth among neighbourhoods within a city. There a two variants of the model based on dwelling types; a house price model and a unit price model. All variables used in the model are defined in detail in Table 7. The regression is described in equation (1):

$$\frac{\Delta \mathrm{P}^{\mathrm{i,j}}_{\mathrm{t,t+k}}}{\mathrm{P}^{\mathrm{i,j}}_{\mathrm{t}}} = \alpha_j + \beta_1 \ln\left(DistEA^{ij}_t\right) + \beta_2 Vct1 + \beta_3 Vct2 + \varepsilon^{\mathrm{i,j}}_{\mathrm{t,t+k}} \quad (1)$$

In which the dependant variable $\Delta P^{i,j}_{t,t+k}/P^{i,j}_t$ is real annual dwelling price growth for houses or units between period *t* and *t+k* for SA2 *i* in city *j*. I include city fixed effects, α_j, so that identification is sourced from variation between SA2s within cities, not across cities.

The key estimate of interest is the beta coefficient (β_1) of the naturally logged distance from the centroid of a SA2 to the nearest top quartile SA2 as ranked by some proxy for endogenous amenity ($\ln\left(DistEA^{ij}_t\right)$).[22] Guerrieri et al. (2013) use the median house price of the neighbourhood to proxy for endogenous amenity, on the basis that house prices are highly

[22] All distances referred to are in kilometres and are measured from the centroids of neighbourhoods.

correlated to incomes, and high income neighbourhoods offer a greater variety of quality endogenous amenities (as discussed in the introduction to this essay). In Australia, the ABS outputs a series of indexes known as Socio-Economic Indexes for Areas (SEIFA), which are designed to rank the relative socio-economic characteristics of areas at a given point in time. As part of SEIFA, the Index of Economic Resources (IER) specifically ranks SA2s by their access to economic resource. A SA2 with a higher IER score indicates that it has many households with high incomes and many owned homes. I use the IER to represent endogenous amenity and rank the SA2s on a per city basis. A negative (positive) and significant β_1 tells us that as a SA2s distance to the nearest to top quartile IER SA2 increases, its price growth decreases (increases), suggesting that households are more willing (less willing) to pay for proximity to wealthy neighbourhoods. The sample is also limited to SA2s that are in the bottom two quartiles of the IER, so that I am testing variations among less-affluent SA2s in response to proximity to affluent SA2s.

I also include two vectors of variables to determine if neighbourhood consumption externalities impact dwelling price growth above and beyond other drivers of dwelling prices. Note that the contents of these vectors are also summarised in Table 7. The first vector (*vct1*) contains factors concerning production agglomeration effects and exogenous Amenities. To control for proximity to jobs raising land values (Alonso, 1964), I include the naturally logged distance to the central business district (CBD) of the city in which the SA2 is contained. I also include the median distance travelled to work from residents inside the SA2.[23] Land values can also be impacted by proximity to desirable fixed natural amenities (Lee & Lin, 2018; Roback, 1982), and therefore I control for proximity to the nearest ocean or major river. I also include the average slope of the SA2, as hilly areas tend to be more visually appealing and provide better views than flat areas, making them more desirable (Lee & Lin, 2018). Weather is another important fixed amenity that impacts land values (Glaeser, Kolko, & Saiz, 2001), but as I am measuring variations in growth between neighbourhoods within cities, not across cities, there is no need to control for weather in the models, as differences in weather within cities will be minor at most. The second vector (*vct2*) contains variables to control for initial differences between SA2s. I include the natural log of real median house or unit price at time *t*, as well as the natural log of real median household income at time *t*. There is a moderate amount of

[23] Obtained from ABS catalogue 2071.0.55.001 - Census of Population and Housing: Commuting to Work - More Stories from the Census, 2016. Note I use the distances from the 2016 Australian census, as this was the first year this data was provided by the ABS.

correlation between initial levels of dwelling prices and household income, but as this is correlation between control variables, and not the key predictor of interest, this is not a concern.

Table 8 presents the results of equation (1). The house and unit model results are displayed for the full period (1996 to 2016), and two sub-periods (1996 to 2006 and 2006 to 2016). All models are reported with heteroscedasticity robust standard errors. Starting with the full period, the beta-coefficient (β_1) is negative and significant for both houses and units, meaning there is systematic variation in dwelling price growth rates among lower-wealth SA2s driven by amenity spillovers from wealthy neighbourhoods. Specifically, lower-income SA2s that were closer to a top quartile IER SA2s increased in house or unit price more than SA2s that were further away. The economic magnitude of these variations are non-trivial. The coefficient for houses (units) represents an annual decrease in the rate of real house price growth of 0.012 (0.0085) percentage points for every one percent increase in the distance to the nearest top quartile SA2. As an example, a lower-wealth SA2 that was roughly 1 kilometre away from a top quartile SA2 would appreciate in real house (unit) price at a 2.4 (1.7) percent higher rate per year than a SA2 that was 4 kilometres away. That is a 48 (34) percent increase over the 20 years.

Another finding to note is that (β_1) is larger in magnitude for houses than units. This suggests that there is heterogeneity between house and unit markets in response to neighbourhood consumption externalities. Nearly 48% of units are investor-owned in Australia, and are predominately located in inner-city areas to meet the demand for housing services in already developed areas (CoreLogic, 2016). It is possible the commodity like nature of units, and their typical location within the already desirable inner-city, makes this dwelling type less susceptible to spillovers from affluent neighbourhoods. Moving to the sub-periods highlights unexpected results. (β_1) is negative and significant for both houses and units during the lower growth 2006 to 2016 period, while it is not significant during the high dwelling price growth period of 1996 to 2006. This is not complementary to Guerrieri et al. (2013), who found the effects of neighbourhood consumption externalities to be most pronounced during housing booms. A potential explanation for this contradictory finding is that despite being high growth in aggregate, 1996-2006 was a period of inconsistent growth, with many cities not experiencing significant price growth till the end of the period. Another explanation is that the cities with the lowest price growth, Sydney and Melbourne, account for 52% of SA2s in the sample and are dominating the model. However, limiting the time-period to 2001-2006, as well as excluding Sydney and Melbourne from the sample, produces the same contradiction.

3.4 MODEL 2 AND RESULTS

In this section I modify equation (1) to instead show the impact of neighbourhood consumption externalities on signs of gentrification, instead of dwelling price growth. The modified regression is described in equation (2):

$$\Delta \mathrm{G}_{\mathrm{t,t+k}}^{\mathrm{i,j}} = \alpha_j + \beta_1 \ln\left(DistEA_t^{ij}\right) + \beta_2 Vct2 + \varepsilon_{\mathrm{t,t+k}}^{\mathrm{i,j}} \quad (2)$$

Which is analogous to equation (1), except the dependant variable is now a measure of gentrification, $\Delta \mathrm{G}_{\mathrm{t,t+k}}^{\mathrm{i,j}}$. The first vector (vct1) is also removed as I no longer need to control for factors that drive dwelling price growth. To measure gentrification, I use the growth in the fraction of residents with bachelor's degrees or above over the period (Diamond, 2016; Guerrieri et al., 2013).[24]

Table 9 presents the results of equation (2). The results are displayed for the full period (1996-2016), and two sub-periods (1996-2006 and 2006-2016). When using the growth in the fraction of residents with a bachelor's degrees or above as the dependant variable, the results are analogous to the results for equation (1). Over the full period, the beta-coefficient (β_1) is negative and significant. A less-affluent SA2 that was roughly 1 kilometre away from a top quartile SA2 would experience growth in the fraction of residents with bachelor's degrees or above at a 2.2 percent higher rate per year than a similar SA2 that was 4 kilometres away. Hence, neighbourhood consumption externalities appear to predict the gentrification of less-affluent neighbourhoods within Australian cities.

3.5 CONCLUSION

In this essay, movements in SA2 level dwelling prices from five Australian capital cities was used to show the impact of neighbourhood consumption externalities on within-city dwelling price growth heterogeneity. Over the 20 year 1996 to 2016 study period, I found a systematic pattern in which less-wealthy neighbourhoods that are closer to wealthy neighbourhoods, experienced higher house and unit price appreciation than other less-wealthy neighbourhoods that were further away. This outcome suggests that positive neighbourhood consumption

[24] This includes any qualification ranked as a seven or above in the Australian Qualifications framework (Office of the Australian Qualifications Framework, 2013).

externalities are present within Australian cities; households are willing to pay for closer access to the greater quality and variety of endogenous amenities found in nearby wealthy neighbourhoods. Exogenous amenities, production agglomeration effects and initial differences between neighbourhoods were controlled for to ensure this impact was above and beyond other drivers of dwelling values. I also found signs that suggest the presence of gentrification; less-affluent neighbourhoods in proximity to affluent ones experienced greater growth in the fraction of residents with a bachelor degree or higher qualification, as compared to similar neighbourhoods that were further away.

The State Governments of the cities in this study have mandated targets for new infill development (National Housing Supply Council, 2010). My findings suggest that less-affluent neighbourhoods in proximity to affluent neighbourhoods are a useful target for urban renewal projects; proximity provides the opportunity to deliver diversity and affordability in the housing stock by tapping into spillover demand from affluent neighbourhoods, avoiding the inflated land and construction costs of development inside those affluent neighbourhoods. However, caution is needed. If proximity to affluent neighbourhoods is also a predictor of gentrification, government intervention might be required to avoid the displacement of low-income tenets in the private rental sector of these neighbourhoods. For example, inclusionary zoning regulations could be used to ensure new developments contain a reasonable proportion of affordable dwellings (Gurran et al., 2018).

Neighbourhood consumption externalities are born from spatial spillovers. An avenue for future research is to convert the linear regression model of this study and Guerrieri et al. (2013) into a spatial autoregressive model. Instead of using distances in a linear regression to estimate the effects of these spillovers, the spatial relationships between neighbourhoods would instead be modelled directly, providing a more robust measure of spillover effects from affluent neighbourhoods.

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3.7 TABLES

Table 6 Summary of SA2 price data for Australia's five major cities, 1996 to 2016, in Australian Dollars

City (GCCSA)	Sydney	Melbourne	Brisbane	Adelaide	Perth	Total
SA2 Data				**Houses**		
SA2 Count (1996)	257	263	224	102	146	992
Real Initial Price of the Average SA2 (1996)	$398,551	$248,004	$249,803	$199,189	$250,582	$282,773
Annual Real Price Growth of the Average SA2 since 1996						
- - Mean	9.8%	12.4%	6.9%	7.4%	7.6%	9.3%
- - Std. Dev.	2.5%	4.0%	2.3%	1.4%	2.2%	3.5%
SA2 Data				***Units***		
SA2 Count (1996)	179	206	76	61	78	600
Real Initial Price of the Average SA2 (1996)	$293,110	$198,595	$238,649	$149,947	$166,640	$222,765
Annual Real Price Growth of the Average SA2 since 1996						
- - Mean	7.4%	8.3%	5.1%	5.7%	8.5%	7.4%
- - Std. Dev.	2.2%	2.9%	2.6%	1.6%	3.4%	2.8%

Source: Authors' own calculations.

