Fertility and Housing Market: Australian Evidence

By

Ang Li

Thesis

Submitted in fulfillment of the requirements for the

Degree of Doctor of Philosophy

School of Economics

Faculty of Arts and Social Science

University of Sydney

Mar 2018

Declaration

Statement of Originality

I certify that the intellectual content of this thesis is the product of my own work and that all the assistance received in preparing this thesis and sources have been acknowledged.

Authorship Attribution Statement

Chapter Three, “Fertility and Housing Wealth”, was the basis of a journal article co-authored with Professor Stephen Whelan and Dr. Kadir Atalay that has been submitted for publication. I wrote the initial draft of the paper and was primarily responsible for the empirical analysis.

Signature: Ang Li

Name: Ang Li

Acknowledgments

I would like to express my deep appreciation to my supervisor, Stephen Whelan, who taught me the meaning of quality in one's work. He has been a source of great help and guidance. His thoughtful criticisms and invaluable suggestions pushed me to do my best work. I also owe my deep gratitude to Kadir Atalay, who gave me a great deal of generous support and thought-provoking advice. Their lessons will remain with me for the rest of my life.

I am immensely grateful to my parents for their unconditional love and support. Their unwavering encouragement and faith in me have provided me the strength and persistence to overcome the challenges in life. One of the greatest causes of my happiness is to make them proud. I will never be able to thank them enough and repay them for what they have done for me.

I wish to thank Chun Yi, Fajar B. Hirawan, Hiroko Komatsu, Naoyuki Kajimoto, and Hasyimah Mohd Amin for their friendship. Lastly but not least, I wish to thank my good friend Mathew Toll. He has provided me great companionship and taught me to believe in myself. Infinite smiles.

Table of Contents

List of Tables

List of Figures

Abstract

This thesis comprises three papers examining the relationship between fertility and housing. The first paper presents time series evidence on the aggregate relationship between fertility rate and house prices in Australia over the past decades. An exploration of underlying household decision-making is undertaken in the second and third papers using micro level household panel data. The second paper examines the effect of changes in house prices and housing wealth on fertility related decisions among non-moving households across their housing tenures. The third paper investigates the alternative response of residential relocation in anticipation of childbearing.

The first paper provides aggregate evidence on the secular variation in fertility rates and house prices over the period 1971-2014 in Australia. Standard cointegration analysis is applied to the endogenous and nonstationary time series variables in the fertility demand function. The stationary long-run cointegrating relationship between total fertility rates, house prices, female labour force participation rates, and male and female wages is modelled for each State and Territory. The macro estimation shows some evidence of a negative correlation between the aggregate fertility rate and house prices, especially in some major housing markets and for younger cohorts. Some age groups across States and Territories exhibit a positive association between fertility rate and house prices. Such a pattern may reflect the effect of housing wealth on fertility. Alternatively, it may be explained by the regional migration of young couples.

Recognising the distinctive implications of house price movement across housing tenures, the second paper examines the effect of changes in house prices and housing wealth on fertility related decisions using the Household, Income and Labour Dynamics in Australia (HILDA) survey during 2001-2015. The identification of conditionally exogenous changes in house prices with respect to fertility decision relies on the geographic and temporal variation in housing prices across localities and over time. Focusing on non-moving owner and rental occupiers, the study finds that the childbirth among homeowners respond positively to an increase in housing wealth. In comparison, there is evidence that the fertility intention of renters respond negatively to higher housing prices. The positive housing wealth response exhibited by homeowners is more salient among females who are younger, formally married and with no children.

Households can also respond to housing market development by residential relocation. The third paper considers the ease or difficulty of housing adjustment in anticipation of family growth, and explores the impact of fertility desire and expectation on residential mobility over various distances. Several empirical strategies such as correlated random effects models, simultaneous-equations models, and instrumental variable models are implemented to correct for the possible bias in unobserved heterogeneity and joint determination. Using the HILDA data set, the study finds a significant impact of fertility intention on residential relocation in Australia, with large heterogeneity across housing markets and relocation distances. Fertility-induced moves are mainly observed for households residing in the housing markets with low affordability pressures and often occur intra-regionally across local government areas.

Keywords: Fertility, Fertility Intentions, House Prices, Housing Wealth, Residential Mobility

Chapter One

Introduction

Housing markets have received considerable attention in Australia during recent decades in part because of the substantial and persistent increase in housing prices over time. Such developments have initiated debate on the impact of higher house prices on a range of household behaviours and well-being. A contemporaneous trend observed in Australia is the low fertility rate and the increasing age of women at first birth. While fertility patterns generally reflect a range of social and economic developments, one important consideration that has received relatively little attention to date is the role of housing market. In particular, increases in prices which affect the cost of housing and in turn the cost associated with childbearing, may be one of the key factors associated with the fertility related decisions.

This thesis is motivated by these considerations and aims to present evidence on the interconnection between housing markets and fertility related decisions in Australia. The analysis in the thesis explores a variety of dimensions associated with the movement in house prices and housing wealth, residential relocation, and, fertility intentions and outcomes. The specific research questions examined in this thesis are:

- Is there any evidence of an aggregate relationship between fertility rates and house prices over the past four decades?
- Are households' fertility related decisions affected by changes in house prices and housing wealth?
- How do households make housing adjustments via residential relocation to fulfil fertility aspirations, given developments in housing markets?

As noted, there has been a significant and sustained rise in the price of housing over the proceeding few decades in Australia. Housing prices grew at a relatively low level of approximately 1.4 percent per annum at the national level during the 1970s and 1980s. From 1990 to the mid-2000s, housing price growth accelerated and reached to 4.5 percent per annum. Since then, housing prices have experienced a steady growth at 2.5 percent per annum in the last decade (RBA 2015). The strength and timing of growth rates in housing markets across the country have shown significant variation, and in some instances, the growth occurred rapidly over a short period time. The Organisation for Economic Cooperation and Development (OECD 2018b) reports that between 1970 and 2016, Australian house prices almost tripled, compared to an increase of 240 percent in Canada and 92 percent in the United States. Moreover, average house prices were four times average household income in the early 2010s, compared to two times in 1970s.

The large and sustained inflation in the price of housing in Australia since the early 1970s has focussed economists' attention on the behavioural implications of such developments. One of the demographic patterns observed in Australia and many other developed countries is low birth rates and the increasing age of women at first birth (OECD 2018a). From a high of 2.95 in 1971, the total fertility rate declined to a low of 1.74 in 2001, and has been below the replacement rate of 2.1 children per woman since 1976 (ABS 2016a). Similar patterns have been observed in other developed countries including the United Kingdom and New Zealand (OECD 2018a). During the past decades, women above 30 years old have had increasingly higher fertility rates while fertility rates among women below 30 years old have been declining. Accordingly, the median age of all mothers has been increasing consistently, from 25.5 years in 1970 to 31.2 years in 2016 (ABS 2016a).

It is important to emphasise that this decline in fertility rates has coincided with significant changes in social expectations and norms. Females are increasingly attaining higher levels of education, delaying fertility, and returning to employment following the birth of children. Such developments have been facilitated by a range of policy settings including a rapid expansion of child care during the 1990s and 2000s (OECD 2000) and the introduction of provisions for maternity and paternity leave (AIFS 2013). Sociologists, demographers, and economists have noted that the postponement and reduction in fertility may be associated with the increasing opportunity costs of children represented by women's education attainment (Adsera 2004; Hakim 2003; Bratti 2003; Engelhardt and Prskawetz 2004; McDonald 2000). One consideration that has received increasing attention more recently is the role of housing markets and in particular the cost of housing.

There is an extensive theoretical and empirical literature that links housing related choices to decisions around fertility and family formation (Feijten and Mulder 2002; Kulu and Vikat

2008; Morrow-Jones 1988; Mulder and Wagner 1998, 2001; Withers 1998; Ström 2010; Kulu and Steele 2013; Vignoli, Rinesi, and Mussino 2013; Ermisch and Di Salvo 1997). More recently, a growing body of studies attempts to explore the connection between the price of housing and fertility related decisions (Clark, Deurloo, and Dieleman 1997; Simon and Tamura 2009; Dettling and Kearney 2014; Aksoy 2016; Clark and Ferrer 2016; Lovenheim and Mumford 2013). There is a widespread perception in Australia that home-ownership will accompany family formation and more generally it is widely recognised that housing of sufficient quality and quantity is a prerequisite for household growth (Feijten and Mulder 2002; Vignoli, Rinesi, and Mussino 2013). Since it is generally acknowledged that housing constitutes a major cost associated with having children, housing market considerations may affect family fertility decisions. In an expensive housing market, higher housing costs may constrain the ability of households to enter homeownership and achieve a preferred housing outcome (Courgeau and Lelièvre 1992; Kulu and Steele 2013). In turn, increased housing costs and the concomitant costs of raising children may lead to the postponement and possibly a decrease in total fertility (Clark 2012; Clark and Huang 2003).

The analysis in this thesis aims to provide an empirical examination of the relationship between housing and fertility related decisions in an Australia context. The empirical analysis of such a relationship is grounded in the theoretical framework developed by Becker (1960). The microeconomic model developed in that paper is extended in Becker (1965), Mincer (1963), and Willis (1973) by incorporating the concept of the opportunity cost of female time measured by female wage rates into the decision making framework. The microeconomic approach views the fertility decision in a lifetime utility maximisation framework in which a family maximises its expected lifetime level of utility by choosing the optimal number of children and other consumption goods, subject to the wealth and time constraints. Assuming children and housing are normal goods and the cost of housing represents an important component of the cost of raising children, the model of fertility identifies an income or wealth effect and a substitution effect on fertility in response to changes in house prices. The net effect depends on housing tenures, the relative size of income and substitution effects and residential mobility intention.

This thesis consists of three related but independent studies. Each study considers a different facet of the relationship between fertility and housing in Australia. The first paper considers the aggregate relationship between fertility rates and housing prices over an extended period of time. In particular, an investigation of the long-term correlation between total fertility rate and median house prices at the State and Territory level is undertaken using time series techniques. Common procedures for endogenous and nonstationary variables are applied to annual time series drawn from the Australian Bureau of Statistics (ABS). Following this, the analysis in the second and third papers turns to an examination of household behaviour by using rich microdata at the individual or household level, namely the Household, Income and Labour Dynamics in Australia (HILDA) survey. The detailed set of covariates available in the dataset provides an opportunity to examine how changes in house prices are connected to fertility related decisions in a range of dimensions including the mobility decision.

The first piece of substantive analysis investigates the relationship between house prices and fertility using aggregate data by estimating a long-term cointegrating relationship between total fertility rates, median house prices, female labour force participation rates, and weekly male and female wages. Standard unit root and cointegration testing procedures, which are well suited to the estimation of the dynamic relation between nonstationary time series in the presence of endogeneity, are applied to annual time series data at the level of States and Territories over the period 1971-2014. The cointegration analysis finds some evidence of a negative relationship between fertility rates and house prices although it varies with the technique used. The negative relationship is more consistently observed for those age groups in their early 30s.

Following the analysis presented in Chapter Two, a comprehensive investigation at the individual and household level is explored in the following two chapters using microdata covering the period between 2001 and 2015. Chapter Three examines the effect of changes in house prices and housing wealth on fertility related decisions among non-movers, and importantly explores both fertility intentions and outcomes. Analysis is undertaken separately for homeowners and private renters given the different impact that a change in house prices is likely to have on those groups. In this analysis, identification relies on the geographic and temporal variation in the magnitude and timing of housing price movements that is arguably conditionally exogenous with respect to fertility decisions. Such an approach has been applied in studies both in Australia (Atalay, Barrett, and Edwards 2015; Atalay, Whelan, and Yates 2016) and other countries (Lovenheim 2011; Lovenheim and Reynolds 2013; Davidoff 2010; Fichera and Gathergood 2016). The analysis suggests that the increase in housing wealth driven by housing price inflation increases fertility among homeowners. In comparison, house price growth decreases the fertility intention of renters. The positive wealth effect exhibited by homeowners is particularly salient among females who are in younger age groups, those who are formally married, childless, owner-occupiers with a mortgage, and those who are moderately liquidity constrained.

The relationship between fertility intentions and residential mobility is considered in Chapter Four. Geographic mobility represents a potentially important aspect of adjustment in the housing market, and existing research highlights the link between fertility and choice of residential location (Michielin and Mulder 2008; Kulu 2008; Kulu and Vikat 2008; Mulder 2006; Ström 2010; Kulu and Steele 2013; Clark and Huang 2003; Clark, Deurloo, and Dieleman 1994; Öst 2012; Clark 2013). The empirical analysis controls for unobserved heterogeneity and the joint determination of fertility and residential location using several modelling strategies. These include a correlated random effects model, a simultaneous-equations model, and an instrumental variables model exploiting family policy changes. Various empirical models suggest a significant impact of fertility intention on residential relocation in Australia. However, there is substantial heterogeneity related to housing market conditions and relocation distances. The translation of fertility intention into relocation was not observed in the housing markets where affordability pressures were prevalent, in comparison with the significant impact of fertility intention observed elsewhere. Moreover, couples with strong fertility intentions tend to move across local government areas within a statistical region. The results have significant policy implications on fertility development and infrastructure planning.

The analysis reported in Chapter Two, Three and Four highlights the relationship between housing markets and fertility intentions, fertility outcomes, and fertility induced residential relocation. Understanding these nexuses is important from a policy perspective for a number of reasons. For the majority of Australian households, housing represents the single largest asset in household wealth portfolio, and the purchase of housing generally represents the largest transaction entered into over the course of the life cycle (ABS 2011c, 2011a, 2015-16a). Given the fluctuations in the housing market over the past few decades, the studies in the thesis that connect between house prices, housing wealth, residential mobility, and childbearing can have significant implications for government policies associated with family and childcare support, housing markets, and, service and infrastructure planning.

The analysis in this thesis indicates that developments in housing markets may have implications for fertility intentions and outcomes, and in particular, higher costs of housing may delay or decrease fertility among younger adults planning to have children. The results suggest that housing price inflation may lead to the depression of fertility intention among private renters, and households in high-cost housing markets may not be able to adjust housing conditions and residential relocations by residential relocation to fulfil their fertility intentions. With falling rates of homeownership in recent years in Australia (ABS 2016c), the results may imply that persistent hosing price appreciation will have implications for the overall fertility level.

The results suggest that effective housing policies may have an important role to play in mitigating low fertility rate and maintaining population growth in Australia. The trend of a decline in fertility has been a public concern because of its implications for economic development, the age structure of the population, and the aging of the population. The findings suggest that housing and other institutional policies need to be in place to ensure effective and efficient implementation of policies designed to promote fertility and maintain a sustainable demographic structure.

The results are also of substantial policy interest for regional governments and communities. Mobility decisions are important for infrastructure planning, labour force mobility, and the demographic characteristics of a region. Understanding when and where households move as an outcome of fertility planning is crucial to designing policies on land use and housing development as well as the provision of sufficient services and facilities including childcare and schools.