Notes: Prices were inflated to 2020 values using the relevant cities' CPI from ABS catalogue 6401.0 – Consumer Price Index, Australia. SA2 and city borders are defined by the ABS ASGS.

Table 7 Summary of model outcomes and predictors

Variable Name	SA2 Average (Std.Dev.)	Variable Definition and Source
Outcomes		
Annual growth in real house price/ unit price	Refer to Table 6	SA2 percentage change in the inflation adjusted hedonic index over the sample period, divided by the number of years comprising the sample period. -- Authors own calculation using hedonic indices licensed from CoreLogic.
Growth in the fraction of residents with bachelor's degrees or above		Growth in the fraction of residents with bachelor's degrees or above between period t and t+k in a SA2. It includes any qualification ranked as a seven or above in the Australian Qualifications framework (Office of the Australian Qualifications Framework, 2013). -- Data sourced from the 2011 Census Data Pack 'T02: Selected Medians and Averages'.
Predictors Vector 1 (vct1)		
Natural log of the distance (Km) to the nearest top quartile SA2	6.6 km (7.4 Km) unlogged	SA2s ranked by the Index of Economic Resources on a per city basis. Geodetic distance in Kilometres from the centroid of a SA2 to the centroid of the nearest top quartile SA2. -- Distance calculated using Robert Picard's "Geonear" Stata package.
City fixed effects dummies	N/A	Dummy variables for each of the five cites, with one city omitted. Included so that identification comes from within-city variations only.
Natural log of the distance (km) to the CBD	22.2 Km (16.7 Km) unlogged	Geodetic distance in Kilometres from the centroid of a SA2 to the centroid of the SA2 that contains that cities central business district. -- Distance calculated using Robert Picard's "Geonear" Stata package.
Natural log of the median distance (km) travelled to work	11 km (7.6Km) unlogged	-- Obtained from ABS catalogue 2071.0.55.001 - Census of Population and Housing: Commuting to Work - More Stories from the Census, 2016. I use the distances from the 2016 Australian census, as this was the first year this data was provided by the ABS.
Natural log of the distance (Km) to the ocean	14.3 km (12.9 Km) unlogged	Geodetic distance in Kilometres from the centroid of a SA2 to the nearest coastline. -- calculated in ArcGIS. Coastline defined using the 'GEODATA COAST 100K 2004' polygon from Geoscience Australia. https://data.gov.au/dataset/geodata-coast-100k-2004.
Natural log of the distance (Km) to the nearest major river	9.1 km (7.6Km) unlogged	Geodetic distance in Kilometres from the centroid of a SA2 to the nearest major river. -- calculated in ArcGIS. Major river defined using the 'Surface Hydrology Polygons (National)' from Geoscience Australia. https://www.data.gov.au/dataset/surface-hydrology-polygons-national.
Average slope (in percent) within SA2	4.6% (3.5%)	The average gradient/slope of the land mass across the SA2, based on a resolution of approximately 90 metre squares. -- calculated in ArcGIS following the methodology described in Lee & Lin (2018), using the 'SRTM-derived 3 Second Digital Elevation Model' from Geoscience Australia. http://www.ga.gov.au/scientific-topics/national-location-information/digital-elevation-data.

Variable Name	SA2 Average (Std.Dev.)	Variable Definition and Source
Predictors Vector 2 (vct2)		
Natural log of initial real median house price/ unit price	Refer to Table 6 (unlogged)	-- Authors own calculation from the APM 'For sale, for rent and sold data by SA2' time series.
Natural log of initial real median household income	$1,361 ($353) unlogged	-- Census variable, sourced from the 2011 Census Data Pack 'T02: Selected Medians and Averages'.

Notes: SA2 averages are for 1996 (1996 to 2016 for growth/change variables). Only SA2s that are contained within the Greater Capital City Statistical Area (GCCSA) of Australia's major cities - Sydney, Melbourne, Brisbane, Perth and Adelaide – are included, as defined by the 2011 ASGS.

Table 8 Regression of SA2 real annual price appreciation on distance to nearest top quartile SA2, as ranked by the Index of Economic Resources, by housing type 1996 to 2016

Time Period	*1st Sub-Period* 1996 to 2006	2nd Sub-Period 2006 to 2016	Full Period 1996 to 2016
SA2 Data		***Price Data***	
House sample:			
β_1 Log Distance to Nearest Top Quartile SA2 as Ranked by the Index of Economic Resources	− 0.005	− 0.0078***	− 0.012***
(Std. Err.)	(0.0024)	(0.0015)	(0.0027)
Observations	495	503	494
R-Squared	0.47	0.75	0.59
Unit sample:			
β_1 Log Distance to Nearest Top Quartile SA2 as Ranked by the Index of Economic Resources	− 0.004	− 0.005*	− 0.0085***
(Std. Err.)	(0.0031)	(0.0011)	(0.0025)
Observations	338	385	340
R-Squared	0.64	0.57	0.62

* P < 0.05, ** p < 0.01, *** p < 0.001

Notes: Sample only includes SA2 that are in the bottom two quartiles of the Index of Economic Resources in their respective cities. Includes city fixed effects. Heteroscedasticity robust standard errors are reported.

Table 9 Regression of SA2 growth in the fraction of residents with bachelor's degrees and above on distance to nearest top quartile SA2, as ranked by the Index of Economic Resources, 1996 to 2016

Time Period	*1st Sub-Period* 1996 to 2006	2nd Sub-Period 2006 to 2016	Full-Period 1996 to 2016
SA2 Data	***Growth in Fraction of Residents with Bachelor's Degrees or Above***		
β_1 Log Distance to Nearest Top Quartile SA2 as Ranked by the Index of Economic Resources	− 0.0046	− 0.0108***	− 0.0110***
(Std. Err.)	(0.0024)	(0.0022)	(0.003)
Observations	496	505	496
R-Squared	0.15	0.32	0.32

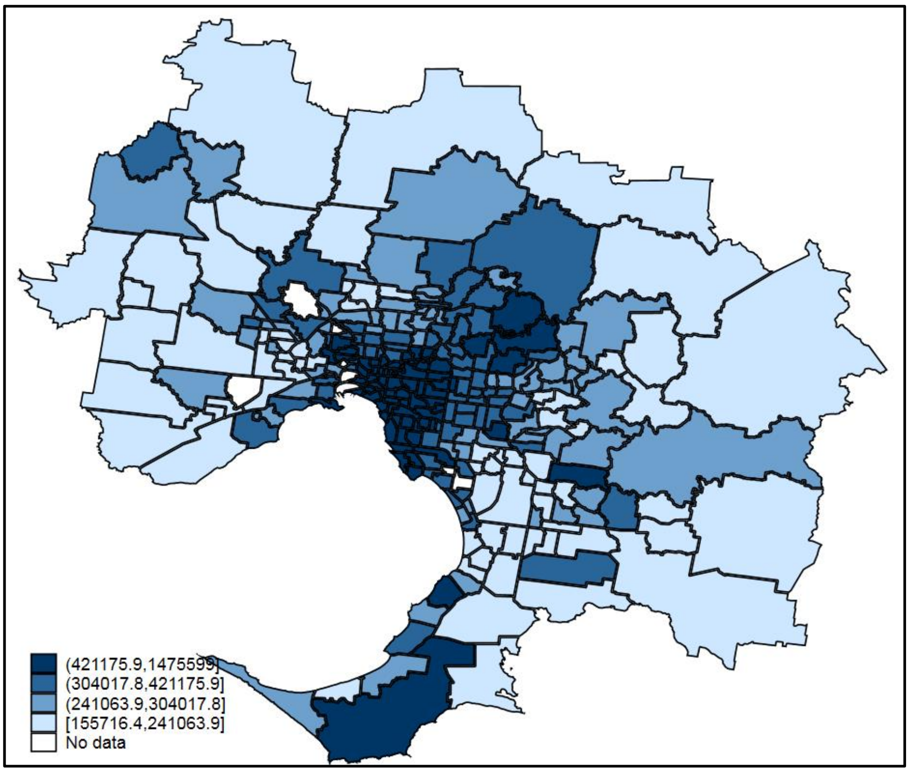
* P < 0.05, ** p < 0.01, *** p < 0.001

Notes: Sample only includes SA2 that are in the bottom two quartiles of the Index of Economic Resources in their respective cities. Includes city fixed effects. Heteroscedasticity robust standard errors are reported.

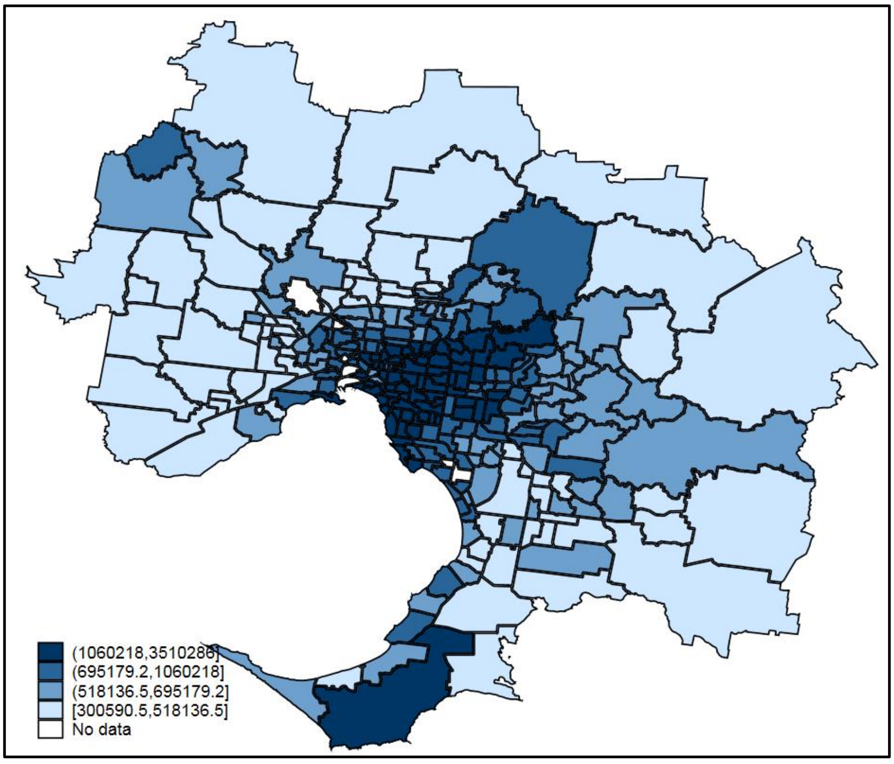
3.8 FIGURES

Figure 1 Map of SA2 real median house prices in the Melbourne GCCSA, 1996 and 2016

a) Real median house prices 1996



b) Real median house prices 2016



Source: Maps constructed by author.
Notes: The borders of the Melbourne GCCSA and the 261 SA2s depicted are defined by the 2011 ASGS.