More generally, the research in this thesis contributes to the literature on the implications of housing markets on household behaviours in a number of ways. To the author’s knowledge, this is the first study in Australia that attempts to explore how fertility decisions are related to developments in the housing market. Importantly, the rich microdata that is used in Chapter Three and Four provide an opportunity to consider both fertility related decisions and outcomes. Arguably, fertility intentions are more reflective of fertility decision-making and long-term family planning, and a number of studies have acknowledged the challenge in using actual births to measure the fertility decision-making process (Michielin and Mulder 2008; Öst 2012). By focusing on behavioural intentions with respect to childbearing, this study provides additional evidence on the housing-fertility nexus, and highlights the role of behavioural intentions in one life domain on influencing the actual outcome in another (Vidal, Huinink, and Feldhaus 2017).

The analysis and discussion in this thesis are particularly germane in the Australian context where home-ownership is historically important in both a social and economic context. Australia households have a high level of homeownership, carry a high level of mortgage debt, and exhibit a high marginal propensity to consume out of illiquid assets (Aron et al. 2012). The combined effect of these characteristics implies that the impact of the substantial temporal and spatial variation in house prices, with rapid house price increases in some periods, is likely to be particularly salient to Australian households. The availability of rich microdata in the form of the HILDA data provides a unique opportunity to analyse the relationship between fertility and housing in the unique Australian economic context. That is, consistently recorded information on fertility, housing and moving history over time allow the studies to disentangle the complex relation between childbearing and housing. Moreover, the measures on self-evaluated home values, demographic and socio-economic characteristics, locational social capital, and contextual factors facilitate controlling for a rich set of observed factors in addition to unobserved influences on household behaviours.

The structure of this thesis is as follows. Chapter Two presents the time-series evidence on the relationship between fertility rates and house prices at the aggregate level. Following this, Chapter Three examines the impact of house price and housing wealth fluctuations on fertility related decisions. Next, Chapter Four provides a study on fertility induced residential mobility. Finally, in Chapter Five, some policy implications and possible future extensions of the work are considered.

Chapter Two

Fertility Rates and House Prices: Time Series Evidence

1. Introduction

Motivated by fertility and housing developments over recent years in Australia and the growing literature that connects family and housing decisions outlined in Chapter One, the objective of this chapter is to present time series evidence on the relationship between fertility rates and house prices at the aggregate level over the past few decades. The evidence is based on a cointegration analysis of historical aggregate data that attempts to identify whether there is a long term equilibrium relationship between the fertility rate, house prices, and male and female labour market behaviours. Of particular interest is how fertility and housing are related.

The theoretical discussion of the relationship between fertility rates and house prices has its origins with the model of fertility developed by Becker (1960), in which fertility is considered in the context of a lifetime utility maximisation framework. According to the microeconomic theory of fertility, children are characterised as consumer durable goods. Households maximise their lifetime utility by choosing the optimal number of children, subject to total time of the husband and wife (including income earning and child care), their non-labour income and household income. The theory is further extended by considering the trade-off between child quantity and quality as well as the cost of parental time (Becker 1965; Mincer 1963; Willis 1973). In any economic model of fertility, households compare the costs and benefits associated with fertility subject to the constraints they face.[1]

The impact of housing costs has attracted more attention in recent years as housing affordability became a major concern for family life course progression. Housing and children may be considered complementary goods, and as a consequence, the cost of housing is likely to be an important influence on fertility related decisions. Along with the rapid and substantial growth

[1] The fertility decision is assumed to be made by a unitary household and reflects the tastes and preferences of all household members, although it will likely be made jointly by the individuals within the household.

in house prices, research on the relationships between housing and fertility decisions has emerged (Aksoy 2016; Clark and Ferrer 2016; Clark and Whiters 2008; Clark 2012; Clark, Deurloo, and Dieleman 1994; Courgeau and Lelièvre 1992; Dettling and Kearney 2014; Feijten and Mulder 2002; Kulu 2008; Kulu and Steele 2013; Kulu, Vikat, and Andersson 2007; Mulder and Billari 2010; Yi and Zhang 2010).

This chapter considers the aggregate relationship between housing prices and fertility by applying a cointegration analysis to annual time series at the State and Territory level in Australia. A number of empirical considerations are crucial in analysing fertility behaviours. It is likely, for example, that many variables entering the fertility demand function are endogenous since decisions relating to childbearing, labour force participation, and housing choices are likely to be determined jointly within a household. Moreover, a key concern in using aggregate time series data to analyse the relationship of interest is that the data used are likely to be nonstationary. The mean and variances of these time series are time varying and hence conventional asymptotic theory cannot be applied (Maddala and Kim 1998). Regressions of integrated variables lead to a spurious regression problem unless the variables are cointegrated. A cointegration relationship is observed when the linear combination of the non-stationary time series is stationary.

The cointegration model is well suited to the estimation of the dynamic relations between nonstationary time series in the long run even in the presence of endogenous regressors (Pesaran and Shin 1998). Cointegration analysis has been used to explore long-term equilibrium relationships between economic variables in a range of different contexts (Pedroni 2004; Dickey, Jansen, and Thornton 1994; Hakkio and Rush 1989; Bahmani-Oskooee 1993; Miller 1991), but has rarely been adopted among demographic studies. Applying an Error Correction Model, Ermisch (1988) found that higher house prices increase the proportion of childless women and moderately decrease family size. Conversely, Day and Guest (2016) argue that for countries with relatively price elastic housing supply and strong tradition of homeownership such as Australia, declines in fertility may be reversed with increases in housing prices and female relative wages. Using Johansen’s Vector Error-Correction Model, Yi and Zhang (2010) estimated the effect of house price on fertility in Hong Kong from 1971 to 2005. They show that increases in house prices are associated with lower fertility, with higher house prices accounting for approximately 65 percent of the fertility decline. The analysis reported in this chapter adopts a similar approach to that in Yi and Zhang (2010).

Following the identification strategy of Yi and Zhang (2010), the aggregate-level dynamics between fertility rates and house prices in Australia is examined, along with labour market status, using the annual time series data for the States and Territories over the period 1971-2014. The cointegration approach allows the investigation of a long-term equilibrium relationship between nonstationary variables. A series of non-stationarity tests with and without structural breaks are performed prior to the cointegration analysis. Next, the presence of cointegration among the time series is tested. The approach in this chapter is to use a number of techniques that attempt to identify the underlying relationship at an aggregate level between housing prices and fertility rates. In particular, the modelling of the cointegration relationship employs Johansen's Maximum Likelihood Estimation (MLE) procedure, Stock-Watson' Principal Component Analysis (PCA) procedure, and Engle-Granger's Ordinary Least Square (OLS) procedure.

The results from the application of the Engle-Granger method without structural breaks indicate evidence of a negative correlation between total fertility rates and house prices in New South Wales. The negative relationship for New South Wales persists after allowing for structural breaks. Across different cointegrating equations, the house price elasticity of fertility in New South Wales ranges from 0.27 to 0.47. That is, a one percent increase in real house prices is associated with a 0.27-0.47 percent decrease in total fertility rates. Using the Johansen method, the negative relationship between total fertility rates and house prices is present in New South Wales and Western Australia, with house price elasticity of fertility of 0.18 and 0.09 respectively. The results from the Stock-Watson method point to a negative relationship between total fertility rates and house prices in New South Wales, Victoria, Queensland, and the Nothern Territory. The house price elasticity of fertility is largest in New South Wales (0.53), followed by Victoria (0.17), the Nothern Territory (0.08), and Queesland (0.06).

There is also evidence of heterogeneity in the estimated response across age groups, suggesting that the negative relationship between fertility rates and house prices is largely driven by those in their early 30s. Higher costs of housing might constrain the ability of young adults to achieve sufficient housing for childbearing, which in turn might delay or decrease their fertility. Few age groups in Victoria, Queensland, Western Australia, the Northern Territory, and the Australian Capital Territory are found to exhibit a positive relationship between fertility rates and house prices. The increase in fertility during the periods of housing price inflation may reflect the migration of young adults across States and Territories, or the positive housing wealth effect that stimulates fertility.

The presence of a cointegration relationship may indicate that developments in housing markets may have implications for fertility. In particular, a negative correlation between fertility rate and housing prices may indicate that higher cost of housing may have implications for maintaining a high level of fertility in Australia, which if true, may imply that housing policies may have an important role to play in mitigating low fertility rate and maintaining population growth in Australia. This is of particular significance in the Australian context where population ageing, and low fertility have been major public issues and several government family policies have been implemented to promote fertility and support families with children.

The remainder of the chapter is set out as follows. In Section two, a literature review is presented, followed by a simple theoretical model of fertility in Section three. Section four describes the data and sets out preliminary summary statistics. In Section five, econometric methodologies are presented and results are reported in Section six. In reporting the results from the empirical analysis, initially the non-stationarity of the times series is tested using a series of approaches including the Dicky-Fuller test, the Phillip-Perron test, the Dicky-Fuller GLS test, and the Zivot-Andrews test. Following this, the cointegration tests and estimations are presented using the Engle-Granger OLS procedure, the Johansen MLE procedure, and the Stock-Watson PCA procedure. A heterogeneous analysis by age is also included in this section. The final section contains concluding remarks and highlights limitations of the analysis.

2. Literature Review

This section provides a brief literature review on economic models of fertility and empirical studies that have taken an aggregate or time series approach. The theoretical literature on economic models of fertility behaviour is developed around the theory of consumer choice. The cost of female time and quality elasticity for children relative to quantity elasticity are the main hypotheses that explain the observed negative relationship between income and number of children (Willis 1973; Mincer 1963; Becker 1960, 1965, 1981). Among empirical research, many studies have attempted to explore empirical evidence on the relationship between the cost of housing and fertility related decisions using regional or aggregate measures. One recent study by Yi and Zhang (2010) applied time series techniques to examine this relationship.

2.1 Theoretical Literature

The starting point for aggregate or time series models is a comparison of the costs and benefits for rational economic agents. There is a large theoretical literature investigating the determinants of fertility either in a static framework to explain the increase in family size or in a dynamic framework to study fertility timing and spacing. As an application of the neoclassical microeconomic theory, the static model assumes children are normal goods and considers a lifetime utility maximisation problem in which families choose the optimal number of children to maximise their lifetime utility subject to budget and time constraints. The model was subsequently enriched by considering the child quality and quantity interaction (Becker 1960) and costs of parental time (Becker 1965; Mincer 1963; Willis 1973; Becker 1981).

The quantity-quality trade-off theory recognises both qualitative and quantitative dimensions of child demand. Assuming stable preference across parity, a unitary household acting as a single decision maker chooses the optimal number of children, their qualities and the family's own standard of living. The choices made reflect a utility maximising decision subject to constraints associated with lifetime income and market prices. Assuming both the quality and quantity of children are normal goods, a higher income elasticity of quality relative to an income elasticity of quantity may lead families to substituting away the number of children towards the quality per child, from which it follows that total fertility is negatively correlated with income (Becker and Lewis 1973).

An alternative explanation for the negative relationship between income and fertility found in empirical studies, proposed by Mincer (1963) and Becker (1965), and extended by Willis (1973), attributes the decline in the fertility rate to the cost of female time and the opportunity cost of children. Families are assumed to combine time supplied by the parents and goods purchased in the market to produce basic commodities within the family via household production functions; and the marginal cost of home-produced commodities is the sum of the marginal cost of goods and time. The increase in the wages of females will cause the time-intensive consumption to be substituted for money-intensive consumption. Given childrearing is a relatively time-intensive activity, the increase in the opportunity cost of mothers' time will raise the cost of children and generate a substitution effect offsetting the income effect, thereby reducing total fertility.

2.2 Empirical Literature

Many empirical studies sought to provide evidence on the relationship between demographic changes and housing markets using regional or national measures on the price of housing (Clark 2012; Curtis and Waldfogel 2009; Malmberg 2010; Sato 2007; Simon and Tamura 2009; Malmberg 2012; Börsch-Supan 1986; Yi and Zhang 2010; Dettling and Kearney 2014; Kulu, Boyle, and Andersson 2009). More specifically, several early empirical studies have attempted to relate the price of living space to family formation. Börsch-Supan (1986) found that higher rental costs increased the probability of remaining in the parental home in the United States. Similarly in the United Kingdom, Ermisch and Di Salvo (1997) and Ermisch (1999) showed that higher regional house prices significantly delayed the exit from parental home and partnership formation. Clark and Mulder (2000) identify housing market size and young adults' resources as important influences on the entry into housing markets. The differences in house prices, housing policy and financial and legal systems can cause differences in timing in the life course, especially the likelihood of making a transition to homeownership (Clark, Deurloo, and Dieleman 1994; Mulder and Wagner 1998).

Provided that housing stability is considered a prerequisite for family formation (Feijten and Mulder 2002; Vignoli, Rinesi, and Mussino 2013), the cost of living space may affect the demand for children. There have been a number of studies conducted using aggregate or macro data that attempt to identify the nature of the relationship between the costs of housing and fertility related decisions. Simon and Tamura (2009) documented a significant and negative relationship between the price of living space, measured by rent rates per room, and the number of children for households in the United States using Census data at the Consolidated Metropolitan Statistical Area (MSA)-level over the period 1940-2000. Similarly, using the American Community Survey for 2006-2008 at Metropolitan Areal level, Clark (2012) showed that the costs of housing, measured as rents or sale prices, are negatively related to the age at first birth. This suggests that fertility for women in expensive housing markets is delayed. Malmberg (2012) adopted a cross-nation approach using OECD house price data for the period from 1950 to 2000 and found that a tight housing market, measured by demographically based indicators of housing demand pressure, is associated with low fertility.

In the context of housing, it is important to emphasise that adjustments may occur along a range of dimensions. For example, adjustments in the location, size and quality of housing may provide a mechanism by which fertility related demand for housing may be reconciled. For example, Kulu, Boyle, and Andersson (2009) used register data across different residential contexts in Northern Europe and showed that fertility was significantly higher in rural suburbs than in urban cities. This finding may reflect the selective moves of couples in a tight housing market who relocate from urban centres to more affordable suburbs or rural areas to accommodate family growth (Kulu 2008; Kulu and Steele 2013; Clark and Huang 2003).

It is also true that the effect of changes in house prices on fertility is likely to be tenure specific. The change in house prices is likely to have both income/wealth and substitution effects on the demand for children. While higher housing costs generate a negative substitution effect on fertility for both home-owing and rental residents, the increase in the price of housing can also increase the housing wealth of homeowners that leads to a positive effect on their fertility. Separately for owners and renters, Dettling and Kearney (2014)'s analysis identified the causal relationship between changes in MSA-level house prices and MSA-demographic group-level fertility rates. Their results suggest that a short-term increase in house prices leads to a decrease in birth rates among non-homeowners and a net increase among homeowners.

One approach to understanding the relationship between demographic trends and housing market conditions is to use time series analysis. The time series variables in the economic model of fertility are likely to be nonstationary and endogenous. These variables tend to have increasing variance over time and be simultaneously determined within the system. Hence, a cointegration approach is well suited to the estimation of the dynamic relationship between the fertility determinants in the long run. Such an approach has been used in a range of studies on the long-run equilibrium relationships between house prices and developments in economic and demographic factors (Drake 1993; Holly and Jones 1997; Gallin 2006; Ludwig and Sløk 2004; Duca, Muellbauer, and Murphy 2011).

The study most closely related to the analysis presented in this chapter is Yi and Zhang (2010). In that study, cointegration analysis was applied to annual data at the aggregate level during the period 1971-2005 for Hong Kong. The variables entering into the cointegrating equation are total fertility rate, house price index, female labour force participation rate, as well as female and male daily wages. Adopting the procedure described in Johansen (1991), they found a one percent increase in house prices is significantly correlated with a 0.45 percent decrease in the total fertility rate. Their results imply that house price inflation over time has accounted for 65 percent of the decrease in fertility in Hong Kong.

3. Theoretical Model

A simple theoretical model is set out in this section to motivate the empirical specification and analysis presented in sections five and six. The model follows Becker (1960)'s economic theory of fertility and considers a standard neoclassical model of optimal consumer behaviour. In a static equilibrium model, families make choices around the number of children and the amount of labour supply at each point in time to maximise expected lifetime utility. Families act as a single decision maker who choose optimal family size and an amount of leisure to maximise their unitary utility function subject to budget and time constraints. For simplicity, the quality of children and the consumption of other goods and services are ignored in the utility function.

The formulation of the model in Becker (1990) incorporates several simplifying assumptions. First, children are assumed to be normal goods. Second, housing is assumed to be a necessity for childbearing which does not directly yield satisfaction or utility. Third, parents act as a single decision maker and derive utility from choosing the number of children and the amount of the wife's leisure jointly.[2] In this simple model the husband is assumed to work full-time and his earnings are fixed and exogenous. Fourth, it is assumed that decisions on the number of children, the participation in labour market, and the amount of labour supply are made by

[2] This assumption is not applicable in the discussion of the out-of-wedlock equilibrium in which marital decisions and fertility decisions are interacted (Willis 1999). In a model of out-of-wedlock childbearing, children are treated as collective goods, and women and men act as separate decision makers to choose between marriage and non-marriage fertility.

parents at one point in the life cycle and are not revised in the future. That is, the sequential and stochastic nature of fertility behaviour is ignored. In addition, economic conditions such as market prices and wage rates of the wife, and any potential uncertainties and risks involved remain constant over the period of the partnership. Next, the cost of children is assumed to be constant, over time and for each child. For simplicity it is assumed that the cost of children doesn't take into account the wife's opportunity cost of time. Further, the time endowment is divided between wife's leisure and her market work, and children takes a fixed amount of time. Finally, following Yi and Zhang (2010)'s model formulation, other goods and services are ignored in the utility function.

The mechanism by which house prices influence fertility decisions is illustrated by considering the comparative statistics of fertility rates with respect to house prices. A representative household derives utility from the consumption of children and the wife's leisure, which is represented by the following function:

$$U = U(N, L_w) \tag{1}$$

where N is the number of children and L_w is the wife's leisure. A household chooses the number of children (N) and the wife's leisure (L_w) such as to maximise $U(N, L_w)$, subject to the following budget and time constraints:

$$P_N N + P_H H(N) + W_w L_w \leq W_w L_0 + Y \tag{2}$$

where P_N is the cost of children; P_H is the per unit price of housing; H is the housing required for N; W_w is the wife's wage rate; L_0 is the time endowment of the wife; and Y is the sum of husband's lifetime earnings as well as financial and non-financial assets of the household, including housing wealth. Housing demand is assumed to be a monotonically increasing function of the number of children, that is $H'(N) > 0$. Critically, this implies that children are complements to housing. Additionally, considering the economies of scale under which children can share housing space, it is assumed that $H''(N) < 0$. The marginal utility of the number of children and the leisure of wife are assumed to be positive, that is, $U_N > 0$ and $U_{Lw} > 0$ respectively.

Maximising the utility function (1) subject to the constraint (2) yields the first order condition:

$$U_N - \lambda(P_N + P_H H'(N)) = 0 \quad (3)$$

where U_N is the marginal utility of children; $P_N + P_H H'(N)$ is the marginal costs or the shadow prices of children that is an increasing function of P_H; and λ is the Lagrange multiplier. The comparative statistics of fertility N with respect to the price of housing P_H is derived by total differentiating the first order conditions using the Cramer's rule (See Appendix C):

$$\frac{dN}{dP_H} = \lambda H'(N)\frac{|\Delta_{11}|}{|\Delta|} - H(N)\frac{dN}{dY} < 0 \quad (4)$$

where Δ is the determinant of the boarded Hessian matrix and Δ_{11} is the cofactor of the element of the first row and first column in the boarded Hessian matrix. The income effect is $-H(N)\frac{dN}{dY}$ and it is negative, assuming children are normal goods and thus $\frac{dN}{dY} > 0$. The substitution effect is $\lambda H'(N)\frac{|\Delta_{11}|}{|\Delta|}$ and it is negative, given that 1) housing demand is a monotonically increasing function of the number of children and thus $H'(N) > 0$; 2) a constrained local maximum for the boarded Hessian matrix implies that $|\Delta| > 0$; and 3) $|\Delta_{11}| = -{W_w}^2 < 0$.

The transformed Slutsky decomposition in Equation (4) indicates that the increase in house prices will tighten the budget constraint and generate a negative income effect on the number of children. Assuming the shadow price of children is an increasing function of housing prices, higher house prices imply higher costs of children, generating a negative substitution effect on the number of children. With the negative substitution effect reinforcing the negative income effect, the model predicts that the total effect of house prices on fertility is negative.

That is, from equation (4), the simple theoretical model implies a negative relationship between fertility and house prices. However, it is worth noting that the derivation of the relationship doesn't recognise the difference in the effect of house prices across housing tenures. If the model setting is relaxed to allow the effect of housing wealth associated with increases in house prices, a positive relationship between fertility and house prices may be observed among existing homeowners.

Some of the assumptions made in the model are not innocuous or realistic, and they reflect social norms that may not be consistent with institutions and patterns of behaviours in contemporary Australia. These assumptions are considered to simplify the analysis of the problem and provide a benchmark from which this stylised model can be enriched. A more general model can take into account of changes in the cost of children and socio-economic characteristics of the household over the life cycle; the sequential and stochastic feature of reproduction; the allocation of the wife's time between leisure, work and children; the dimension of child quality; and the allocation and transfer of intra-household resources between the wife and the husband. For example, Willis (1973) formulated child quality as a function of market goods and family members' time devoted to the children; and Heckman and Walker (1990) incorporated a sequential stochastic framework in a dynamic utility maximising model in which the costs of contraception were compared with the utility associated with possible fertility in each monthly childbearing period.

4. Data

The empirical analysis in this Chapter uses annual aggregate time series data in Australia at the State and Territory level for the period from 1971 to 2014. At the aggregate level, a range of economic variables may be associated with fertility rates. Following Yi and Zhang (2010), the study focusses on five variables in the fertility demand function, namely total fertility rates (TFR), house prices (HP), female labour force participation rates (FLFPR), male and female weekly earnings (MW and FW). The data sources for the time series used in the analysis are described in Table A1. Details about the construction of each of the data series are described below.

Data on fertility come from the Australia Bureau of Statistics (ABS) (ABS 2016a). The total fertility rate (TFR) measures the average number of children a female would bear during her lifetime had she experienced current age-specific fertility rates at each age of her reproductive life. As mentioned in the last chapter, the fertility pattern in Australia has experienced significant changes over the past few decades, from a high of 2.95 children per woman in 1971 to a low of 1.74 in 2001. It is expected therefore that some dramatic developments in social and economic factors may have underpinned such demographic transition.

Data on the price of housing are comprised of two parts. The data from 2003 to 2014 are derived from the quarterly median prices of established houses in eight capital cities produced by the ABS (ABS 2016f). The data from 1971 to 2003 come from the annual median house prices for eight capital cities presented in Abelson and Chung (2005). This data is based on price series from Land Title Office (LTO), Real Estate Institute Australia (REIA), Commonwealth Bank of Australia (CBA), the Valuers General Office in each capital cities (VGs), and Applied Economics. The quarterly time series from the ABS for the period 2003-2014 are annualised by taking an average value of the four quarters for each year, and spliced with the annual time series from Abelson and Chung (2005) for the period 1971-2003. The house prices for capital cities are used as proxies for the house prices of the corresponding State and Territory. The first common period link method is applied to link two time series (see Appendix B).

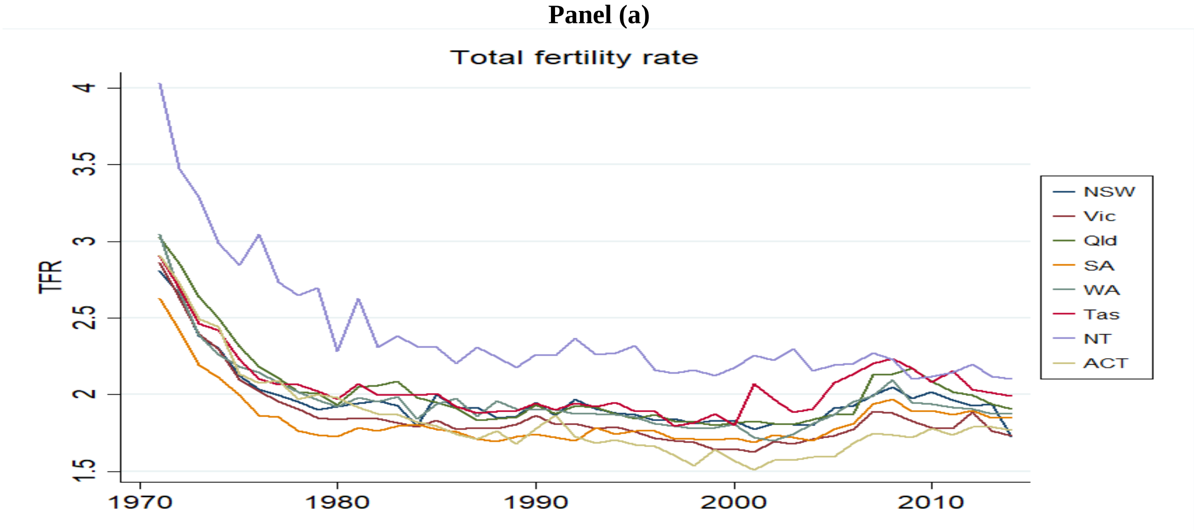
The annual female labour force participation rate is defined as the female population in the labour force as a percentage of the female civilian population aged 15 years and over (ABS 2015b). The weekly total earnings for males and females are defined as weekly ordinary time earnings plus weekly overtime earnings (ABS 2015a). The monthly female labour force participation rates and the biannual average weekly earnings for males and females are used to calculate an arithmetic average across a calendar year. All variables enter the estimation models in logarithmic form, and values of house prices and wage rates are CPI adjusted to 2010 dollars.

The trends in the levels of total fertility rates, median established house prices, female labour force participation rates, and male and female average earnings from 1971 to 2014 are displayed in Figure 2.1. An examination of Figure 2.1 highlights a number of important patterns. First, during the period considered, the total fertility rate decreased dramatically in the 1970s and has been below the replacement level since 1976. Panel (a) of Figure 2.1 indicates that all States and Territories experienced a steady decrease in the total fertility rate during 1980s and 1990s, offset by a slight rise in the early 2000s. In contrast, house prices in Panel (b) have been increasing steadily and at times rapidly, reaching peaks in 2004 and 2014. The initial check on the correlation between the total fertility rates and house prices at the State and Territory level is also presented in the cross-correlation correlograms (see Appendix A Figure A2.1). These reveal that an increase in house prices is correlated with a decrease in fertility in year t, t-1, and t-2. In section six, the appropriate number of lags will be selected based on several information criteria.

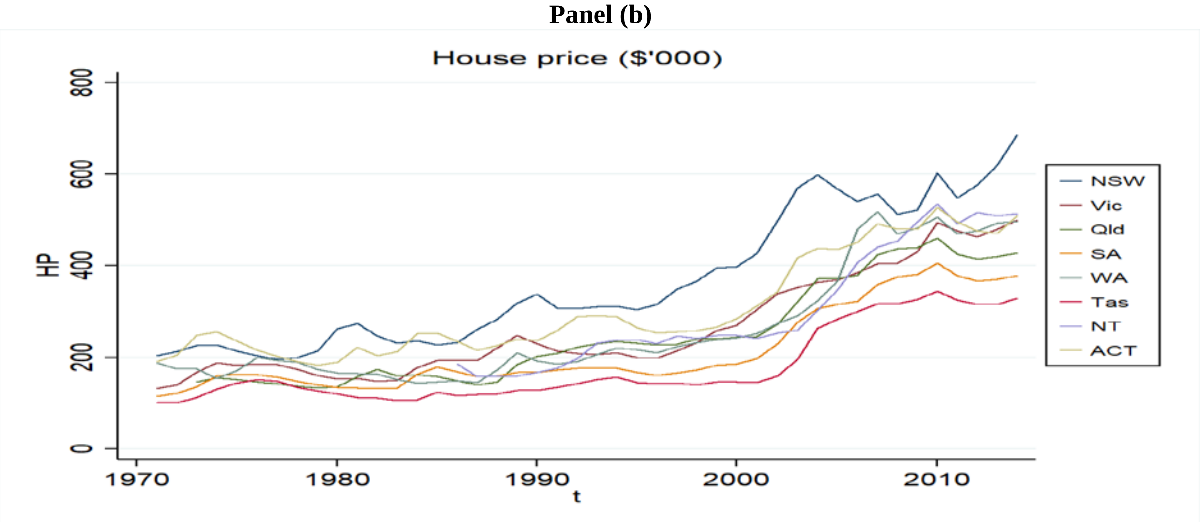
Over time, the female labour force participation rate has been increasing in a roughly consistent manner (Panel (c)). Average male and female earnings also experienced an upward trend, with a trough for some States and Territories in the early 1990s associated with the relatively large economic downturn at that time (Panel (d) and (e)). The cross-correlation correlograms between total fertility rates and female weekly wages indicate evidence of a negative correlation between the two time series across States and Territories (see Appendix A Figure A2.2).