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4 Chapter 4: Geographic reference income and the subjective wellbeing of Australians

4.1 Introduction

This study estimates the impact of the income of one's neighbours within an area on the wellbeing of individual Australians. It is reasonable to assume that as an individual's income rises, they will be able to consume more and will experience an increase in wellbeing. Modern urban literature on cities as centres of consumption suggests that individuals should also benefit from the rising incomes and consumption of those around them; in high-income countries technological advancement has enabled an increasingly affluent population to shift away from production agglomeration towards agglomeration in "consumer cities", endowed with higher amenity and oriented towards consumer wellbeing (Broxterman et al., 2019; Glaeser et al., 2001). However, this benefit is contradicted by literature on the relative income hypothesis. In a widely cited paper, Luttmer (2005) provides evidence that wellbeing is decreased by the incomes of one's neighbours, which is attributed to negative comparisons between one's own income and the incomes of others.[25] The income of others in a given area, to which one compares their income, is known as geographic reference income.

This apparent wellbeing contradiction has important implications for urban policy surrounding residential segregation. Residential segregation is the spatial manifestation of the inequality of household incomes interacting with variation in household preferences, resulting in clusters of advantage and disadvantage across urban areas (Cheshire et al., 2014). In Australia, it is often assumed that the negative consequences on individuals from clusters of social disadvantage will be reduced through social mixing policies (Parkinson et al., 2014). These policies seek to encourage diversity of income, tenure and class within neighbourhoods and are most often implemented in Australia through the dispersion of social housing tenants away from clusters of disadvantage (Parkinson et al., 2014). In the consumer city paradigm, these individuals would benefit from the higher levels of endogenous amenity found in more affluent neighbourhoods. However, as argued by Cheshire et al. (2014), if the negative externalities for

[25] This contradiction is evident if the benefits of technological change and consumption agglomeration are unevenly distributed amongst households. Suppose an alternative scenario in which technological change raises the income of all households by a proportionate amount so that relative income is unchanged. Because relative incomes are unchanged there will be no offsetting impact on levels of individual wellbeing.

the poor from living among the rich outweigh the positive externalities, then polices to encourage social mixing would be a cost-ineffective use of societal resources. Instead, it would be better to redistribute resources and opportunities from the richer to the poorer, given it is this inequality that manifests spatially as residential segregation in the first place.

The objective of this study is to establish the direction of the relationship between geographic reference income and individual subjective wellbeing in Australia. To achieve this objective, I analyse panel data on the subjective and economic wellbeing of individuals from the Household, Income and Labour Dynamics in Australia (HILDA) Survey. Using a within-between random effects ordered probit panel-data model, I model the subjective wellbeing of individuals in HILDA as a function of their own household equivalised income and the equivalised income of those around them.

This essay makes four specific contributions to the Australian and international literature. First, as far as I am aware, this is the first comprehensive study of this relationship in the Australian literature, and the findings will help inform urban policy surrounding residential segregation. Second, recent international literature has established that the impact of geographic reference income on wellbeing differs depending on the scale of the geographic reference group used (Brodeur & Flèche, 2019; Ifcher et al., 2018). It appears that at the neighbourhood level, geographic reference income raises wellbeing, while at the region-wide level, it reduces wellbeing. However, these studies are US-based, and thus I contribute to the literature by testing whether these differences between region-wide and local neighbourhood effects apply outside of the US context. Evidence from Senik (2008) suggests that income comparisons are impacted by country and culture, and therefore we could observe differences between countries. Third, these recent US-based studies are cross-sectional studies, so it is possible their subsequent estimates were driven by the self-selection of innately happy, or unhappy, people into higher-income areas (Luttmer, 2005). To overcome this limitation, I take advantage of panel-data modelling to reduce the likelihood of endogeneity issues. Fourth, my chosen panel-data model is novel to the geographic reference income literature; it allows us to control for time-invariant endogeneity issues, while also acknowledging the ordinal nature of measurements of subjective wellbeing, a combination ignored by the prior literature.

I begin by outlining prior literature that has explored the relationship between neighbourhood effects and life outcomes. I then describe the HILDA survey data and the specification of my panel-data model and its variants. The findings of the analysis of geographic reference income and wellbeing are then presented and followed by a discussion on the consequences of these results for Australian policy on residential segregation.

4.2 PRIOR LITERATURE

The urban economics literature has long sought to establish the relationship between the neighbourhood one lives in and life outcomes. When it comes to one's economic and educational outcomes, neighbourhood effects generally have little to no impact (Gibbons et al., 2013; Sanbonmatsu et al., 2006). This is best illustrated through the influential Moving to Opportunity (MTO) randomised housing mobility experiment, which was conducted in five large US cities during the mid-1990s (Clark, 2008). In this experiment, participating households living in assisted housing in low-income neighbourhoods were randomly allocated into treatment and control groups. The treatment group were moved to higher-income neighbourhoods, while the control group were moved to other low-income neighbourhoods. There is little evidence that the economic and educational outcomes of the treatment group were improved, however, more recent evaluations have found it did improve quality of life outcomes, namely self-reported wellbeing and physical health (Ludwig et al., 2012).[26] This suggests there is a positive link between neighbourhood effects and quality of life outcomes, driven by the affluence of one's neighbourhood.

Studies motivated by the relative income hypothesis suggests that this link could instead be negative. The relative income hypothesis posits that the contribution of income to wellbeing depends on both one's own income (absolute income) and comparisons to the income of the others (reference income) (Duesenberry, 1949). This contribution is summarised in equation (1):

$$SWB_i = SWB(AI, RI, X) \quad (1)$$

In which SWB is the subjective wellbeing of individual i, AI is their absolute income, RI is reference income, and X is all other determinates of subjective wellbeing. If envy, aspirations or shame motivate feelings of relative deprivation, the effect of RI will be negative (Kingdon & Knight, 2007), and the rising income of others will decrease $i's$ wellbeing. 'Others'

[26] Evidence of improvements in economic and educational outcomes exists for young children; Chetty et al. (2016) found the experiment to have a positive impact on the future earnings and educational outcomes of children in the treatment group that were below the age of 13 when moved.

constitute what is known as the reference group. Reference groups can be based on people known to the individual, people with similar characteristics, people in geographic proximity, or a combination of the prior definitions. Different strands of literature have explored these diverse reference group definitions. For example, Senik (2008) provides evidence that wellbeing is affected by the average income of one's professional peers in Europe and the US. Clark & Senik (2010) find that Europeans compare incomes more to their work peers than family and friends. In this essay I focus on geographic reference groups, the most frequently used reference group in the literature, given my interest in neighbourhood effects.

The most widely cited paper that uses geographic reference groups is Luttmer (2005). Using American panel data from the National Survey of Families and Households (NSFH) Luttmer (2005) finds that, after controlling for one's own income and other drivers of wellbeing, higher earnings of neighbours are associated with lower levels of self-reported happiness. The paper, among others (Blanchflower & Oswald, 2004; Helliwell & Huang, 2014), suggests that the relative income hypothesis is pertinent to individual wellbeing; feelings of relative deprivation reduce wellbeing at the neighbourhood level.

A potential issue shared between these papers is the size of the geographic reference groups used. In Luttmer (2005), income and wellbeing data was matched to 'neighbourhoods' as defined by Public Use Microdata Areas (PUMAs), which contain 150,000 people on average. Because they use such large areas, the wellbeing models could be capturing effects other than income comparisons, or failing to observe a different sign and strength of comparison effects at smaller scales. Using cross-sectional wellbeing data from South Africa and much smaller reference groups of about 3000 people, Kingdon & Knight (2007) conversely find a positive relationship between reference income and one's wellbeing. This positive effect disappears and then turns negative as the geographic reference group increases in scale. They suggest that feelings of relative deprivation are replaced by feelings of community altruism at smaller scales, in which individuals desire to see those around them benefit, regardless of one's own position. The effect of RI in equation (1) would then be positive at smaller scales.

Recent US-based studies from Brodeur & Flèche (2019) and Ifcher et al. (2018) confirm that the scale of the geographic reference group matters. When modelling multiple scales of geographic reference groups concurrently, they find that self-reported wellbeing is increasing with postcode-level reference income measures. However, when income is compared relative to the region as a whole, as defined by Metropolitan Statistical Areas (MSAs), self-reported wellbeing is decreasing in region-wide reference income measures. Though they share similar results to Kingdon & Knight (2007), the US-based studies suggest other channels through which the positive local neighbourhood effect and negative region-wide effects of reference income at these alternative spatial levels come about. These channels can be summarised as public goods and amenities, the cost of living, and the direct effects of the relative income hypothesis already discussed (relative deprivation and community altruism).[27]

The concepts of neighbourhood consumption externalities and endogenous amenities are important to the public goods and amenities channel. In the consumer cities literature, neighbourhood consumption externalities occur when households gain utility from having higher-income households nearby, as it allows them to consume amenities that are endogenously determined by the incomes, wealth and talents of residents in higher-income neighbourhoods.[28] This is as opposed to exogenous or fixed amenities, such as proximity to oceans and rivers. Several examples of desirable amenities that are endogenous to high-income neighbourhoods include lower crime rates, higher quality of public goods such as schools, and increasing returns to scale in production of desired neighbourhood amenities such as cafés or personal fitness services (Guerrieri et al., 2013). Both Brodeur & Flèche (2019) and Ifcher et al. (2018) find that public goods and amenities explain a sizable portion of the positive relationship between reference income and wellbeing at the neighbourhood level.