Figure 2. 1. Changes in Total Fertility Rates, House Prices, Female Labour Force Participation Rates, and Male and Female Wage Rates across States and Territories in Australia, 1971-2014

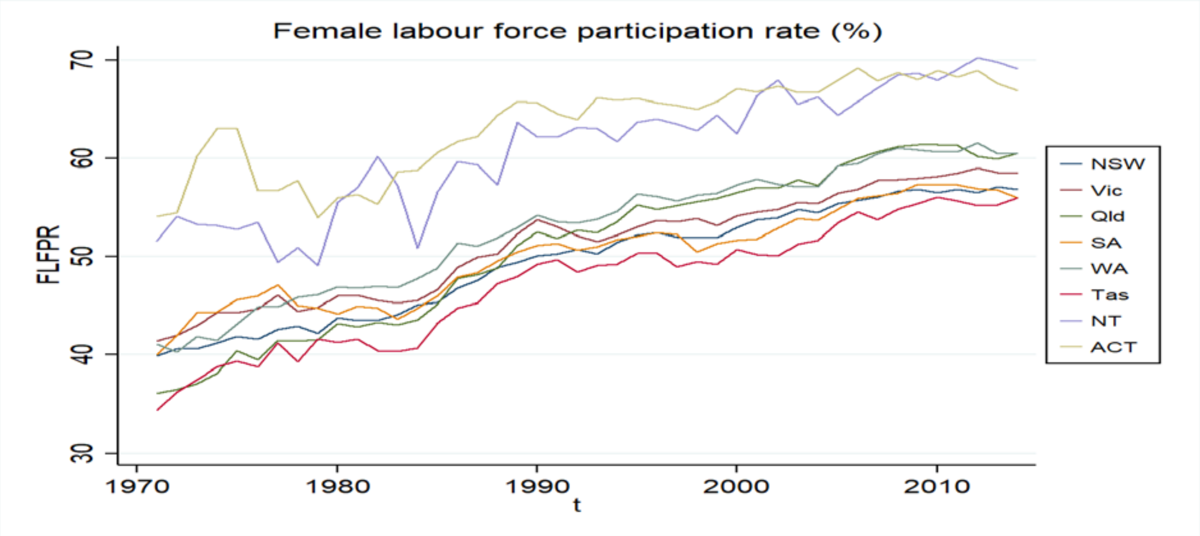
Panel (a)



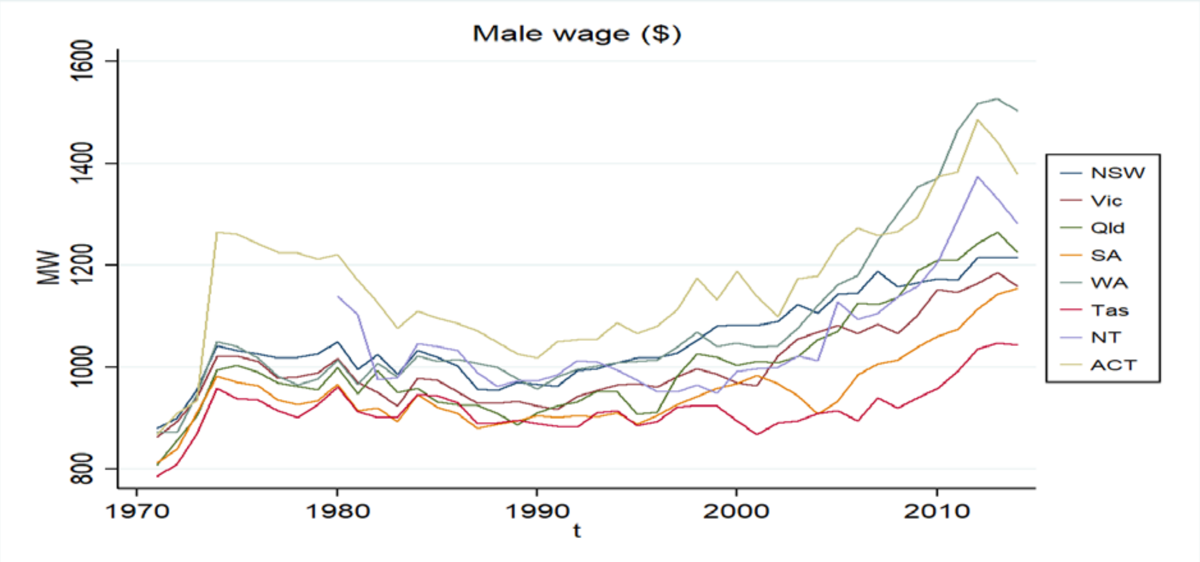
Panel (b)



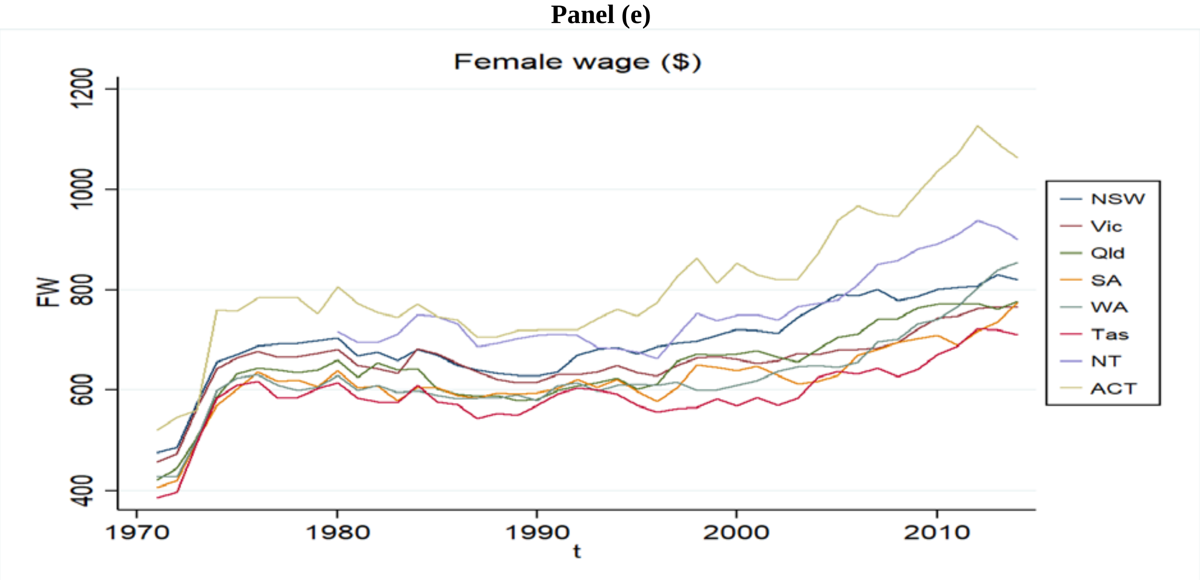
Panel (c)



Panel (d)



Panel (e)



Notes: Values of house prices and wage rates are CPI adjusted to 2010 dollars. Source: TFR is from ABS cat. no.3105.0.65.001 (1971-2010) combining with ABS cat. no.3301.0 (2011-2014); HP is from Abelson and Chung (2005) (1971-2003) combining with ABS cat. no.6416.0 (2002-2014); FLFPR is from ABS cat. no.6204.0.55.001 (1971-1977); and MW and FW are from ABS cat. no.6302.0 (1971-2014). The data on annual median house prices in earlier years are not available for some States and Territories in Abelson and Chung (2005).

Table 2.1 provides the summary statistics for each State and Territory. It is important to note that data considerations mean that the analytical periods differ across States and Territories. The mean fertility rate over the entire sample is 1.99, with the highest fertility rate of 2.21 in the Northern Territory and the lowest fertility rate of 1.78 in the Australian Capital Territory. Average house prices range from $177,490 in Tasmania to $363,520 in New South Wales, and exhibit a large amount of variation in New South Wales and Australian Capital Territory with the standard deviations significantly larger than the means. The female labour force participation rates are on average around 0.53 across the country, with the highest rates in the Australian Capital Territory. As noted above, however, these means do not capture the secular trends in the female labour force participation rate over time. As expected, weekly total earnings of males are higher than that of females in all States and Territories, while the Australian Capital Territory exhibits the highest wage rates for both males and females.

Table 2. 1. Summary Statistics

State	Variable	Sample Period	Mean	S.D.	Min	Max
NSW	TFR		1.97	0.21	1.73	2.81
	HP ($'000)		363.52	147.77	195.11	686.33
	FLFPR (%)	1971-2014	0.50	0.06	0.40	0.57
	MW ($)		1052.33	85.07	880.54	1216.47
	FW ($)		697.28	77.54	475.49	830.38
Vic	TFR		1.87	0.25	1.63	2.86
	HP ($'000)		262.42	112.72	131.12	499.25
	FLFPR (%)	1971-2014	0.51	0.05	0.41	0.59
	MW ($)		1003.19	77.85	862.38	1186.35
	FW ($)		657.85	59.61	457.06	766.03
Qld	TFR		1.98	0.18	1.80	2.64
	HP ($'000)		249.81	109.61	132.69	461.25
	FLFPR (%)	1973-2014	0.52	0.08	0.37	0.61
	MW ($)		1014.93	104.93	886.24	1265.73
	FW ($)		656.59	64.71	506.29	777.84
SA	TFR		1.84	0.19	1.69	2.63
	HP ($'000)		213.25	90.82	114.82	405.50
	FLFPR (%)	1971-2014	0.50	0.05	0.40	0.57
	MW ($)		951.13	72.60	811.84	1155.72
	FW ($)		619.43	67.34	405.92	773.98
WA	TFR		1.97	0.24	1.70	3.05
	HP ($'000)		260.84	125.58	143.59	518.48
	FLFPR (%)	1971-2014	0.53	0.06	0.40	0.62
	MW ($)		1086.66	169.95	872.47	1527.38
	FW ($)		628.12	83.50	427.51	854.43
Tas	TFR		2.05	0.22	1.79	2.90
	HP ($'000)		177.49	81.41	99.96	344.83
	FLFPR (%)	1971-2014	0.47	0.06	0.34	0.56
	MW ($)		917.85	49.34	786.10	1047.05
	FW ($)		591.80	64.42	385.19	722.24
NT	TFR		2.21	0.07	2.10	2.37
	HP ($'000)		306.34	130.59	157.69	534.75
	FLFPR (%)	1986-2014	0.65	0.03	0.57	0.70
	MW ($)		1064.05	124.25	948.67	1374.97
	FW ($)		771.69	85.28	662.95	938.38
ACT	TFR		1.78	0.19	1.51	2.44
	HP ($'000)		312.46	110.83	182.02	527.68
	FLFPR (%)	1974-2014	0.64	0.04	0.54	0.69
	MW ($)		1182.42	117.52	1018.34	1485.61
	FW ($)		833.22	118.52	704.76	1127.37

Source: TFR is from ABS cat. no.3105.0.65.001 (1971-2010) combining with ABS cat. no.3301.0 (2011-2014); HP is from Abelson and Chung (2005) (1971-2003) combining with ABS cat. no.6416.0 (2002-2014); FLFPR is from ABS cat. no.6204.0.55.001 (1971-1977); and MW and FW are from ABS cat. no.6302.0 (1971-2014). The data on annual median house prices in earlier years are not available for some States and Territories in Abelson and Chung (2005), resulting in different analytical periods among States and Territories.

5. Empirical Methodology

This section presents the econometric methods and specifications applied in non-stationarity testing as well as cointegrating testing and estimation. The test for unit roots is used to test whether the data are nonstationary and can be transformed to stationary series by differencing once. Since a unit root process can be transformed to a stationary process by first differencing, such series is said to be integrated of order 1 and denoted as $I(1)$, and accordingly a stationary process is denoted as $I(0)$ (Maddala and Kim 1998). Following this, the methods for testing the cointegration of the five time series are presented; that is, whether there can be a linear combination between them that is $I(0)$.

5.1 Tests for Unit Roots

A linear regression using unit root time series is potentially plagued by a spurious regression problem. The regression of two uncorrelated unit root series can give a high R^2. However, it is possible that a linear combination of unit root variables gives a stationary process, providing a meaning representation of long-term stable relationships. This combination of non-stationary variables that produce a stationary process is called cointegration. Hence, an important first step in undertaking the time series analysis is to test for the non-stationarity of univariate time series, prior to the cointegration test on the group of variables.

In this section, a series of routinely performed unit root tests with and without structural breaks are presented. Those tests include the Augmented Dickey-Fuller (ADF) test (Dickey and Fuller 1979, 1981); the Philip-Perron (PP) test (Phillips and Perron 1988); the Dickey-Fuller Generalised Least Squares (DF-GLS) test (Elliott, Rothenberg, and Stock 1992); and, the Zivot-Andrews test (Zivot and Andrews 2002).

The tests presented in this section allow for the identification of unit roots under different scenarios. Unit root tests without structural breaks include the ADF test, the PP test, and the DF-GLS test. The standard Dicky-Fuller unit root test assumes independently and identically distributed errors. The ADF test generalises the conventional test by including a drift, a linear trend, and lags of the first-differenced variables to account for serial correlation in the error term. The PP test modifies test statistics using consistent estimators of variances in the presence of weakly dependent and heterogeneously distributed errors. The DF-GLS test performs the ADF test on GLS-detrended data. Allowing for the possibility of a one-time change in the level and/or trend of the variable, the Zivot and Andrews' test performs a unit root test with structural breaks by adding indicator dummy variables for mean and/or trend shifts after the period in which the structural break occurs.

5.1.1 Augmented Dickey-Fuller Approach

The assumption of no intercepts or trends in the time series may be somewhat restrictive. Allowing for an intercept term and a linear time trend in the time series, and assuming the absence of structural breaks, the ADF test for the presence of a unit root is performed for each of the five time-series variables by running the following regression:

$$\Delta y_t = \alpha + \beta t + \rho y_{t-1} + \sum_{i=1}^{k} \gamma_i \Delta y_{t-i} + \varepsilon_t \tag{5}$$

where α is the intercept; β is the coefficient on the linear trend; ρ is the parameter to be tested; γ_i is the coefficient on Δy_{t-i} that accounts for higher order correlation; and ε_t is an independent and identically distributed error term. The lag length of the first differences is selected based on standard approaches such as a Breusch-Godfrey LM test for autocorrelation (Breusch 1978), an Engle LM test for autoregressive conditional heteroscedasticity (Engle 1982), or the Schwarz information criterion (Schwert 2002). A test of the following null hypothesis represents the test for the presence of a unit root:

$H_0: \rho = 0;\ H_A: \rho < 0$

5.1.2 Zivot-Andrews Approach

One potential limitation of the specification in Equation (5) is the implicit assumption of no level or trend breaks in the time series. Building upon the ADF framework, the Zivot and Andrews approach tests for a unit root against the alternative of a one-time change in the intercept and/or trend coefficient at an unknown break point T_b. This is captured in the following specification:

$$\Delta y_t = \alpha + \beta t + \theta DU_t + \delta DT_t + \rho y_{t-1} + \sum_{i=1}^{k} \gamma_i \Delta y_{t-i} + \varepsilon_t \quad (6)$$

where DU_t is a year dummy variable for a change in the level that takes the value of 1 if $t > T_b$, and DT_t is a year dummy variable for a change in the slope of the trend that takes the value of t if $t > T_b$. Therefore, testing the null hypothesis H_0: $\theta = 0$ is to test the presence of a structural break of the intercept at T_b, and testing the null hypothesis H_0: $\delta = 0$ is to test the presence of a structural break of the trend at T_b.

The specifications in Equation (5) and (6) test the non-stationarity of the time series, with and without the possibility of a structural break. The tests for the unit root is the precondition for the implementation of the cointegration tests and estimation described below.