Ifcher et al. (2018) proxies for cost of living using both neighbourhood and region-wide median rents. They find that controlling for region-wide rent removes the negative effect of reference income on wellbeing, while neighbourhood rents have no impact on the positive impact of neighbourhood reference income. This suggests that it is cost of living, not negative income comparison effects that drives the negative region-wide effect seen in the US-based studies. Why would cost of living reduce wellbeing at the region-wide level, but not at the neighbourhood level? A possible explanation is that neighbourhood and region-wide rents proxy for different components of cost of living (Ifcher et al., 2018). Region-wide rents are a better representation of general expenses, such as the cost of food and utilities, which

[27] Hirschman & Rothschild (1973) suggest the existence of another channel, a positive 'tunnel effect', in which reference income is a positive signal of one's own future income, raising current wellbeing. Senik (2008) presents evidence supporting this notion when using one's professional peers as the reference group, but no evidence for the tunnel effect has been found when using geographic reference groups (Ifcher et al., 2018). It appears that reference groups based on geographic proximity are a poor measure of one's expectations of future income, as opposed to one's professional peers.

[28] See Broxterman et al. (2019) for a series of papers discussing endogenous amenities and the consumer city.

households have a limited ability to avoid. Meanwhile, neighbourhood rents could price in the level of local amenity, compensating for the increased cost of living in that neighbourhood and offsetting its negative wellbeing effect.

The Brodeur & Flèche (2019) and Ifcher et al. (2018) studies used cross-sectional data and were therefore unable to discount endogeneity and selection concerns brought about by unobserved individual heterogeneity; their results could be driven by omitted individual characteristics that influence one's self-reported happiness and the decision of where to live (Luttmer, 2005). For example, the positive effect of reference income on wellbeing observed at the neighbourhood level may not be driven by any of the previously proposed channels, and could instead be the result of inherently happy individuals selecting into higher-income neighbourhoods and reporting an inherently high subjective wellbeing (Luttmer, 2005). Here I take advantage of panel-data modelling to control for time-invariant aspects of unobserved individual heterogeneity, to see if the positive neighbourhood reference income and negative region-wide reference income relationships still hold under more stringent conditions.

4.3 PRESENT STUDY

4.3.1 Key data sources

To conduct my analysis, I utilise panel data on subjective and economic wellbeing of individual Australians. Longitudinal wellbeing data was sourced from the nationally representative HILDA survey (Watson & Wooden, 2012). The first wave of data collected in 2001 surveyed 19,194 individuals in 7,682 households, and the survey has grown each year to now include 23,237 individuals in 9,639 households as at the latest wave available, wave 19.[29] Members of participant households aged 15 years and over complete interviews and self-completion questionnaires on a yearly basis. The key data point of interest for my analysis is the answer to the question on overall life satisfaction, which provides us with a measure of an individual's subjective wellbeing. Each wave of the survey respondents were asked "All things considered, how satisfied are you with your life?" as rated on an ordinal scale of one unit increments between 0 (totally dissatisfied) and 10 (totally satisfied). Australians are generally skewed towards a high level of satisfaction, with a modal response of 8.[30]

[29] Any new member of a household in the pre-existing survey would become a part of the survey. A top-up sample of individuals and households was also added to the survey in wave 11 (2011).

[30] Authors own calculation using HILDA waves 1, 6, 11, and 16.

HILDA also provides a measure of absolute income for each individual that can then be compared to measures of geographic reference group income. Household financial year total income is documented for each wave of the survey. Using the number of adults and children in each household, I then equivalised this income data using the OECD modified equivalence scale.[31] This household income data, and all other monetary data used in this study, was inflation adjusted to real 2020 values using the Consumer Price Index (CPI) of the individual's relevant State.[32]

The restricted version of HILDA reports detailed information on the location of each household, allowing us to link respondents to data on the geographical areas in which they live. My measure of reference income for each of these areas – median household total equivalised income – was sourced from the Australian census (ABS, 2017). As the Australian census is only conducted every five years, I restricted my analysis to the four HILDA waves corresponding to the Census years 2001, 2006, 2011, and 2016. Across these years there are 62,137 person-year observations in which a HILDA respondent provided life satisfaction and income responses. There are 52,084 person-year observations across 17,285 individuals in which the respondent provided the necessary responses in at least two waves of HILDA, enabling the estimation of within-individual effects for this sample.

As discussed earlier, recent US-based studies have established that the impact of reference income on wellbeing differs depending on geographic scale used (Brodeur & Flèche, 2019; Ifcher et al., 2018). I therefore test multiple geographic reference groups concurrently. To represent an individual's local neighbourhood, my spatial unit of analysis is the Statistical Area level 2 (SA2). SA2s are an area structure specifically designed by the Australian Bureau of Statistics (ABS) for outputting statistics and are part of the Australian Statistical Geography Standard (ASGS) (ABS, 2020).[33] It represents a community that interacts together socially and

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[31] I use this method of equivalence as it is the same method used for the equivalised income data reported in the Australian Census, which I used as my source of reference group income. This method was performed by first calculating a household's equivalence factor by allocating points to each person in a household (1 point to the first adult, 0.5 points to each additional person who is 15 years and over, and 0.3 to each child under the age of 15). Household income was then divided by the equivalence factor.

[32] CPI data was attained from Australian Bureau of Statistics catalogue 6401.0 – Consumer Price Index, Australia.

[33] The borders of a small number of SA2s changed over the study period. SA2 data was therefore corresponded so that all years of data share consistent border structures compliant to the 2011 ASGS.

economically, usually made up of a limited number of suburbs or rural localities.[34] It is the finest level of spatial aggregation for which I am able to obtain the necessary aggregated equivalised household income data. SA2s are similar in scale to the postcode-level measures used in the recent US-based studies, enabling comparison of results.

To represent the impact of region-wide incomes, my second geographic reference group is Greater Capital City Statistical Areas (GCCSAs). GCCSAs are also part of the ASGS, and represent the functional extent of Australia's eight state and territory capital cities. It includes populations that live in built-up areas of capital cities, as well as populations in the smaller towns and areas surrounding those cities, that regularly work, socialise or consume within those cities (ABS, 2020). 38.6% of my sample do not populate Australia's capital cities. In the GCCSA classifications these populations are classified as Rest of State; for example, a household living in the large city of Gold Coast, Queensland, is classified as Rest of Queensland. Rest of State is too broad of a geographic reference group to represent region-wide incomes, and so for these individuals the first sub-classification of GCCSAs are used instead, Statistical Area level 4s (SA4s). SA4s represent regional labour markets, and aggregate to form whole GCCSAs; for example, the region-wide geographic reference group of a household living in Gold Coast, Queensland, is the Gold Coast SA4, which forms part of the Rest of Queensland GCCSA. For the 13.5% of the sample that live in rural areas, it is arguable whether regional labour markets (SA4s) represent reference income akin to urban populations. A concern is that including rural Australians will bias the resulting wellbeing estimates, if they do not compare incomes or experience agglomeration effects to the same extent as their highly agglomerated city-based counterparts. Therefore, I experiment with the inclusion and exclusion of rural Australians in my model.

4.3.2 Estimation strategy

The objective of the present study is to establish the relationship between different scales of geographic reference income and the subjective wellbeing of individual Australians, while controlling for unobserved individual heterogeneity to the greatest extent possible. To achieve this objective, panel-data models were used, exploiting the longitudinal nature of the HILDA sample by capturing variations in wellbeing both between individuals and within the same individual over time. A random-effects panel-data model uses variation within and between

[34] The population of SA2s generally ranges between 3,000 to 25,000 persons, with an average population of 10,000 (ABS, 2020)

individuals to control for unobserved heterogeneity, but random-effects will only produce consistent estimates if the unobserved heterogeneity is uncorrelated with the independent variables of the model (Cameron & Trivedi, 2010). As shown later in the analysis, this assumption does not hold, meaning a conventional random-effects specification is not suitable for this study.

As opposed to random-effects, fixed-effects panel-data models measure within-individual variations only, and produce consistent estimates even if unobserved heterogeneity is correlated to the independent variables of the model (Cameron & Trivedi, 2010). A caveat of fixed-effects is that it can only control for unobserved *time-invariant* heterogeneity, such as the unchanging personality traits of an individual. This characteristic is still useful for this study; fixed-effects eliminates the possibility that the reference income wellbeing relationships to be estimated are driven by the self-selection of innately happy or unhappy individuals into higher-income areas, or any other example of unobserved time-invariant heterogeneity (Luttmer, 2005). The ordinal nature of my subjective wellbeing measure and dependant variable – life satisfaction – complicates the use of fixed-effects. Ordinal panel data is typically modelled using a maximum likelihood ordered logit or ordered probit panel model. However, there is no generally accepted method of consistently estimating a fixed-effects ordered logit or ordered probit panel-data model.[35]

My solution to this issue is the application of a within-between random effects (REWB) specification to an ordered probit panel-data model. As explained by Bell et al. (2019), REWB models allow one to estimate within-group effects (fixed-effects) inside a random-effects model. Conveniently, for my purposes, this makes fixed-effects compatible with an ordered logit or ordered probit panel-data model. As far as I am aware, this type of model has not previously been used in the geographic reference income literature. In the context of panel data on individuals, REWB decomposes the relevant independent variable X_{it} into a between-individual component, which is the mean of one's observations ($\bar{X}_i$), and a within-individual component, in which each observation is de-meaned ($X_{it} - \bar{X}_i$). De-meaning independent variables to find a within-effect is similar to the application of Mundlak transformations, such as those applied to ordered probit panel models by Ferrer-i-Carbonell (2005) and Senik (2004),

[35] For example, popular econometrics and statistical software package Stata provides only a random-effects specification for its ordered logit or ordered probit panel-data models (StataCorp., 2021).

in their exploration of the reference income wellbeing relationship for non-geographic reference groups[36].

The REWB ordered probit panel-data model used in my analysis is described in equation (2):

$$SWB_i = \beta_{1W}\ln(AI_i - \overline{AI}_i) + \beta_{2W}\ln(RI^{SA2} - \overline{RI}^{SA2}) + \beta_{3W}\ln\left(RI^{GCCSA/SA4} - \overline{RI}^{GCCSA/SA4}\right)$$

$$+ \beta_{1B}\ln(\overline{AI}_i) + \beta_{2B}\ln(\overline{RI}^{SA2}) + \beta_{3B}\ln\left(\overline{RI}^{GCCSA/SA4}\right) + V_{\mathrm{it}} + \mu_{\mathrm{i}} + \varepsilon_{\mathrm{it}} \quad (2)$$

In which the dependent variable SWB is the subjective wellbeing of individual i, AI_i is the absolute income of individual i, RI^{SA2} and $RI^{GCCSA/SA4}$ are the reference incomes of one's SA2 and GCCSA/SA4 reference groups, V_{it} is a vector of control variables, μ_i are the model's random-effects for individual i, and $\varepsilon_{\mathrm{it}}$ is an idiosyncratic error term.[37] The within-effect coefficients of the reference income variables, β_{2W} and β_{3W}, are the estimates key to establishing the geographic reference income and wellbeing relationship within Australia. For a given geographic reference group, a positive and significant coefficient implies the positive wellbeing externalities from high reference income areas, such as better public goods and amenity, outweigh the negative externalities, such as feelings of relative deprivation. The opposite is true if the within coefficient is negative and significant. As discussed earlier, recent US-based studies suggest there is a positive coefficient at the neighbourhood level and a negative coefficient at the region-wide level, albeit without limiting unobserved individual heterogeneity through panel-data modelling.