5.2 Tests for Cointegration

Nonstationary unit root variables are cointegrated when their linear combination is stationary; that is, the variance and autocovariance of the linear combination converge to a constant asymptotically. The cointegration of $I(1)$ variables implies that they have a tendency to move together over time and thus there is a long-run equilibrium relationship between the time series variables. Locating the most stationary linear combination involves cointegration testing and cointegrating relation estimation. This section introduces several standard methods of cointegration analysis. A single equation method such as the one proposed by Engle and Granger (1987) identifies one single cointegrating vector. The cointegration tests are residual-based and the cointegration relations are estimated with ordinary least squares (OLS) regression. Multiple equation methods require the selection of the number of cointegrating relationships before the estimation of the cointegrated systems. The estimation methods for multiple cointegrating equations include Johansen (1991) maximum likelihood estimation (MLE) and Stock and Watson (1988) principal component analysis (PCA). Each of these methods is used in the analysis presented in section six.

5.2.1 Engle-Granger OLS Approach

The Engle and Granger (1987) procedure examines the existence of a cointegrating relation in a two-step residual-based test using OLS regression. The first step involves a unit root test on the residuals from the regression that includes all the time series variables. The regressions with stationary residuals give cointegrating relationships. In the second step, the lagged residual from the first step is added into an Error Correction Mechanism (ECM) model, in which the short-term adjustment dynamics can be examined.

In the first step, to test for cointegration, a unit root test such as the ADF is performed on the estimated residuals from the linear combination of the five time series, that is, the potential cointegration regression:

$$y_{1t} = \alpha_0 + \beta t + \alpha_1 y_{2t} + \alpha_2 y_{3t} + \alpha_3 y_{4t} + \alpha_0 y_{5t} + \varepsilon_t \qquad (7)$$

where $y_{1t} \dots y_{5t}$ are five time series variables. Each variable is selected to be the dependent variable in turn to check for all the possible cointegrating relations among them. If the variables are cointegrated, the estimated residuals will be close to being stationary. The cointegration test tests the null hypothesis that $\hat{\varepsilon}_t$ is a $I(1)$ process against the alternative that $\hat{\varepsilon}_t$ is $I(0)$. That is, the null hypothesis is no cointegration and the alternative hypothesis is that there is cointegration. Similar to the ADF test, lags of the first differenced residuals will be added into the test regression to adjust for serial correlation.

In the second step, the cointegrating relationship is further explored using an ECM model, with lagged $\hat{\varepsilon}_t$ added into the equation if $\hat{\varepsilon}_t$ is found to be $I(0)$ in the first step:

$$\Delta y_{1t} = \alpha_0 + \delta\hat{\varepsilon}_{t-1} + \gamma_1 \Delta y_{1t-1} + \alpha_1 \Delta y_{2t-1} + \alpha_2 \Delta y_{3t-1} + \alpha_3 \Delta y_{4t-1} + \alpha_0 \Delta y_{5t-1} + u_t \qquad (8)$$

where δ is an estimate on the speed of adjustment towards the equilibrium in the short run, indicating how the time series adjusts from its disequilibrium towards the long-term equilibrium given there is discrepancy between actual and equilibrium value in the last period. Further lags of Δy_1 are added to correct for serial correlations in the error. The Engle-Granger two-step procedure estimates a long-term stable relationship in the cointegrating regression in the first step and a short-term correction term in the ECM model in the second step.

5.2.2 Johansen MLE Approach

Johansen's maximum likelihood estimation (MLE) approach has the advantage that the estimates have the properties of being symmetrically distributed, median unbiased, and asymptotically efficient (Gonzalo 1994). The procedure involves a cointegration rank test to determine the number of cointegrating vectors in the system and a cointegrating system estimation. Johansen's procedure reparametrizes the Vector Autoregression (VAR) as the Vector Error Correction model (VECM) in the following form:

$$\Delta Y_t = v_0 + v_1 t + \Phi Y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \Delta Y_{t-i} + \varepsilon_t \qquad (9)$$

where Y_t is a vector of five $I(1)$ time-series variables; v_0 is a vector of intercepts; v_1 is a vector of coefficients on deterministic trends; $\Phi = \alpha\beta'$ where β represents r cointegrating vectors and α represents the weights on the vectors; Γ_i is a matrix of coefficients on the lags of all the first differenced time series; and ε_t is a vector of Gaussian errors with $E(\varepsilon_t) = 0$ and $E(\varepsilon_t \varepsilon_t') = \sum$. In the current analysis, there are five equations in the system. The Johansen procedure depends on the assumption of independent and identically distributed normal errors and the cointegration test is sensitive to this assumption (Huang and Yang 1996).

The Johansen cointegrating rank test is a test of the rank of the matrix Φ to determine the number of non-zero eigenvalues. The rank of the cointegrating space Φ can be determined with a trace test and a max-eigenvalue test. If Φ is a matrix of full rank and has no zero eigenvalues, all the variables in Y_t are stationary processes and any linear combination of Y_t will be stationary. If Φ is a matrix of 0 and thus has rank zero, all the variables in Y_t are unit roots and any linear combinations of Y_t will be nonstationary, suggesting that no cointegrating relationships exist.

In the intermediate case where matrix Φ is less than full rank, the rank of Φ, r, is the number of stationary linear combinations, or equivalently the number of cointegrating relationships in the system. The matrix Φ can be decomposed into the product of $\alpha\beta'$, where α is a 5 by r matrix of adjustment parameters; β' is an r by 5 matrix of the coefficients on the cointegrating vectors capturing long-run relationship; and, $\beta' Y_{t-1}$ gives the cointegrating relations.

5.2.3 Stock-Watson PCA Approach

The Stock-Watson principal component analysis (PCA) approach was first used by Stock and Watson (1988) in the context of testing for common trends. The asymptotic distributions of the estimators of cointegrating vectors were later illustrated by Gonzalo (1994) and Harris (1997). Since the variance of a stationary process ($I(0)$) is smaller than that of a unit root variable ($I(1)$), the principal components with the smallest eigenvalues, which correspond to the smallest variances, give the most stationary linear combinations of the time series and hence the cointegrating vectors. The principal components with larger eigenvalues or equivalently larger variances represent the common stochastic trends (Maddala and Kim 1998). The connection between principal components and cointegration relationships allows for the application of principal component analysis to cointegration estimation. The principal component method doesn't suffer from the problem of the sensitivity in the specification of the number of lagged terms in the VAR model that may occur in the Johansen approach (Harris 1997).

The Stock-Watson procedure is performed as follows (Stock and Watson 1988). First, the principal component analysis of Y_t is applied to generate the eigenvectors of $\Sigma Y_t Y_t'$. If there is one cointegrating relationship, there will be one linear combination that is $I(0)$ with smallest variances (or eigenvalues), and four linear combinations that are $I(1)$ with larger variances (or eigenvalues). Assuming the presence of one cointegrating relationship, four principal components with largest variances (or eigenvalues) are used to fit a VAR model to the differences, denoted as:

$$\Delta P_t = A_1 \Delta P_{t-1} + \cdots + A_{p-1} \Delta P_{t-p-1} + \varepsilon_t \qquad (10)$$

where P_t is the vector of four principal components with largest variances and

$$\hat{F}_t = P_t - \hat{A}_1 P_{t-1} - \cdots - \hat{A}_{p-1} P_{t-p} \tag{11}$$

is computed. Next, $\Delta\hat{F}_t$ is regressed on $\hat{F}_{t-1}$ to generate the estimated coefficient matrix *B*. The eigenvalues of matrix *B* are normalised and compared to the distributional tables in Stock and Watson (1988). The null hypothesis is that there are four common trends against the alternative that there are three common trends. Failing to reject the null suggests the presence of four common trends and one cointegrating relationship, and rejecting the null suggests a reduction of one in the common trends and an increase of one in the number of cointegrating vectors (Rao 1997).

6. Results

6.1 Unit Root Testing

The non-stationarity and the $I(1)$ feature of the time series variables must be checked prior to the test for cointegration. Unit root test results for five time series variables in each State and Territory using the ADF, the PP, and the DF-GLS tests are reported in Table 2.2. The ADF and DF-GLS unit root tests involve fitting a regression in the form of Equation (5), the Zivot and Andrews test involves the estimation of Equation (6), and the PP test uses a nonparametric method. The null hypothesis for each test is $H_0: \rho = 0$ against $H_A: \rho < 0$. Failing to reject H_0 suggests the presence of a unit root.

Table 2. 2. Unit Root Testing without Structural Breaks

State	Variable	**ADF t-stat** [lags]	**PP t-stat** [lags]	**DF-GLS t-stat** [lags]
NSW	TFR	-3.133 [2]	-10.969 [3]	-1.571 [1]
	HP	-3.355 [1]	-11.890 [3]	-2.469 [1]
	FLFPR	-0.936 [0]	-2.287 [3]	-0.580 [1]
	MW	-2.370 [0]	-10.598 [3]	-2.337 [1]
	FW	-3.133 [2]	-13.836 [3]	-4.101* [1]
Vic	TFR	-5.015* [0]	-9.120 [3]	-1.196 [6]
	HP	-2.265 [1]	-6.835 [3]	-1.110 [6]
	FLFPR	-2.308 [0]	-10.855 [3]	-1.738 [1]
	MW	-1.802 [0]	-7.485 [3]	-2.223 [1]
	FW	-2.878 [2]	-14.783 [3]	-3.244 [1]
Qld	TFR	-3.160 [2]	-7.742 [3]	-1.651 [2]
	HP	-2.785 [2]	-9.525 [3]	-2.156 [1]
	FLFPR	-0.652 [1]	-2.877 [3]	-0.481 [1]
	MW	-1.620 [0]	-7.187 [3]	-1.819 [1]
	FW	-2.042 [3]	-13.272 [3]	-3.304* [1]
SA	TFR	-3.244 [2]	-11.565 [3]	-1.284 [1]
	HP	-2.237 [1]	-5.289 [3]	-1.812 [1]
	FLFPR	-2.718 [1]	-2.123 [3]	-2.323 [2]
	MW	-1.799 [1]	-2.608 [3]	-2.350 [4]
	FW	-3.194 [2]	-11.262 [3]	-3.276 [1]
WA	TFR	-4.312* [1]	-8.978 [3]	-1.424 [1]
	HP	-1.918 [1]	-5.299 [3]	-1.222 [1]
	FLFPR	-1.101 [0]	-2.802 [3]	-0.625 [1]
	MW	-0.563 [0]	-2.345 [3]	-1.444 [2]
	FW	-2.081 [2]	-9.760 [3]	-2.393 [2]
Tas	TFR	-2.986 [2]	-9.196 [3]	-1.301 [1]
	HP	-1.083 [0]	-3.965 [3]	-1.617 [1]
	FLFPR	-3.071 [0]	-13.507 [3]	-1.665 [1]
	MW	-2.391 [0]	-12.613 [3]	-2.349 [1]
	FW	-1.517 [3]	-14.462 [3]	-3.018 [1]
NT	TFR	-4.495 [0]	-12.621 [3]	-1.327 [1]
	HP	-2.002 [0]	-11.477 [3]	-1.718 [1]
	FLFPR	-4.223* [0]	-25.428*[3]	-4.978* [1]
	MW	-2.320 [0]	-5.990 [3]	-0.793 [1]
	FW	-1.683 [1]	-5.421 [3]	-1.158 [1]
ACT	TFR	-2.687 [0]	-5.398 [3]	-0.263 [1]
	HP	-2.532 [1]	-7.913 [3]	-1.973 [1]
	FLFPR	-2.929 [0]	-17.213 [3]	-1.512 [1]
	MW	-1.552 [0]	-3.044 [3]	-0.695 [1]
	FW	-1.456 [1]	-3.566 [3]	-1.132 [1]

Notes: An intercept and a trend are included. All tests use critical values at the 5% level. * indicates the statistics are significant at the 5% level and null is rejected, i.e. they are stationary series. The selection of lag length is based on the LM tests for autocorrelation and heteroscedasticity in the ADF tests, the Schwartz Criterion (Schwert 2002) in the DF-GLS tests, the default $4(T/100)^{2/9}$ lags in the PP tests.

The test results in Table 2.2 indicate that the test statistics for TFR, HP, FLFPR, MW, and FW across States and Territories are mostly insignificant at the five percent significance level. This implies that in general, there is not sufficient evidence to reject the null hypothesis of a random walk, suggesting the presence of a unit root process for the majority of the time series. One exception is FLFPR in the Northern Territory, with the tests rejecting the presence of a unit root process in favour of a trend-stationary process at the five percent level.

One limitation of the unit root tests described above is that they don't allow for the possibility of structural breaks in the time series. Unit root tests that ignore the possibility of one or more structural breaks in the stationary alternative may have low power (Perron 1989). The unit root tests proposed by Zivot and Andrews test the null hypothesis of a unit root process against the alternative of a stationary series with a shift in level and trend. The results from testing a unit root in the presence of a structural break are reported in Table 2.3.

The test results suggest that there is not sufficient evidence to reject the presence of a unit root for most time series at the five percent level. Very few series are found to be stationary with intercept and trend breaks. The most significant structural breaks identified in the tests are female wages in the early 1990s and early 2000s. The substantial rise in the wage rates during these periods may be associated with recoveries from the recessions, industrial relations reforms, or the resource boom in the related areas. The possibility of structural breaks in cointegration relationships is explored with the Engle-Granger estimation in the following section.

Table 2. 3. Unit Root Testing with Structural Breaks

State	Variable	Test Statistic [lags]	Break Year
NSW	TFR	-4.929 [1]	2007
	HP	-4.823 [1]	2001
	FLFPR	-3.308 [1]	1985
	MW	-5.001 [0]	1986
	FW	-7.628* [2]	1992
Vic	TFR	-4.895 [0]	2005
	HP	-4.182 [1]	2001
	FLFPR	-4.974 [0]	1986
	MW	-4.315 [0]	1994
	FW	-9.037* [1]	1995
Qld	TFR	-5.299 [2]	2007
	HP	-4.152 [1]	2002
	FLFPR	-3.224 [1]	1986
	MW	-4.702 [0]	1994
	FW	-7.377* [2]	1985
SA	TFR	-5.955* [0]	2005
	HP	-4.726 [1]	2002
	FLFPR	-3.492 [2]	1985
	MW	-4.247 [0]	2003
	FW	-8.290* [1]	2006
WA	TFR	-6.193* [0]	2004
	HP	-3.138 [0]	1979
	FLFPR	-4.170 [0]	1986
	MW	-6.219* [1]	2001
	FW	-9.263* [1]	2003
Tas	TFR	-4.383 [0]	2005
	HP	-4.224 [1]	2003
	FLFPR	-4.743 [0]	1985
	MW	-6.790* [1]	2006
	FW	-8.816* [1]	2000
NT	TFR	-4.884 [2]	1980
	HP	-3.331 [2]	1998
	FLFPR	-6.492* [0]	1980
	MW	-4.089 [2]	2001
	FW	-3.857 [0]	1993
ACT	TFR	-4.258 [2]	2006
	HP	-4.190 [1]	2002
	FLFPR	-4.840 [0]	1983
	MW	-4.203 [0]	1989
	FW	-3.919 [0]	1987

Notes: Both an intercept break and a trend break are allowed. * indicates the test statistics are significant and null is rejected at the 5% level, i.e. the presence of a one-time structural break. The selection of lag length is based on the marginal significance of the last included lag (Zivot and Andrews 2002).

6.2 Cointegration Testing and Estimation

Following the unit root tests that ensure the $I(1)$ property of the time series, the results from cointegration analysis are presented below. The Engle-Granger OLS approach (without and with structural breaks), the Johansen MLE approach, and the Stock-Watson PCA approach are employed individually.

6.2.1 Engle-Granger OLS approach

The results for the Engle-Granger cointegration tests and the ECM estimation, assuming no structural breaks in the underlying cointegrating relationship, are presented in Table 2.4. The cointegration test applies a unit root test on the residuals from the cointegration regression. The tests reject the null of a unit root process in five regressions including MW and FW in NSW, MW in Queensland, TFR in WA, and FLFPR in the NT, suggesting the presence of five cointegrating relationships across States and Territories (marked by asterisks in column (1)). The estimated error correction coefficients on the lagged residuals in the second stage are negative and highly significant in NSW, Queensland, and the NT (column (3)).[3] This indicates that any disequilibrium in the previous period will be pushed back towards the long-term equilibrium over time.

[3]Note that NT has a small size. Empirical evidence pointed out that with finite samples, single equation method tends to suffer from substantial size distortion, that is, the inference test is more likely to fail to reject the null hypothesis when it should be rejected (Phillips and Loretan 1991); and Johansen estimators exhibits large variation (Hargreaves 1994; Phillips 1994).

Table 2. 4. Engle-Granger Testing and Estimation for Cointegration without Structural Breaks

		1st Stage		2rd Stage
		(1)	(2)	(3)
State	Equation	**Cointegration Test** t-stat [lags]	**Cointegrating Vector** (TFR HP FLFPR MW FW)	**ECM Estimation** δ [lags]
NSW	TFR	-4.08 [0]		
	HP	-3.75 [1]		
	FLFPR	-3.93 [0]		
	MW	-6.78* [0]	(1*** **0.4665**** -3.5621*** -7.7101 4.1604***)	-0.86*** [0]
	FW	-5.92* [0]	(1*** **0.2692*** -1.0814 -4.8320*** 3.3410)	-0.88** [1]
Vic	TFR	-3.69 [0]		
	HP	-2.72 [0]		
	FLFPR	-3.51 [0]		
	MW	-4.10 [1]		
	FW	-3.96 [0]		
Qld	TFR	-4.27 [0]		
	HP	-3.98 [2]		
	FLFPR	-3.96 [0]		
	MW	-5.19* [0]	(1*** -0.0101 -1.2539*** -3.2032 1.8701***)	-0.47** [0]
	FW	-4.45 [0]		
SA	TFR	-3.93 [1]		
	HP	-2.86 [1]		
	FLFPR	-2.70 [2]		
	MW	-4.42 [2]		
	FW	-4.56 [1]		
WA	TFR	-5.61* [0]	(1 -0.1970*** -0.2422 -0.9314*** 0.9704***)	-0.55 [3]
	HP	-3.34 [0]		
	FLFPR	-2.84 [0]		
	MW	-4.38 [2]		
	FW	-4.87 [2]		

Table 2. 4. Engle-Granger Testing and Estimation for Cointegration without Structural Breaks (cont.)

Tas	TFR	-4.70 [0]		
	HP	-4.13 [0]		
	FLFPR	-3.56 [0]		
	MW	-2.61 [0]		
	FW	-3.89 [0]		
NT	TFR	-4.95 [0]		
	HP	-2.23 [1]		
	FLFPR	-5.43* [0]	(1 -0.1180 -10.6142 0.0250 0.2528)	-0.96*** [0]
	MW	-2.78 [0]		
	FW	-3.24 [0]		
ACT	TFR	-4.67 [0]		
	HP	-3.13 [1]		
	FLFPR	-4.39 [0]		
	MW	-4.21 [0]		
	FW	-4.64 [0]		

Notes: In column (1), * indicates the rejection of the null at the 5% level, i.e. the presence of cointegrating relationship. In column (2), the bold numbers indicate a negative relationship between TFR and HP. Note that the positive estimated coefficients on fertility rates and house prices on the same side of the cointegration equation imply a negative relationship between the two variables. The estimated coefficients on TFR are normalised to 1. In column (2) and (3), * p<0.1, ** p<0.05, *** p<0.01. Critical values are drawn from Davidson and MacKinnon (1993). The selection of lag length in the ECM is based on the Breusch-Godfrey LM tests for autocorrelation (Godfrey 1991), the Engle LM tests for autoregressive conditional heteroscedasticity (Engle 1982), and the skewness and kurtosis tests for normality (D'agostino, Belanger, and D'Agostino Jr 1990). These diagnostic tests are reported in Appendix A2.2.

Importantly, the Engle-Granger cointegration tests show that the negative and significant correlation between fertility rates and house prices is only observed in NSW. Note that the positive estimated coefficients on fertility rates and house prices on the same side of the cointegration equation imply a negative relationship between the two variables. The point estimates can be interpreted as follows: a one percent increase in house prices is associated with a 0.47 percent decrease in total fertility rates using the male wage equation and a 0.27 percent decrease using the female wage equation (column (2)). This implies the house price elasticity of fertility of 0.47 and 0.27 respectively. In Queensland and the NT, the relationship is negative but insignificant, and in WA, the relationship is positive and statistically significant.

With respect to other variables, across States and Territories where cointegration is present, higher total fertility rate is associated with higher female labour force participation rates, higher male wage rates, and lower female wage rates. This implies that for women, the negative substitution effect of the shadow price of children dominates its positive income effect, leading to a negative correlation between fertility rates and female wages.

Like the unit root tests that allow for the possibility of structural breaks (Table 2.3), the Engle-Granger cointegration test can also account for a change in the intercept and trend in the cointegrating relationship. The conventional Engle-Granger cointegration test has low power to identify the presence of cointegration when there is a break in the underlying cointegrating relationship (Gregory and Hansen 1996; Gregory, Nason, and Watt 1996). The Gregory-Hansen test for cointegration extends the conventional Engle-Granger cointegration method and accommodates a single shift in the intercept and slope at an unknown point in time under the alternative. The test results are reported in Table 2.5. The residual-based tests test the null hypothesis of no cointegration against the alternative of cointegration with a change in the intercept (column 1) and a change in the intercept and slope (column 2).

The test results in Table 2.5 indicate that the null of no cointegration is rejected at the five percent level in multiple equations (marked by asterisks in columns (1) and (2)). The cointegrating relationships with potential level and slope changes are present for all the States and Territories. In addition to the cointegrating relationships found in Table 2.4, more cointegrating relationships are detected in the Gregory-Hansen tests when structural breaks are allowed for.

Table 2. 5. Engle-Granger Testing for Cointegration with Structural Breaks

		(1) Shift in Level		(2) Shift in Level and Slope	
State	**Equation**	Test Statistic Zt	Break Year	Test Statistic Zt	Break Year
NSW	TFR	-5.60		-5.85	
	HP	-4.38		-4.88	
	FLFPR	-5.06		-6.23	
	MW	-7.55*	1995	-7.59*	1990
	FW	-6.76*	2002	-7.05*	1990
Vic	TFR	-5.46		-5.55	
	HP	-4.84		-5.00	
	FLFPR	-6.17*	1986	-6.70*	1987
	MW	-5.16		-5.41	
	FW	-5.51		-5.32	
Qld	TFR	-4.94		-7.52*	2000
	HP	-4.12		-6.55*	2000
	FLFPR	-7.03*	1983	-8.16*	1990
	MW	-7.27*	1983	-7.18*	1988
	FW	-8.22*	1983	-8.47*	1985
SA	TFR	-5.81		-5.72	
	HP	-4.98		-4.87	
	FLFPR	-6.21*	1986	-7.41*	1986
	MW	-5.47		-6.06	
	FW	-5.57		-6.24	
WA	TFR	-7.26*	1996	-7.24*	1996
	HP	-5.12		-5.33	
	FLFPR	-4.21		-6.77*	1984
	MW	-5.00		-4.90	
	FW	-5.79		-5.92	
Tas	TFR	-5.64		-6.36	
	HP	-4.55		-4.48	
	FLFPR	-6.99*	1985	-7.73*	1987
	MW	-4.15		-5.11	
	FW	-5.84*	1985	-5.22	
NT	TFR	-5.88*	1994		
	HP	-4.79			
	FLFPR	-6.19*	1992		
	MW	-5.15			
	FW	-4.65			
ACT	TFR	-6.98*	1993	-6.80*	1995
	HP	-4.91		-4.95	
	FLFPR	-5.28		-9.51*	1983
	MW	-5.45		-6.95*	1981
	FW	-5.74		-6.89*	1991

Notes: Zt-type test statistics are reported. The 5% level critical value in models with changes in the level (column 1) = -5.83. The 5% level critical value in models with changes in the slope (column 2) = -6.41. * indicates significance at the 5% level and the null of no cointegration is rejected, i.e. the presence of cointegration with structural breaks. Lags are chosen by Akaike criterion.

Given the level and slope changes specified in the Gregory-Hansen test in Table 2.5, corresponding dummy variables are created such that they take the value of 1 for the years following the structural break. The cointegration models with a level shift are parameterised by including the year dummy variable and a linear time trend, and the cointegration models with a slope shift are parameterised by including the interaction terms between the year dummy variables and the right-hand side time series variables. The re-parametrised cointegrating relationships that allow for level and slope changes are reported in Table 2.6.

The Engle-Granger estimation results for cointegration with structural breaks in Table 2.6 indicate that NSW consistently exhibits a negative and significant correlation between fertility rates and house prices, with the estimated coefficients ranging from 0.310 to 0.414 among various cointegration regressions. This implies that a one percent increase in house prices is associated with a 0.310-0.414 percent decrease in fertility rates, or that the house price elasticity of fertility is 0.310-0.414.

Allowing for a level or slope shift, the cointegration estimates in Victoria, the NT, and the ACT also show a negative relationship between fertility rates and house prices, although in an insignificant manner. In contrast, a positive and significant relationship between fertility rates and house prices is observed in Queensland, SA, WA, and Tasmania. There are a number of possible reasons for this pattern. The positive (negative) relationship between fertility and house prices suggest that the positive income/wealth effect dominates (is dominated by) the negative price effect. The net effect of housing prices on fertility at the aggregate level depends on the individuals' responsiveness and the proportion of homeownership in the region. High preference for children or high rates of homeownership in Queensland, SA, WA and Tasmania may explain the overall positive relationship between housing price inflation and fertility rates. Moreover, the positive relationship may also be driven by the migration between States and Territories, especially among younger individuals.

The parameter estimates on FLFPR, MW, and FW reported in Table 2.6 are broadly consistent with the results reported in Table 2.4. Higher female labour force participation and higher male wages are associated with higher total fertility rates. Female wages are negatively correlated with fertility rates, suggesting that the negative substitution effect of the female wage increase on fertility dominates the positive income effect.

Table 2. 6. Engle-Granger Estimation for Cointegration with Structural Breaks

		Level Shift Cointegrating Vector					Slope Shift Cointegrating Vector				
State	Equation	TFR	HP	FLFPR	MW	FW	TFR	HP	FLFPR	MW	FW
NSW	MW	1***	**0.414****	-3.580***	-8.033	4.314***	1***	0.146	-0.008	-4.381	2.860***
	FW	1***	**0.310*****	-0.952	-3.458***	2.652	1***	0.078	0.351	-2.412***	2.001
Vic	FLFPR	1	0.653	-20.648	-4.438*	4.627**	1***	-0.445***	1.683	-1.420***	1.390***
Qld	TFR						1	-0.219***	0.766***	-1.262***	0.880***
	HP						1	-0.409	1.116***	-0.420	0.581**
	FLFPR	1	-0.764*	8.271	3.789***	-1.345	1***	-0.309***	0.943	-0.841***	0.752***
	MW	1***	-0.022	-1.220***	-3.211	1.826***	1***	-0.1632	0.678**	-1.997	1.140***
	FW	1***	-0.025	-0.638	-2.690***	2.714	1***	-0.247***	0.749	-1.429***	1.076
SA	FLFPR	1	-2.230***	19.769	-0.504	-1.823	1	-1.330***	7.177	0.156	-0.155
WA	TFR	1	-0.214***	0.060	-0.850***	0.979***	1	-0.219***	0.687***	-1.049***	1.060***
	FLFPR						1	-0.177	1.832	-0.371	0.447
Tas	FLFPR	1	-0.360	15.691	4.932**	-4.184***	1***	-0.073	1.431	-0.928***	0.611***
	FW	1***	-0.377***	-1.929***	-2.573***	2.542					
NT	TFR	1	0.006	-0.159	-0.090	0.268					
	FLFPR	1	-0.123	-10.573	0.035	0.280					
ACT	TFR	1	-0.108*	-0.324	-0.674**	0.026	1	-0.073	0.043	-1.586***	1.027**
	FLFPR						1	5.580	-18.143	4.733	-11.741
	MW						1	-0.739	2.068*	-4.851	2.079***
	FW						1	-0.313	0.099	-2.368***	2.477

Notes: The shift dummy, identified in Table 2.5, is defined as unity after the shift year. Numbers in bold indicate the presence of a negative relationship between TFR and HP. Note that the positive estimated coefficients on fertility rates and house prices on the same side of the cointegration equation imply a negative relationship between the two variables. The estimated coefficients on TFR are normalised to 1. * p<0.1, ** p<0.05, *** p<0.01.

6.2.2 Johansen MLE approach

Johansen's MLE method is comprised of a cointegration rank test and a Vector Error-Correction Model (VECM) estimation that produces cointegrating vectors. The cointegration rank test identifies the number of cointegrating relationships. A trace test and a maximum eigenvalue test are performed to determine the rank of the matrix Φ in Equation (9). The cointegrating relationships, represented by the matrix β' in Equation (9), are estimated in the VECM. The cointegration rank test results and the estimated cointegrating relationships are reported in Table 2.7 and 2.8 respectively.

The trace test reported in Table 2.7 tests the null hypothesis of at most r cointegrating vectors (r=0, 1, 2, 3, 4) against the alternative of strictly more than r cointegrating vectors. The maximum eigenvalue test tests the null hypothesis of r cointegrating vectors against the alternative of $r+1$ vectors (Johansen 1995). Test results indicate that both test statistics fail to reject the null hypothesis of the cointegration rank being one at the five percent level.[4] The Johansen cointegration tests in Table 2.7 point to the presence of one cointegrating relationship for all the States and Territories.

[4] Tasmania shows two cointegrating vectors using Max-eigenvalue statistics and one using Trace statistics.