The between-effects of the reference income variables, β_{2B} and β_{3B}, are not directly relevant to the analysis, but, they can be used to test for equivalence between the within- and between-effects. If not equivalent, there is correlation between unobserved heterogeneity and the variable, and I am therefore justified in applying fixed-effects inside of a REWB panel-data model, instead of a traditional random-effects specification (Schunck, 2013).

In an alternative specification of the base model, I test if the within coefficients of the reference income variables are dependent on one's rank in the distribution of household incomes within that geographic reference group. Prior literature suggests reference income might have a

[36] A key difference between REWB and the application of Mundlak transformations is that REWB estimates a within-effect and between-effect, while the latter estimates a within-effect and a less useful contextual-effect (Bell et al., 2019).

[37] All prior studies of reference income and wellbeing log transform their income variables, and so I also follow this convention.

asymmetric effect on wellbeing, such as if lower-income households are more prone to feelings of relative deprivation than higher-income neighbours (Distante, 2013). To test for asymmetry, I interact a binary variable representing one's income status (individual is in the bottom half of their reference group) with reference income. If the within coefficient of these interaction terms are insignificant, there is no asymmetry; one's rank in the distribution of household incomes in a given area does not alter the impact of reference income on wellbeing. If these interaction terms are found to be positive (negative) and significant, there is asymmetry; a lower rank in the distribution of household incomes increases the positive (negative) impact of reference income on wellbeing.

In another specification of the base model, I test the extent to which the within coefficients of the reference income variables can be explained by the cost of living in that geographic reference group. As discussed earlier, evidence presented in Ifcher et al. (2018) suggests that it is a higher cost of living, as proxied by median rent, that drives the negative region-wide income effect seen in Brodeur & Flèche (2019) and Ifcher et al. (2018). The cost of housing services in an area, as measured by rents, should move roughly in line with the overall cost of living in that area. Following Ifcher et al. (2018), I proxy for cost of living by including median SA2 and GCCSA/SA4 rents. If the within-effects of these rent variables are found to be negative and significant, and the coefficients of my original reference income variables are reduced, then the cost of living channel is a key driver of the wellbeing and reference income relationship.

4.3.3 Summary statistics and other control variables

All specifications of the model contain a vector of control variables established in the literature to control for wellbeing impacts outside of absolute and relative income. I can categorise these control variables as demographic, socioeconomic, housing, and health, as well as state and time fixed-effects. Summary statistics for these control variables, as well as the key variables discussed in the prior section, are provided in Table 10. The average real household equivalised income of person-year observations in the sample is $67,218, but there is large amount of variation around this mean, with a standard deviation of $73,411.[38] 40.1% of household income

[38] The maximum household income observed is $4,594,092. Removing the bottom and top five percent of observations, as ranked by household income, reduces the average to $60,134 and the standard deviation to a less extreme $31,512.

observations are below one’s SA2 real median household equivalised income, and 45.8% are below one’s GCCSA/SA4 real median household equivalised income.

Demographic control variables include the participant’s age, sex, country of birth, marital status and the number of adults and children in the household. Table 10 shows the typical observation to be that of a 46 year old married non-Indigenous Australian female. The impact of age on wellbeing tends to be ‘U-shaped’, meaning wellbeing declines with age, until a point later in life after which it starts increasing again (Wilkins et al., 2020). Therefore I specify age as a quadratic (age squared). I also include a specific marker for lone parent households, which tend to have lower life satisfaction than other household types, given the greater difficulties juggling both family and income-earning responsibilities (Shields & Wooden, 2003).

Socioeconomic and housing variables include educational attainment, employment status, dwelling type, dwelling tenure, and one’s section of state. The employment status categories account for full-time students and retirees, as well as the employed and unemployed. Section of state is how the ABS defines populations as urban or rural in the ASGS (ABS, 2020). 64.8% of person-year observations resided in major urban areas, 21.8% resided in other urban areas, and 13.5% resided in rural areas. The typical observation is that of a full-time employed house owner that did not complete high school and lives in a major urban area.

To cover for the impact of an individual’s health on wellbeing, I include a control for whether the individual has a long-term disability. The HILDA survey does contain an individual’s self-assessed health, which is likely a better measure of one’s overall health. However, there are likely to be endogeneity concerns when using both self-assessed health and self-assessed wellbeing in the same model (e.g. very happy people are likely to be more positive about their state of health) (Clark et al., 2009; Shields & Wooden, 2003). Hence, I use the presence of a long-term disability, an exogenous measure of health, and augment this with severity – slight, moderate, and severe –based on the individuals answer to a question on how much their condition impacts their ability to work.

I also control for the presence of any other adults during the interview in which the respondent provided their life satisfaction rating. Interviewers in HILDA were unable to ensure that interviews were conducted in private. In the presence of others, one might feel pressured to report a higher life satisfaction to avoid upsetting another person or creating conflict. 36.4% of person-year observations in my sample were potentially impacted from this upward bias.

4.4 RESULTS

The results of my analysis are presented in Table 11, in which column C1 is the estimates of the REWB ordered probit model specified in equation (2), and the remaining columns C2-C4 are extensions to this main model. I begin by discussing the results of the main model C1. The within-effect coefficients of my reference income variables, neighbourhood (SA2) and region-wide (GCCSA/SA4) real median household equivalised income, are the estimates key to establishing the geographic reference income and wellbeing relationship within Australia. I find that, on controlling for one's own household income and other drivers of wellbeing, the increasing income of others is *positively* associated with wellbeing at the neighbourhood level ($\beta_{2W} = 0.257$), and *negatively* associated at the region-wide level at roughly the same magnitude ($\beta_{3W} = -0.248$).[39]

There are several key points to take away from these relationships. First, these wellbeing relationships match the local neighbours as positives, region-wide neighbours as negatives - conclusions recently established in the US-based literature (Brodeur & Flèche, 2019; Ifcher et al., 2018). In Australia and the US, at the neighbourhood level, it appears that the positive externalities from living amongst those with higher-incomes, such as better public goods and amenity, outweigh the negative externalities, such as feelings of relative deprivation. At the region-wide level, this outcome is reversed. Additionally, through the application of fixed-effects to panel data, I have established that these relationships are not overtly driven by the self-selection of innately happy or unhappy individuals into higher-income neighbourhoods or regions.

Second, I comment on the magnitude of the reference income coefficients, both in comparison to the effect of one's household income, and in terms of marginal effects. As expected, increasing own household equivalised income has a positive impact on subjective wellbeing ($\beta_{1W} = 0.031$), significant at the 0.1% level. But, my findings suggest that the incomes of others have a greater impact on one's life satisfaction than one's own income; neighbourhood and region-wide income impact underlying subjective wellbeing at 8.3 and 8 times the rate of own household income. This is as opposed to Brodeur & Flèche's (2019) and Ifcher et al's.

[39] Both estimates are statistically significant at the 0.1% level.

(2018) US-based studies, which found neighbourhood and region-wide income effects to be smaller in magnitude than household income.

The raw coefficients outputted by ordered probit models show the sign of estimated relationships, and the magnitude of relationships relative to other covariates. However, it is difficult to interpret the importance of these relationships in isolation. In the context of my study, I can calculate the average marginal effects of my reference income variables for the eleven possible life satisfaction rankings, to give a tangible interpretation to β_{2W} and β_{3W}. These average marginal effects are presented in Figure 2; it presents the percentage point change in the probability of selecting a given ranking of my ordinal dependant variable – life satisfaction – for every 10% increase in neighbourhood or region-wide reference income. All reported effects are significant at the 1% level. Figure 2 shows that an increase in neighbourhood reference income reduces the probability of selecting life satisfaction rankings 1 to 8, and increases the probability of selecting the highest life satisfaction rankings 9 to 10. For example, the probability of selecting category 10 increases by 0.0039 percentage points for every 10% increase in neighbourhood reference income.[40] For region-wide reference income, the outcome is reversed. There is an increase in the probability of selecting life satisfaction rankings 1 to 8, and a decrease in the probability of selecting the highest life satisfaction rankings 9 to 10. The probability of selecting category 10 decreases by 0.0037 percentage points for every 10% increase in region-wide reference income. Interestingly, for both neighbourhood and citywide income, the probability of selecting a ranking of 8 is near unchanged by increasing income. A ranking of 8 appears to represent the turning point at which the effects of income on probability shifts from negative to positive and vice versa. As mentioned earlier, Australians are generally skewed towards a high level of satisfaction, with a modal response of 8 in the HILDA data. The effects are likely reflecting shifts up and down from this commonly chosen ranking.

Third, tests of equivalence concerning the within-effects and between-effects of my reference income variables endorse my choice of model. For both neighbourhood income and region-wide income, a Wald test rejects a hypothesis of no difference between the within-effect and between-effect at the 1% level.[41] This suggests that unobserved individual heterogeneity is

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[40] If an individual originally had a 10% chance of selecting a ranking of 10, they would now have a 10.39% chance of selecting a ranking of 10. Note that Figure 2 also suggests the chance of selecting a ranking of 9 is increased.

[41] The application of Wald tests to REWB models is demonstrated in Schunck (2013).

correlated to my income variables, and I am therefore justified in including within-effects through the use of REWB, instead of a conventional random-effects specification. Failure to do so would lead to inconsistent estimates.

Fourth, the exclusion of rural Australians from the sample does not radically alter the relationships found. In C2, I remove the 13.5% of the sample that lives in rural Australia. The within-effects of my income variables remained largely unchanged, bar a small increase in the positive effect of neighbourhood reference income, roughly equivalent in magnitude to the effect of household income. This increase is not surprising given positive consumption agglomeration effects, such as higher levels of public goods, are more active at the neighbourhood level in urban areas as opposed to rural areas.