Table 2. 7. Johansen Testing for Cointegration Rank (No. Cointegrating Relationships)

State	Rank	**Trace Statistic**	**Max-Eigenvalue Statistic**
NSW	0	120.36**	91.15**
	1	29.21	18.88
	2	10.33	5.31
	3	5.01	4.47
	4	0.55	0.55
Vic	0	114.65**	78.16**
	1	36.49	26.44
	2	10.04	5.59
	3	4.45	4.06
	4	0.39	0.39
Qld	0	89.74**	51.08**
	1	38.66	29.11
	2	9.55	5.39
	3	4.16	3.74
	4	0.42	0.42
SA	0	105.12**	80.33**
	1	24.79	14.37
	2	10.42	6.87
	3	3.54	3.42
	4	0.12	0.12
WA	0	103.07**	80.74**
	1	22.33	17.44
	2	4.89	3.39
	3	1.50	1.50
	4	0.00	0.00
Tas	0	95.00**	44.91**
	1	50.09	38.69**
	2	11.40	8.54
	3	2.87	2.62
	4	0.24	0.24
NT	0	58.39	22.21
	1	36.18	20.00
	2	16.17	8.58
	3	7.59	5.94
	4	1.64	1.64
ACT	0	98.34**	44.25**
	1	54.09	29.10
	2	25.00	18.77
	3	6.22	6.05
	4	0.17	0.17

Notes: A trend is included in the cointegrating vector and an intercept is included in the VAR model. ** significant at the 5% level. critical values at the 5% level under H_0: r=0 in the trace and max-eigenvalue tests are 87.31 and 37.52 respectively (Osterwald-Lenum 1992). Lag length is selected by Akaike's information criterion (AIC), Hannan Quinn information criterion (HQIC), or Schwarz's Bayesian criterion (SBIC).

The estimated coefficients in the cointegrating relationship between the total fertility rate, house prices, female labour force participation rates, and male wage and female wages, as well as their corresponding adjustment parameters for all States and Territories in the VECM are presented in Table 2.8. The top panel reports the estimated cointegrating vectors (β' in Equation

(9)) and the lower panel reports the adjustment vectors (α in Equation (9)). The VECM specification allows for a linear trend in the cointegrating equation.

The relationship between fertility rates and house prices is negative and significant at the five percent level in NSW. The point estimate indicates that a one percent increase in house prices is associated with a 0.18 percent decrease in fertility rates in NSW over time. That is, the house price elasticity of fertility is 0.18. This result suggests that over the period 1971-2014, the total inflation in house prices can account for 45.2 percent of the decline in fertility rates in NSW.[5] In the study by Yi and Zhang (2010) that considered the experience in Hong Kong between 1971 and 2005, they found 65.3 percent of the fertility decrease could be accounted for by the house price increase over time. For WA, a one percent increase in house prices is associated with a decrease in fertility rates of 0.096 percent, implying a house price elasticity of fertility of 0.096, statistically significantly at the 10 percent level. In other States and Territories, namely Victoria, Queensland, SA, Tasmania, the NT, and the ACT, the relationship between house prices and total fertility rates is statistically insignificant.

[5] During the period 1971-2014, total fertility rates decreased from 2.806 to 1.727, and the house price index increased from 202.957 to 686.325. The total decline in fertility rates that can be accounted for by house price inflation is therefore 0.18*[ln(686.325)-ln(202.957)]/[ln(1.727)-ln(2.806)], that is 45.18%.

Table 2. 8. Johansen Estimation for Cointegration

	Cointegrating Vector β'				
State	TFR	HP	FLFPR	MW	FW
NSW	1	**0.181****	-1.761***	-4.062***	2.287***
Vic	1	-0.110	-0.084	-0.475	0.422**
Qld	1	-0.200	-0.290	-1.135***	0.557***
SA	1	0.319	0.314	-1.076***	-1.886***
WA	1	**0.096***	-0.873**	-0.221	0.897***
Tas	1	-0.068	0.217	1.527	-1.618***
NT	1	-0.065	-0.994***	0.029	0.165
ACT	1	-0.547	-5.087***	-4.876***	2.101***
	Adjustment Parameters α				
	TFR	HP	FLFPR	MW	FW
NSW	-0.268***	-0.248	0.012	0.201***	0.087
Vic	-0.074	0.191	0.088*	0.143*	0.337***
Qld	-0.974***	-0.651	-0.051	0.204	-0.082
SA	-0.311	-0.533	-0.074	0.045	0.708***
WA	-0.330***	-0.232	0.021	0.041	0.177**
Tas	-0.071	0.267*	-0.038	0.068	-0.012
NT	-0.549***	0.320	0.532***	-0.359*	-0.173
ACT	-0.052**	0.137	0.069***	0.036*	0.020

Notes: The estimated coefficients on TFR are normalised to 1. Numbers in bold indicate the presence of a negative relationship between TFR and HP. The lag length prior to the VECM estimation is selected based on Akaike's information criterion (AIC), Hannan Quinn information criterion (HQIC), or Schwarz's Bayesian criterion (SBIC), and is readjusted according to the post-estimation tests for autoregressive conditional heteroscedasticity, normality, and serial correlation of the residuals (see Appendix A2.3). * p<0.1, ** p<0.05, *** p<0.01.

Consistent with the results in the Engle-Granger procedure, total fertility rates are positively correlated with female labour force participation rates. Note that Australia is among the OECD countries with highest female labour force participation and over the period of analysis, Australia had experienced a substantial increase in female labour force participation rate. (OECD 2018c). During the period 1971-2014, female labour force participation rates increased from 45.4 percent to 70.5 percent in Australia, compared to an increase from 46.7 percent to 62.8 percent for the OECD as a whole. These patterns may be attributed to Australia's increasing levels of female education, changes in cultural attitudes, and favourable policies that support childcare and parental leave. In general, male wages positively correlate with fertility rates while female wages negatively correlate with fertility rates across States and Territories.

The results of the estimated coefficients on the short-run correction terms are shown in the bottom panel in Table 2.8. Several adjustment coefficients on TFR, FLFPR, MW and FW are statistically significant, implying that there will be significant and rapid adjustments toward equilibrium when the system is out of equilibrium. More specifically, in general, when the fertility rate is above its equilibrium, it will fall back while female labour force participation rates and female wage rates will adjust upwards.

The diagnostic tests for serial correlation, normality, and heteroscedasticity of the residuals for the five equations in the cointegrating system find no evidence of the violation of the assumption of independent normal errors in the Johansen procedure, supporting the model specifications (see Appendix Table A2.4). Note that the Lagrange multiplier tests for autocorrelation suggest no first-order serial correlation in the residuals of the VECM models across States and Territories. Further, the Jarque-Bera tests for normality of residuals show no skewness and kurtosis in the residuals for each equation and all equations jointly. In addition, the Lagrange multiplier tests for autoregressive conditional heteroscedasticity (ARCH) do not reject the null of no ARCH (1) effect. Finally, the root statistics list four eigenvalues that are equal to 1 and the remaining eigenvalues that are strictly less than unity, consistent with the evidence of one stationary cointegrating relationship and four nonstationary unit root processes.

6.2.3 Stock-Watson PCA approach

The results from estimating the cointegrating relationship using the Stock-Watson procedure are presented in Table 2.9. The tests for common trends among States and Territories fail to reject the the null hypothesis of four common trends at the one percent level. This is consistent with the evidence of one cointegrating relationship. The estimating results indicate that there is a negative relationship between total fertility rates and house prices in NSW, Victoria, Queensland, and the NT. The house price elasticity of fertility is largest in NSW (0.54), followed by Victoria (0.17), the NT (0.08), and Queensland (0.06). In contrast, SA, WA, Tasmania, and the ACT exhibit a postive relationship between the two variables. Consistent with the results using the Engle-Granger procedure and the Johansen procedure, male wages are found to be postively correlated with total fertility rates while female wages negatively correlated with total fetility rates for all the States and Territories.

Table 2. 9. Stock-Watson Testing and Estimation for Cointegration

State	Test Statistic	Cointegrating Vector β				
		TFR	HP	FLFPR	MW	FW
NSW	-50.128	1	**0.535**	-0.989	-5.811	3.721
Vic	-47.095	1	**0.171**	0.247	-2.690	1.960
Qld	-48.382	1	**0.063**	0.247	-2.674	2.146
SA	-46.850	1	-0.110	0.185	-1.596	1.442
WA	-50.392	1	-0.078	0.753	-1.035	1.174
Tas	-50.661	1	-0.107	-3.624	-37.021	17.963
NT	-36.039	1	**0.084**	1.183	-0.556	0.897
ACT	-45.094	1	-0.124	-0.304	-2.733	2.223

Notes: An intercept and a linear trend are included in Equation (10). The autoregressive order of Equation (11) is selected according to Akaike's information criterion (AIC), Hannan Quinn information criterion (HQIC), or Schwarz's Bayesian criterion (SBIC). The estimated coefficients on TFR are normalised to 1. Numbers in bold indicate the presence of a negative relationship between TFR and HP. 1% critical value $q_{4,3}$ = -57.2, 2.5% critical value $q_{4,3}$ = -51.7, and 5% critical value $q_{4,3}$ = -47.0.

6.3 Response Heterogeneity

In Table 2.10, the results from estimating the cointegrating relationship using the Johansen procedure in Equation (9) across age cohorts are reported for each State and Territory. The age-specific fertility rate is defined as the number of births per 1,000 women of reproductive age occurring during a given year (ABS 2016a).[6] The analysis covers fertility rates for women of all ages except the 45-49 age group considering the very low fertility rate among those above 45 years of age.

The estimated cointegrating relationships reported in Table 2.10 show that almost all the age groups in NSW and WA show a negative and significant relationship between fertility rates and house prices, consistent with the main results presented in Table 2.8. The results also indicate that most of the States and Territories observe a negative relationship between fertility rates and house prices for the 30-34 age group. There are a range of possible reasons for the observed salient and negative response of fertility to house prices among those in their early 30s. Given the aggregate nature of the relationship, a better understanding on the underlying behaviours of households will require analysis using microeconomic data.

[6] Births to mothers aged under 15 years are included in the 15-19 years age group, and births to mothers aged above 50 years are included in the 45-49 years age group (ABS 2016a).

In Victoria, Queensland, WA, the NT, and the ACT, the estimates point to a positive relationship between fertility and house prices for a number of age groups including 20-24, 35-39, and 40-44. One possible explanation may be young adults with high fertility intention and the expectation of better job opportunities moving to these States and Territories. The migration across States and Territories drives up the fertility rates in the destination regions and drives down the fertility rates in the origin regions. In a similar vein, international immigration may also contribute to the positive correlation between fertility and house prices. Alternatively, the increase in house prices may generate a positive housing wealth effect that assists households to finance their demand for children. A better understanding and identification of the causal mechanisms will likely require a more nuanced analysis of individual or household level data.

Table 2. 10. Johansen Estimation for Cointegration by Age

Cointegrating Vector		Age Groups					
		15-19	20-24	25-29	30-34	35-39	40-44
NSW	TFR	1	1	1	1	1	1
	HP	**0.523*** **	**0.254*** **	**1.601*** **	**0.140** **	**0.020**	**0.420**
	FLFPR	-3.901***	-0.349	-7.064***	-2.262***	-5.152***	-5.028***
	MW	-7.376***	-0.669***	-8.557***	-2.513***	-4.61***	-9.271***
	FW	3.902***	2.190***	2.581*	1.758***	2.328***	5.036***
Vic	TFR	1	1	1	1	1	1
	HP	**0.095**	-0.037	-0.225	**0.081**	-0.108	-0.207
	FLFPR	-2.085***	0.380	1.614	-1.286**	-0.684	-0.574
	MW	-2.304***	0.568	6.274***	0.669	-0.353	-1.594
	FW	1.004***	-1.457***	-5.516***	-0.059	1.292***	1.985***
Qld	TFR	1	1	1	1	1	1
	HP	-0.030	**1.090** **	**0.118**	-0.008	-0.489***	-0.081
	FLFPR	-1.567*	-3.285	1.744	-1.091*	-1.239***	-1.720
	MW	0.295	1.672	-0.527	0.237	0.563	-0.820
	FW	-2.608***	-6.549***	2.513**	-0.477**	-0.953***	-2.726***
SA	TFR	1	1	1	1	1	1
	HP	**0.809**	**1.012**	**2.797**	**0.361* **	**2.464**	**4.814**
	FLFPR	-1.969	-1.494	-7.471	-0.078	-9.326**	-14.655
	MW	5.934*	5.176**	15.085***	3.820***	5.819*	14.248
	FW	-10.881***	-13.302***	-33.027***	-3.567*	-16.087***	-28.969***
WA	TFR	1	1	1	1	1	1
	HP	-0.685***	**0.162** **	**0.461*** **	**0.217* **	**0.738*** **	**1.423* **
	FLFPR	-0.762	-0.525	-2.876***	-2.613*	-2.154	-10.481
	MW	1.684**	-0.169	-0.414	0.423	2.580***	6.555*
	FW	-0.262	-1.832***	-1.711***	-1.430*	-5.056***	-14.520***
Tas	TFR	1	1	1	1	1	1
	HP	**1.181** **	**0.128**	**0.198* **	**0.161* **	-0.036	**5.254**
	FLFPR	3.958	-0.485	-1.831***	-0.252	0.974*	1.919
	MW	13.385***	0.366	-0.148	2.422*	2.871***	43.033***
	FW	-10.176***	-3.136***	-1.923***	-1.086*	-0.776**	-32.962***
NT	TFR	1	1	1	1	1	1
	HP	-0.103	-0.142***	**0.015**	**0.048** **	-0.031	**0.375**
	FLFPR	3.826***	-1.102***	0.245	-2.345***	-2.243***	-5.418***
	MW	0.001	-0.121	-0.206**	-0.335***	0.076	1.414**
	FW	1.418***	0.090	0.098	0.196**	0.684**	-1.085
ACT	TFR	1	1	1	1	1	1
	HP	**0.060**	**0.066**	-0.197	**0.296**	-0.268**	-0.482**
	FLFPR	6.347***	-15.604***	-26.023***	-18.726***	-2.431***	-3.771***
	MW	4.326**	-4.829	-25.361***	-8.297*	0.003	-3.325***
	FW	-1.583	-2.671	15.796	-0.154	-1.380	0.397

Notes: All estimations use Johansen's procedure. Age group 45-49 is excluded because of its very low fertility rate. The estimated coefficients on TFR are normalised to 1. Numbers in bold indicate the presence of a negative relationship between TFR and HP. Lag selection is based on tests for autocorrelation and heterogeneity of the residuals. * p<0.1, ** p<0.05, *** p<0.01.

7. Conclusion

This chapter examines the relationship between fertility rates and house prices at the aggregate level. Following Becker (1960)'s economic model of fertility, a simple theoretical model is presented to characterise the relation between fertility demand and house prices. Assuming complementarity between housing and children, an increase in house prices generates a negative substitution effect and a negative income effect on the number of children. The empirical investigation on the aggregate relationship applies cointegration analysis using annual time series at the State and Territory level in Australia for the period from 1971 to 2014.