Fifth, the reference income relationships established in C1 are symmetrical between individuals regardless of the rank of their income relative to their neighbourhood or region. In C3, I add two interaction terms that interacts if an individual is in the bottom half of household incomes in their neighbourhood or region with neighbourhood income and region-wide income. The within-effects of these interaction terms are found to be statistically insignificant, and the coefficients of my original reference income variables remain practically unchanged. Thus, there is no asymmetry in the reference income relationships; for example, at the neighbourhood level, no matter one's position in the distribution of household incomes within one's neighbourhood, all individuals receive the same positive wellbeing uplift as neighbourhood income rises. It is possible an asymmetrical relationship could exist if neighbourhood reference income was defined at a smaller geographic scale, such as one's city block. Clark et al. (2009) used unusually detailed Danish microdata on the income of one's immediate neighbours to show that individuals were happier when their immediate neighbours were richer, and additionally, wellbeing was also increased by a higher position in their immediate neighbourhood income ranking.

Sixth, the negative region-wide reference income relationship is not explained by a higher cost of living. In C4, I proxy for a higher cost of living through the addition of median SA2 and GCCSA/SA4 rents. The within-effects of these rent variables are found to be statistically insignificant, and the coefficients of my original reference income variables remain practically unchanged. Unlike the US-based Ifcher et al. (2018) study, a higher cost of the living does not drive the negative region-wide reference income wellbeing relationship established in my analysis. It is possible an element of unobserved time-invariant heterogeneity that was not controlled for in the US-based study is correlated to both rents and reference income, and so the inclusion of rents in their model unintentionally captured this correlation. The inclusion of fixed-effects in my study removes this concern and I can conclude that the cost of living channel is not associated with the wellbeing and reference income relationship at the neighbourhood and region-wide levels. Other channels of negative wellbeing, such as feelings of relative deprivation, must drive the negative region-wide relationship instead.

4.5 CONCLUSION

The objective of this study was to establish the direction of the relationship between geographic reference income and individual subjective wellbeing in Australia. My empirical investigation finds that, after controlling for individuals' household incomes and time-invariant unobserved heterogeneity, there is a positive relationship between reference income and wellbeing at the neighbourhood level, and a negative relationship at the region-wide level, of roughly the same magnitude. This suggests that at the neighbourhood level, the positive externalities from living amongst higher-income households, such as better public goods and amenity, outweigh the negative externalities, such as feelings of relative deprivation. At the region-wide level, this outcome is reversed, and unlike in the international literature, this result cannot be explained by a higher cost of living in higher-income regions. There is no asymmetry between households in these effects; the wellbeing relationship is the same no matter one's rank in the distribution of incomes within an area. Additionally, the neighbourhood and region-wide reference income effects are 8.3 and 8 times the magnitude of household income. Given the size of these reference income effects, these relationships are relevant to Australian policy makers.

The wellbeing relationships established above suggest a multifaceted approach is required by Australian urban policy makers in their policy responses to residential segregation, one that takes into account the reference income and wellbeing relationship at both the neighbourhood and region-wide levels. In Australia, it is often assumed that there are negative consequences on individuals from clusters of social disadvantage, and that these negative effects can be reduced through social mixing policies; policies that encourage diversity of income, tenure and class within neighbourhoods (Parkinson et al., 2014). Though, if living amongst more affluent households has a net negative impact on one's economic and quality of life outcomes, then social mixing policies will be an ineffective use of societal resources, and it would be better to instead implement policies that reduce societal inequality in the first place (Cheshire et al., 2014). The positive neighbourhood reference income wellbeing relationship I find for Australia suggests that there is merit in policies that encourage social mixing, as it will allow some households to maximise their wellbeing by sorting into higher-income neighbourhoods.[42] In addition, the negative reference income wellbeing relationship at the region-wide level suggests that policies to reduce societal inequality will also be required, as this negative wellbeing impact will persist even in socially mixed neighbourhoods.

This research shows how locating new social housing within wealthier neighbourhoods would have positive benefits for tenants, improving wellbeing outcomes. However, with modern Australian governments reluctant to invest directly in social housing (Lawson et al., 2019), improving supply and affordability in the private rental sector is key to assisting lower-income Australians to access the wellbeing benefit available in higher-income neighbourhoods. The proportion of renters in Australia is growing as the affordability of home ownership declines over time (Burke et al., 2020), and it is generally cheaper to rent than buy in more affluent neighbourhoods.

One positive policy intervention delivering a supply of affordable housing across neighbourhoods in Australia was the now defunct National Rental Affordability Scheme (NRAS). Rowley et al. (2016) found that the scheme, which delivered over 30,000 dwellings, greatly increased the number of neighbourhoods accessible to eligible low- to mid-income households. Starting in 2008 the scheme provided tax benefits to property owners who constructed rental properties and leased them at 20% below the market median rent. Despite flaws in its design and implementation, the scheme delivered affordable rental dwellings in neighbourhoods of a range of socioeconomic status. In the suburbs of the major Australian city of Sydney that contained NRAS dwellings, the application of the rent discount increased the range of suburbs affordable to an eligible two adult household from 10% of suburbs to over 50%, significantly increasing neighbourhood options. A reimagined NRAS scheme could provide affordable rental accommodation to eligible households, with the added benefit of positive wellbeing gains to households who are able to sort into higher-income neighbourhoods.

[42] A less positive interpretation could be applied to social mixing. An influx of lower-income residents into higher-income neighbourhoods would raise the wellbeing of *new* residents, as reference incomes are higher relative to their previous neighbourhood. However, if this influx of lower-income residents lowers reference income, the results suggest the wellbeing of *existing* residents will be reduced.

For Australian households that don't qualify for housing assistance, a general increase in the diversity of dwelling and tenure types in higher-income neighbourhoods is needed to encourage social mixing. In Australia's major cities, the new supply of units and apartments is predominantly located in higher-priced neighbourhoods (Phelps et al., 2020). However, these small dwelling types are not suited or desirable to all households, such as those with children. The Australian housing literature has criticised the under-supply of medium density infill housing within Australian cities, a problem often referred to as the 'missing middle' (Daley et al., 2018). Changes to policies including incentives to encourage medium density private rental accommodation in higher-income neighbourhoods would assist in delivering more housing choice and greater affordability within traditionally high amenity areas.

There are also important theoretical implications of this research for the consumer cities literature. As discussed in the introduction to this essay, modern urban literature on cities as centres of consumption suggests that increasingly affluent populations are shifting away from production agglomeration towards agglomeration in "consumer cities", endowed with higher amenity and oriented towards consumer wellbeing (Glaeser et al., 2001). The series of papers presented in Broxterman et al. (2019) show there to be a positive link between higher levels of endogenous amenity in affluent cities, and the growth and development of those cities. It appears that the level of geographic reference income, which determines endogenous amenity, encourages migration into higher-income cities. However, the wellbeing relationships established in my study suggest that, on the metric of one's subjective wellbeing, locating to a higher-income city is not enough to improve wellbeing. An individual needs to be located around high-income households within that city at a local neighbourhood level to benefit.

There are multiple opportunities for future research. First, the study could be adapted to explore other reference group definitions. My study used geographic reference groups to determine reference income in Australia, but prior international literature has also used people with similar characteristics, work peers, or various other combinations of reference group definitions (Brown et al., 2015). Second, future studies could explore the relationship between reference income and life outcomes available in HILDA other than subjective wellbeing, such as physical and mental health. Third, though I apply individual fixed-effects to control for unobserved time-invariant heterogeneity, a limitation of this study is that endogeneity and endogenous self-selection concerns can also be caused by time-*variant* aspects of unobserved heterogeneity (Luttmer, 2005). A potential solution for future research is to focus on subsets of the HILDA sample for whom income and housing decisions are arguably more exogenous. For example, social housing tenets might be less susceptible to selection concerns, as they are offered housing through administered (not market) mechanisms. Variation in neighbourhood incomes is then more likely exogenous for this sub-sample. Comparison between these sub-samples and the full-sample might inform of any endogeneity and/or self-selection concerns.

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4.7 TABLES

Table 10 Descriptive statistics describing person-year observations of the variables used in the forthcoming panel-data models of subjective wellbeing.

	Mean	***Std Dev***
Life satisfaction	7.92	1.49
0 (totally dissatisfied)	0.16%	
1	0.17%	
2	0.37%	
3	0.72%	
4	1.13%	
5	4.27%	
6	5.75%	
7	19.00%	
8	33.45%	
9	22.06%	
10 (totally satisfied)	12.92%	
Real household equivalised income	$67,218	$73,411
SA2 real median household equivalised income	$46,941	$13,819
GCCSA/SA4 real median household equivalised income	$51,378	$9,139
In the bottom half of SA2 income	40.01%	
In the bottom half of GCCSA/SA4 income	45.84%	
SA2 real median rent	$311	$109
GCCSA/SA4 real median rent	$299	$80
Age	45.62	18
Gender		
Male	46.73%	
Female	53.27%	
Marital status		
Legally married	51.74%	
De facto	12.68%	
Separated	2.85%	
Divorced	6.35%	
Widowed	5.07%	
Never married and not de facto	21.31%	
Number of adults	2.24	0.99
Number of children aged 0-4	0.20	0.52
Number of children aged 5-9	0.19	0.51

Number of children aged 10-14	0.21	0.52
Lone parent household		
No	95.9%	
Yes	4.1%	
Country of birth		
Australia – non-Indigenous	75.72%	
Australia – Indigenous	2.25%	
Main English-speaking	9.95%	
Other	12.09%	
Dwelling type		
House	88.89%	
Unit or other	11.11%	
Dwelling tenure		
Own or mortgage	62.8%	
Rent or pay board	25.28%	
Rent free or life tenure	2.5%	
Still living at home	9.43%	
Education		
Bachelor’s degree or higher	22.95%	
Other post-school qualification	29.96%	
Completed high school	14.68%	
Less than high school completion	32.41%	
Employment status		
Employee full-time	35.89%	
Employee part-time	17.25%	
Employer or self-employed	10.45%	
Not in labour force – student	2.93%	
Not in labour force – retired	18.65%	
Not in labour force – other	11.50%	
Unemployed	3.34%	
Long-term health condition		
No	72.87%	
Slight	7.84%	
Moderate	18.23%	
Severe	1.06%	
Other adult present during interview		
No	63.63%	
Yes	36.37%	
ABS Section of state		
Major urban	64.77%	
Other urban	21.76%	

Rural balance or bounded locality	13.47%	
State		
New South Wales	30.06%	
Victoria	25.09%	
Queensland	20.48%	
South Australia	9.32%	
Western Australia	9.25%	
Tasmania	3.13%	
Northern Territory	0.7%	
Australian Capital Territory	1.97%	
Year of observation		
2001	19.89%	
2006	23.09%	
2011	29.82%	
2016	27.20%	
Person-year observations (N)		52,084
Individuals (n)		17,285
Average N per n		3
Minimum N per n		2
Maximum N per n		4

Source: Authors own calculations using Australian Census data and responses to wave 1, 6, 11, and 16 of the HILDA survey.

Notes: SA2s and GCCSAs/SA4s are defined by the 2011 ABS ASGS. For individuals outside Australia's capital cities, SA4s are used as the spatial unit instead of GCCSAs. All monetary figures are in Australian dollars and were inflated to real 2020 values using the relevant CPI from ABS catalogue 6401.0 – Consumer Price Index, Australia. 'Main English speaking' countries are the United Kingdom, New Zealand, Canada, USA, Ireland and South Africa.

Table 11 REWB ordered probit panel models of subjective wellbeing.

Dependant variable: One's Life satisfaction	*(C1) REWB Ordered Probit*	*(C2) C1 sans Rural Australians*	*(C3) C1 with Interactions*	*(C4) C1 with Rent Variables*
	Coeff. (S.E)	***Coeff. (S.E)***	***Coeff. (S.E)***	***Coeff. (S.E)***
Within-Effects:				
Ln real household equivalised income (β_{1W})	0.031^{***} (0.007)	0.030^{***} (0.006)	0.023^{**} (0.008)	0.031^{***} (0.007)
Ln SA2 real median household equivalised income (β_{2W})	0.257^{***} (0.046)	0.289^{***} (0.048)	0.265^{***} (0.047)	0.214^{***} (0.053)
Ln GCCSA/SA4 real median household equivalised income (β_{3W})	-0.248^{***} (0.066)	-0.246^{**} (0.086)	-0.232^{**} (0.089)	-0.242^{**} (0.098)
Bottom half of SA2 income	-	-	0.028 (0. 602)	-
Bottom half of GCCSA/SA4 income	-	-	0. 690 (0. 914)	-
Bottom half of SA2 income: Ln SA2 real median household equivalised Income	-	-	-0.001 (0.002)	-
Bottom half of GCCSA/SA4 income: Ln GCCSA/SA4 real median household equivalised Income	-	-	-0.003 (0.002)	-
Ln SA2 real median rent	-	-	-	0.072 (0.048)
Ln GCCSA/SA4 real median Rent	-	-	-	-0.001 (0.083)
Between-Effects:				
Ln real household equivalised income	0.117^{***} (0.013)	0.0119^{**} (0.019)	0.069^{***} (0.017)	0.117^{***} (0.013)
Ln SA2 real median household equivalised Income	0.089^{*} (0.043)	0.094^{*} (0.054)	0.108^{*} (0.050)	0.147^{**} (0.052)
Ln GCCSA/SA4 real median household equivalised income	-0.366^{***} (0.088)	-0.354^{**} (0.091)	-0.329^{***} (0.092)	-0.091 (0.140)
Bottom half of SA2 income	-	-	0. 196 (0. 999)	-
Bottom half of GCCSA/SA4 income	-	-	-0. 416 (0. 629)	-
Bottom half of SA2 income: Ln SA2 real median household equivalised Income	-	-	-0.008 (0.004)	-
Bottom half of GCCSA/SA4 income:	-	-	-0.006 (0.004)	-

Ln GCCSA/SA4 real median household equivalised Income				
Ln SA2 real median rent	-	-	-	-0.085 (0.050)
Ln GCCSA/SA4 real median rent	-	-	-	-0.156 (0.090)
Control variables:				
Age and age squared	✓	✓	✓	✓
Gender	✓	✓	✓	✓
Marital status	✓	✓	✓	✓
Number of adults and children	✓	✓	✓	✓
Lone parent household	✓	✓	✓	✓
Country of birth	✓	✓	✓	✓
Dwelling type and tenure	✓	✓	✓	✓
Educational attainment	✓	✓	✓	✓
Employment status	✓	✓	✓	✓
Long-term health condition and severity	✓	✓	✓	✓
Other adult present during interview	✓	✓	✓	✓
ABS Section of state (urban or rural)	✓	✗	✓	✓
State fixed-effects	✓	✓	✓	✓
Time fixed-effects	✓	✓	✓	✓
McFadden's Pseudo R-squared	.077	.073	.079	.077
Person-year observations (N)	52,084	45,072	52,084	52,084
Number of individuals (n)	17,285	15,885	17,285	17,285

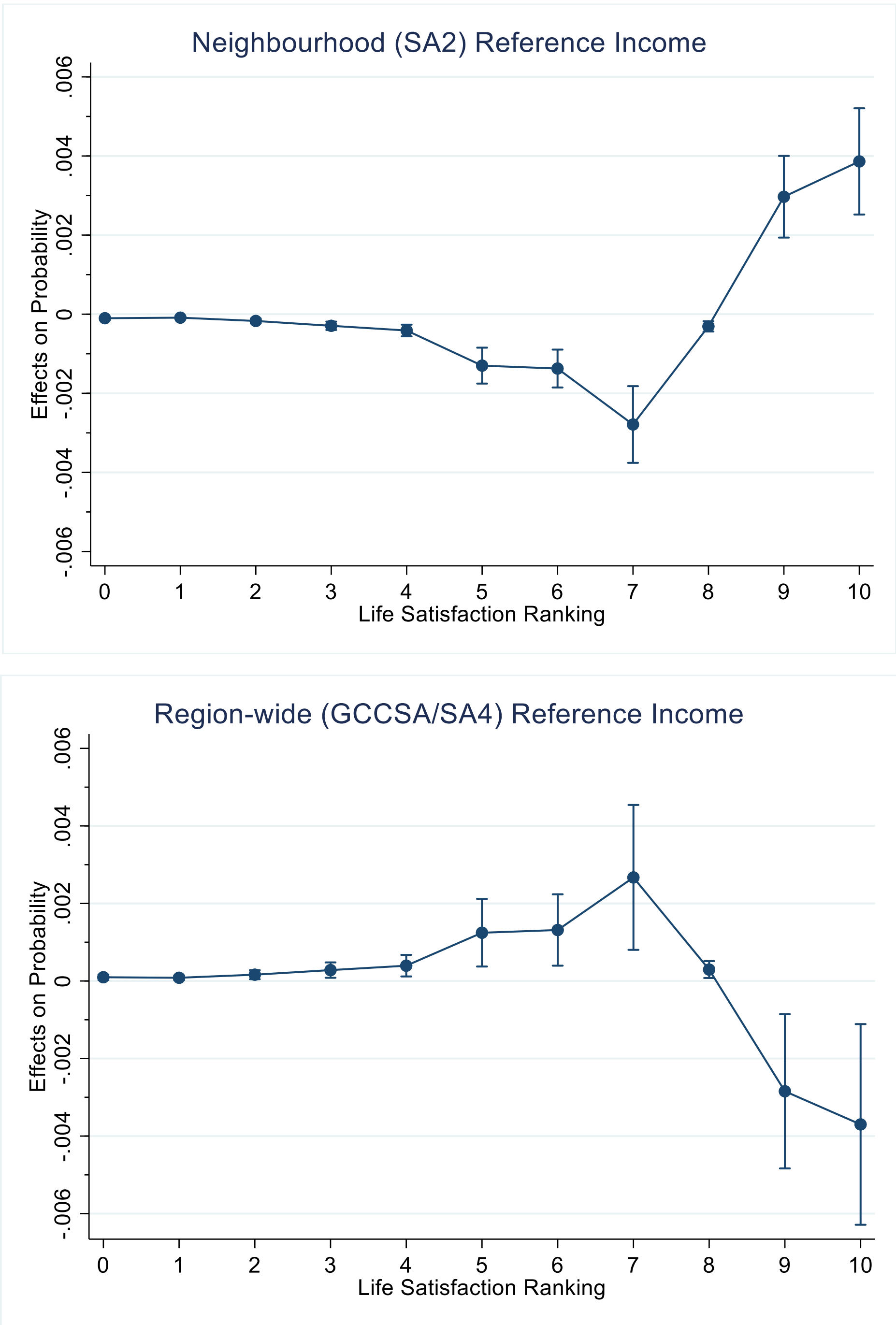
* P < 0.05, ** p < 0.01, *** p < 0.001.

Source: Authors own calculations using Australian Census data and responses to wave 1, 6, 11, and 16 of the HILDA survey.

Notes: SA2s and GCCSAs/SA4s are defined by the ABS ASGS. For individuals outside Australia's capital cities, SA4s are used as a spatial unit instead of GCCSAs. Life satisfaction measures answers to the question "All things considered, how satisfied are you with your life?" as rated on a scale of one unit increments between 0 (totally dissatisfied) and 10 (totally satisfied). The 17,285 individuals in the main panel-data model average three observations per individual, with a minimum of two observations and a maximum of four observations. The coefficients of the control variables, as well as marginal effects for any individual variable are available upon request.

4.8 FIGURES

Figure 2 The average marginal effects of a 10% increase in the de-meaned reference income variables, with 95% confidence intervals.



Source: Authors own calculations using Australian Census data and responses to wave 1, 6, 11, and 16 of the HILDA survey.

Notes: Life satisfaction measures answers to the question "All things considered, how satisfied are you with your life?" as rated on a scale of one unit increments between 0 (totally dissatisfied) and 10 (totally satisfied). The vertical axis estimates the percentage point change in selecting a given life satisfaction ranking, following a 10% increase in the relevant reference income variable. All estimates are significant at the 1% level.

4.9 COPYRIGHT AND DISCLAIMER NOTICES

5 CHAPTER 5: GENERAL CONCLUSION

The three essays within this thesis address unresolved questions surrounding the connection between residential segregation and dwelling price or wellbeing outcomes within Australian cities and neighbourhoods. In this conclusion, I first summarise the main findings, and subsequent policy implications, of each essay, I then restate the theoretical and methodological contributions of my thesis to the literature, and conclude by discussing my future research intentions.

5.1 SUMMARY OF FINDINGS AND POLICY IMPLICATIONS

In the first essay (Chapter 2), now published in the *International Journal of Housing Policy* (Phelps et al., 2020), I addressed heterogeneity in neighbourhood dwelling price movements, specifically that between lower-priced and higher-priced neighbourhoods within Australian cities. My empirical investigation of neighbourhood dwelling price dynamics in the five major cities of Australia found patterns of convergence or divergence within those cities over the observation period 2001-2016. However, these patterns were not constant, and appeared to shift from convergence to divergence over the study time-frame. In the first of three sub-periods, all cities, regardless of dwelling type, experienced rapid convergence of neighbourhood dwelling prices over the period 2001-2006. I offered the introduction of assistance for first home buyers, interest rate rises, and patterns of new supply as explanations. In the subsequent two sub-periods, price dynamics shifted away from convergence, and in many cases towards divergence. This shift is associated with expansionary monetary policy post-GFC.

The presence of convergence or divergence in Australian cities suggests that policymakers need to be wary of using city-wide price growth indices that track movements in average or median prices. Price dynamics in the lower-priced or 'starter home' market, where affordability and accessibility problems are of most interest to policymakers, are not necessarily accurately represented by such indices. My findings also suggest that there is an association between convergence/divergence and interest rate changes. This compliments recent Australian evidence that monetary policy has differential effects across housing market segments (He &

La Cava, 2020). These effects are markedly different in periods when monetary policy is relaxed rather than tightened. These uneven impacts demand a nuanced approach to the crafting of housing policy domains most impacted by convergence or divergence – intra- and inter-generational housing wealth inequality, housing asset-based welfare, and access to homeownership.

In the second essay (Chapter 3), I addressed how the price growth of less-affluent neighbourhoods is influenced by proximity to more-affluent neighbourhoods within Australian cities. Over the 1995-96 to 2015-16 study timeframe, I found a systematic pattern in which less-affluent neighbourhoods in proximity to affluent ones experienced higher house and unit price appreciation than similar neighbourhoods that were further away. This outcome suggests that positive neighbourhood consumption externalities were present within Australian cities; households were willing to pay for closer access to the greater quality and variety of endogenous amenities found in nearby wealthy neighbourhoods. I also found signs that suggest the presence of gentrification; less-affluent neighbourhoods in proximity to affluent ones experienced greater growth in the fraction of residents with a bachelor degree or higher qualification, as compared to similar neighbourhoods that were further away.

The State Governments of the cities in this study have mandated targets for new infill development (National Housing Supply Council, 2010). My findings suggest that less-affluent neighbourhoods in proximity to affluent neighbourhoods are a useful target for urban renewal projects; proximity provides the opportunity to deliver diversity and affordability in the housing stock by tapping into spillover demand from affluent neighbourhoods, avoiding the inflated land and construction costs of development inside those affluent neighbourhoods. However, caution is needed. If proximity to affluent neighbourhoods is also a predictor of gentrification, government intervention might be required to avoid the displacement of low-income tenets in the private rental sector of these neighbourhoods. For example, inclusionary zoning regulations could be used to ensure new developments contain a reasonable proportion of affordable dwellings (Gurran et al., 2018).

In the third essay (Chapter 4), I addressed the impact of the incomes of one's neighbours on the wellbeing of individual Australians. Panel data on the subjective and economic wellbeing of households was used to establish the geographic reference income and subjective wellbeing relationship within Australia. I found that, after controlling for one's own household income and unobserved time-invariant heterogeneity, the increasing income of others is positively associated with wellbeing at the neighbourhood level, and negatively associated with wellbeing at the region-wide level, at roughly the same magnitude. Additionally, there is no asymmetry between households in these effects; the wellbeing relationship is the same no matter one's rank in the distribution of incomes within an area. As in recent US-based studies (Brodeur & Flèche, 2019; Ifcher et al., 2018), it appears that at the neighbourhood level, the positive externalities from living amongst those with high-incomes, such as better public goods and amenity, outweigh the negative externalities, such as feelings of relative deprivation. At the region-wide level, this outcome is reversed. Unlike the recent US-based studies, the negative region-wide relationship cannot be explained by a higher cost of living. This warrants further analysis to establish the negative wellbeing channels that explain this divergent result.

These findings on geographic reference income suggest a multifaceted approach is required by Australian urban policy makers in their policy responses to residential segregation, one that takes into account the reference income and wellbeing relationship at both the neighbourhood and region-wide levels. The positive relationship between reference income and wellbeing suggests that there is merit in policies that encourage social mixing, as it will allow some lower-income households to maximise their wellbeing by sorting into higher-income neighbourhoods. For example, locating new social housing within wealthier neighbourhoods would have positive wellbeing benefits for tenants. The defunct National Rental Affordability Scheme could also be revisited to deliver more affordable private rental accommodation in higher-income areas (Rowley et al., 2016). The negative relationship between reference income and wellbeing at the region-wide level suggests that policies to reduce societal inequality will also be required, as this negative wellbeing impact will persist even in socially mixed neighbourhoods.

5.2 CONTRIBUTIONS TO LITERATURE

The essay in Chapter 2 contained three contributions. First, it considerably expanded the scope of existing Australian literature on neighbourhood dwelling price converge. Prior literature was limited to the neighbourhoods of one Australian capital city (Wood et al., 2016), and did not explore interesting sub-periods contained within its study timeframe, as characterised by different economic conditions. My study expanded the analysis to five capital cities, as well as three sub-periods corresponding to changing economic conditions. The results revealed that patterns of convergence/divergence do differ by city and/or sub-period. Therefore patterns of convergence/divergence are not uniform across cities or time. Second, the essay compliments the emerging evidence base suggesting monetary policy has differential effects across market segments of the housing market (He & La Cava, 2020), by showing it is associated with periods of convergence/divergence. Third, I contributed methodologically to the international literature by differentiating between dwelling types in my analysis. As opposed to houses, Australian units are generally located in inner-city areas and rates of ownership are evenly split between investors and owner-occupiers (CoreLogic, 2016). Consequently, neighbourhood price dynamics might differ across these market segments. To estimate neighbourhood dwelling price convergence, prior literature has used price data for all dwelling in a neighbourhood, or single family detached houses only. The hedonic price indices used in my study allowed for separation between dwelling types (houses or units), revealing that patterns of convergence/divergence are not uniform across dwelling types within a city.

The essay in Chapter 3 made four contributions to literature. First, it is the first Australian study to confirm the presence of positive neighbourhood consumption externalities within Australian cities. This finding will better inform Australian urban policy makers on how households make neighbourhood sorting decisions. My evidence also suggests that proximity to affluent neighbourhoods may be a predictor of gentrification, contributing to Australia's relatively sparse literature in this area (Atkinson et al., 2011). Second, my findings provide external validity to the limited pool of international literature on neighbourhood consumption externalities. My study joins Bayer et al. (2007) and Guerrieri et al. (2013) in supporting the existence of positive neighbourhood consumption externalities, and is the first to do so outside of a US context. Third, as in Chapter 2, I contributed methodologically to the international literature by differentiating between dwelling types in my analysis. The hedonic price indices used in my study allowed for separation between dwelling types (houses or units), revealing that houses experience a higher rate of price appreciation than units as proximity to affluent neighbourhoods decreases. Fourth, I made two further methodological extensions to the Guerrieri et al. (2013) estimation strategy to improve its accuracy; I included variation in elevation as a natural amenity control variable (Lee & Lin, 2018) and used an index of economic resources to rank neighbourhoods by affluence, instead of neighbourhood dwelling prices.

The essay in Chapter 4 made four contributions to literature. First, it is the first study to establish the geographic reference income and subjective wellbeing relationship within the Australian literature. This finding will help inform urban policy surrounding residential segregation. Second, my findings provide external validity to the US-based literature. Recent US-based studies (Brodeur & Flèche, 2019; Ifcher et al., 2018) have highlighted that this wellbeing relationship is sensitive to the scale of the geographic reference group used. My study confirmed that differences between region-wide and local neighbourhood effects apply outside of the US context. However, I did not find that cost of living explained the negative region-wide effect of reference income in Australia, suggesting another wellbeing channel must be responsible. Third, a methodological limitation of recent US-based studies was that they were cross-sectional studies, and so it is possible their subsequent estimates were driven by issues of endogeneity and endogenous self-selection. To overcome this limitation, I took advantage of panel-data modelling to reduce the likelihood of endogeneity issues. Fourth, the within-between random-effects ordered probit panel-data model used in my study is novel to the geographic reference income literature; it allowed me to control for time-invariant endogeneity issues, while also acknowledging the ordinal nature of measurements of subjective wellbeing, a combination ignored by prior literature.

5.3 LIMITATIONS AND FUTURE RESEARCH

Due to the time and funding constraints of a PhD thesis, I was not able to implement all of my research ideas. Therefore, to end this thesis, I state some of my future research intentions.

A necessary component of Chapters 2 and 3 was the use of hedonic dwelling price indices. These indices had to be licensed from a private property data and analytics company, and are prohibitively expensive. Therefore, I had to strategically limit the analysis in those chapters to SA2s within the five mainland state capitals, and the years aligning with the Australian Census – 1996, 2001, 2006, 2011, and 2016. With further funding, the scope of those chapters could be expanded both geographically and temporally. It would be of interest to see if observations of convergence, or evidence of neighbourhood consumption externalities, apply to Australia's smaller cities and towns, as it does in the capitals. In the convergence analysis, I suggest that easing monetary policy is associated with a shift towards divergence later in the study time-frame. Since 2016, the cash rate has been cut further (RBA, 2021) and so it would be of interest to see if the shift towards divergence continued to 2021. If it did not, monetary policy might then be of less importance than suggested.

The estimation strategies of Chapters 2 and 3 could also potentially be made more sophisticated. Chapter 2 explored unconditional convergence, but my data could be adapted to other more intricate measures of convergence, such as conditional or stochastic converge (Islam, 2003). As in Guerrieri et al. (2013), Chapter 3 supports the existence of neighbourhood consumption externalities in a linear environment. Neighbourhood consumption externalities are born from spatial spillovers. In my post-doctoral research, I intend to convert the linear regression model of Chapter 3 into a spatial autoregressive model. Instead of using distances in a linear regression to estimate the effects of these spillovers, the spatial relationships between neighbourhoods would be modelled directly, providing further insights.

Though I apply individual fixed-effects to control for unobserved time-invariant heterogeneity, a limitation of Chapter 4 was that endogeneity and endogenous self-selection concerns can also be caused by time-*variant* aspects of unobserved heterogeneity. In future research, I intend to focus on subsets of the HILDA sample for whom income and housing decisions are arguably more exogenous. For example, social housing tenants might be less susceptible to selection concerns, as they are provided with housing administered by government organisations. Similarly, the sample could be limited to individuals who have not moved neighbourhood during the study timeframe (Luttmer, 2005). Comparison between these sub-samples and the full-sample might inform of any endogeneity and/or self-selection concerns.

5.4 Chapter references

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