The cointegration analysis is suited to the study of the long-term relationships between time series variables that are endogenous and nonstationary. The cointegration equation includes the key variables in the fertility demand function such as total fertility rates, house prices, female labour force participation rates, male wages and female wages. A series of unit root tests are performed to check the non-stationarity of the time series. The $I(1)$ property of the time series ensures the performance of the following cointegration tests and analysis using the Engle and Granger (1987) ordinary least squares method, the Johansen (1991) vector error correction model method, and the Stock and Watson (1988) principal component analysis method.

Using the Engle-Granger method without structural shifts and allowing for one structural break, the correlation between total fertility rates and house prices is shown to be negative and significant in New South Wales. No evidence for such a relationship is found in other States and Territories. Across different cointegrating equations, the house price elasticity of fertility in New South Wales ranges from 0.27 to 0.47.

The results from the use of the Johansen method indicate the presence of a negative relationship between total fertility rates and house prices in New South Wales and Western Australia, with a house price elasticity of fertility of 0.18 and 0.09 respectively. The estimated heterogeneous responses across age groups employing this procedure indicate that the negative relationship between fertility rates and house prices is particularly salient for those in their early 30s, who may be more likely to have higher fertility expectation, lower fertility timing constraints, yet limited financial resource and borrowing capability.

The estimates using the Stock-Watson method reveal a negative relationship between total fertility rates and house prices in New South Wales, Victoria, Queensland, and the Northern Territory. The house price elasticity of fertility is largest in New South Wales (0.53), followed by Victoria (0.17), the Northern Territory (0.08), and Queensland (0.06). Across methods, the negative correlation between total feritlity rates and house prices is consistently observed in New South Wales.

Consistent with a priori expectation, higher total fertility rate is associated with higher female labour force participation rates and higher male wage rates across States and Territories. In contrast, there is evidence that total fertility rate is negatively correlated with female earnings, suggesting a negative substitution effect of the price of children dominating the positive income effect.

The estimated coefficients on the cointegrating relationship vary across different methods. There is no consensus in the literature about the superiority of one method over others, and single equation approaches and multiple equation approaches are not necessarily comparable (Maddala and Kim 1998). Since single equation methods do not enable the identification of the number of cointegration relationships, the Johansen method is more commonly used in practice in cointegration analysis. The drawback of the Johansen procedure includes the sensitivity to misspecification of the lag length and lower test power in the tests for the second and subsequent cointegrating vectors in finite samples.

Overall, the analysis suggests the presence of a long-term equilibrium relationship among total fertility rates, house prices, female labour force participation rates, and male and female wages in some locations and for certain sub-demographic groups. A more fruitful and insightful approach is the exploitation of information at the individual or household level. Rich microdata at the household level allow the exploitation of the variation in demographic and socioeconomic characteristics as well as housing and residential environment features across households. In the next two chapters, the relationship between fertility and housing will be more comprehensively examined using panel data.

Appendix

Appendix A

Table A2. 1. Data Source

Variable	Definition	Source
TFR	Total fertility rates	ABS cat. no.3105.0.65.001 (1971-2010)
		ABS cat. no. 3301.0 (2011-2014)
HP	House prices	Abelson and Chung (2005) (1971-2003)
		ABS cat. no. 6416.0 (2002-2014)
FLFPR	Female labour force participation rates	ABS cat. no. 6204.0.55.001 (1971-1977)
		ABS cat. no. 6202.0 (1978-2015)
MW	Male weekly earnings	
FW	Female weekly earnings	ABS cat. no. 6302.0 (1971-2014)

Notes: Between 1971 and 1973, estimates of male and female earnings for New South Wales include the Australia Capital Territory, and estimates for South Australia include the Northern Territory (ABS 1974). The analytical sample on male and female earnings in the Australia Capital Territory and the Northern Territory begin from year 1974.

Figure A2. 1. Cross-Correlation Correlograms between Total Fertility Rates and House Prices

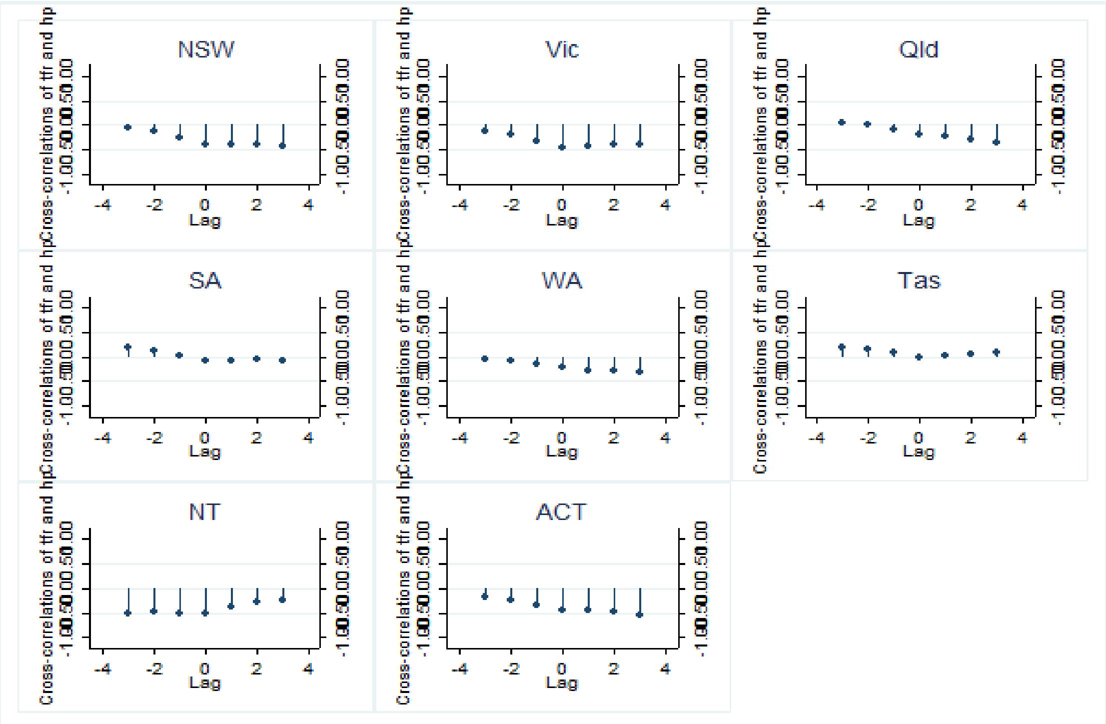


Figure A2. 2. Cross-Correlation Correlograms between Total Fertility Rates and Female Wages

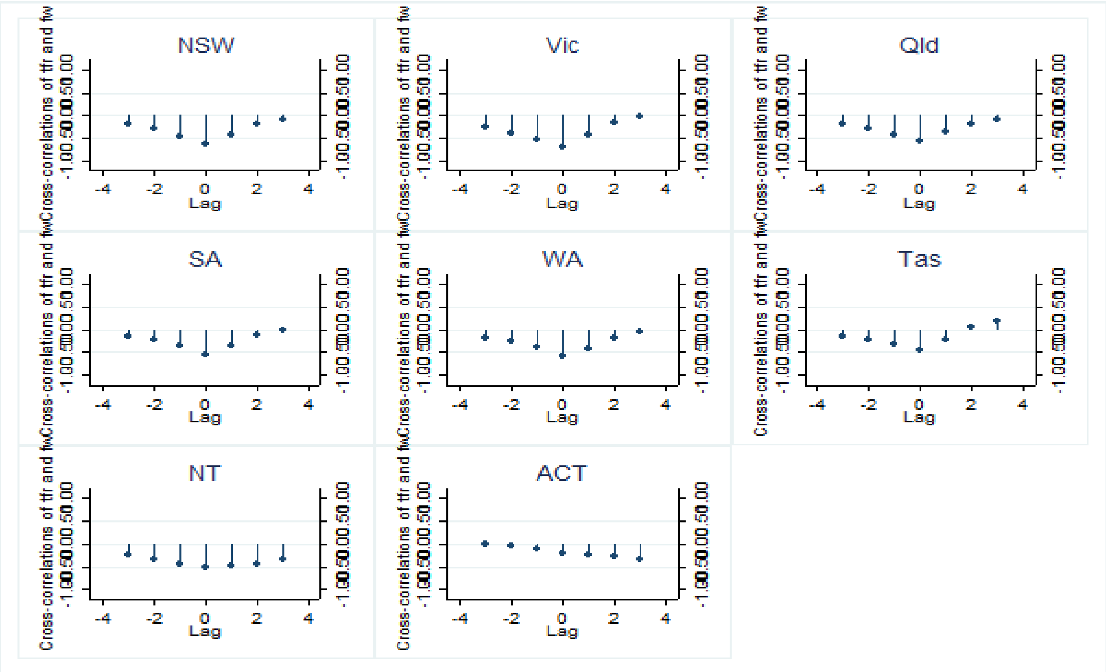


Table A2. 2. Diagnostic Tests for Residuals in ECM Estimation

		Autocorrelation	**Heterogeneity**	**Normality**
		Breusch-Godfrey LM Test [lag1]	Engle ARCH Effect LM Test	Skewness and Kurtosis Test
State	Equation	Prob > $\chi2$	Prob > $\chi2$	Prob > $\chi2$
NSW	MW	0.449	0.700	0.434
	FW	0.272	0.831	0.950
Qld	MW	0.841	0.466	0.516
WA	TFR	0.617	0.161	0.161
NT	FLFPR	0.283	0.652	0.130

Notes: The null hypotheses of no first-order autocorrelation, no autoregressive conditional heterogeneity, and normality of residuals cannot be rejected at the 5% level in the Breusch-Godfrey LM tests for higher-order serial correlation, the Engle LM tests for ARCH effects, and the skewness and kurtosis tests for normality. There is evidence supporting the specification of the ECM models specified in Table 2.4.

Table A2. 3. Lag Selection in VCEM Estimation

	Pre-Estimation			Post-Estimation
State	AIC	HQIC	SBIC	Based on Diagnostic Test
NSW	1	1	1	1
Vic	4	1	1	1
Qld	4	1	1	3
SA	4	1	1	4
WA	1	1	1	3
Tas	1	1	1	4
NT	4	4	4	1
ACT	4	4	1	1

Notes: The lag length selected prior to the VECM estimation is based on Akaike's information criterion (AIC), Hannan Quinn information criterion (HQIC), and Schwarz's Bayesian criterion (SBIC). The lag length with the smallest value of the information criterion statistics is selected. After estimating the VECM, the number of lags are readjusted given the tests on the post-estimation serial correlation, heteroscedasticity and normality of the residuals in five equations. The final selection of lag order for the Johansen cointegration analysis is reported in the last column.

Table A2. 4. Diagnostic Tests for Residuals in VECM Estimation

State	Equation	**Autocorrelation** Lagrange-Multiplier test [lag1] Prob > χ2	**Normality** Jarque-Bera test Prob > χ2	**Heterogeneity** Lagrange-Multiplier test Prob > χ2	**Specification of Equation** Roots of Companion Matrix Eigenvalues
NSW	D.TFR		0.371	0.416	
	D.HP		0.911	0.416	
	D.FLFPR		0.248	0.416	
	D.MW		0.916	0.416	
	D.FW		0.571	0.416	
	All	0.149	0.793		(1, 1, 1, 1, 0.046)
Vic	D.TFR		0.000***	0.115	
	D.HP		0.885	0.572	
	D.FLFPR		0.347	0.749	
	D.MW		0.402	0.661	
	D.FW		0.672	0.510	
	All	0.339	0.000***		(1, 1, 1, 1, 0.723)
Qld	D.TFR		0.860	0.785	
	D.HP		0.189	0.646	
	D.FLFPR		0.038**	0.063*	
	D.MW		0.950	0.387	
	D.FW		0.965	0.582	(1, 1, 1, 1, 0.780, 0.682,
	All	0.779	0.409		0.632, 0.519, 0.473, 0.403)
SA	D.TFR		0.818	0.176	
	D.HP		0.060*	0.775	
	D.FLFPR		0.336	0.710	
	D.MW		0.865	0.103	
	D.FW		0.652	0.959	(1, 1, 1, 1, 0.765, 0.724,
	All	0.444	0.497		0.661, 0.646, 0.380, 0.370)
WA	D.TFR		0.160	0.503	
	D.HP		0.479	0.254	
	D.FLFPR		0.105	0.472	
	D.MW		0.559	0.967	
	D.FW		0.614	0.135	(1, 1, 1, 1, 0.762, 0.717,
	All	0.156	0.229		0.652, 0.641, 0.462, 0.302)
Tas	D.TFR		0.318	0.783	
	D.HP		0.089	0.050	
	D.FLFPR		0.123	0.718	
	D.MW		0.544	0.027**	(1, 1, 1, 1, 0.801, 0.765,
	D.FW		0.350	0.839	0.729, 0.640, 0.523, 0.509,
	All	0.974	0.146		0.489, 0.183)
NT	D.TFR		0.470	0.838	
	D.HP		0.644	0.838	
	D.FLFPR		0.452	0.838	
	D.MW		0.606	0.838	
	D.FW		0.550	0.838	
	All	0.72	0.800		(1, 1, 1, 1, 0.138)
ACT	D.TFR		0.754	0.811	
	D.HP		0.487	0.347	
	D.FLFPR		0.874	0.427	
	D.MW		0.894	0.912	
	D.FW		0.944	0.105	
	All	0.431	0.989		(1, 1, 1, 1, 0.561)

Notes: The LM tests for autocorrelation test the null hypothesis of no autocorrelation at the lag order of 1 in the residuals for five equations jointly; The Jarque-Bera tests for normality test the null hypothesis of no skewness and kurtosis in the residuals for each equation individually and five equations jointly; The LM tests for heterogeneity test the null hypothesis of no ARCH (1) effect for each equation; The root statistics provide indicators of whether the number of cointegrating equations is misspecified or equivalently whether the cointegrating equations are nonstationary; and roots close to one will cast doubt on the stationarity of the cointegrating equation; *** significant at the 1% level, * p<0.1, ** p<0.05, *** p<0.01.

Appendix B

The annual median house prices in Australia's eight capital cities for the period 1971-2003 are provided by Abelson and Chung (2005). The compiled data are based on Land Title Office (LTO), Real Estate Institute Australia (REIA), Commonwealth Bank of Australia (CBA), the Valuers General Office in each capital cities (VGs), and Applied Economics. The data are deflated to 2010 dollars. The median house prices for the period 2003-2014 are drawn from the ABS (2016b). The ABS's residential property sales data are provided by State and Territory LTOs, VGs, or home mortgage lenders prior to year 2014. The quarterly median house prices drawn from the ABS are averaged across quarters and deflated to 2010 dollars. The two time series are spliced through a linking factor. The linking factor is calculated as the ratio of the first observation of the new series (ABS cat. no. 6416.0) to the corresponding observation of the old series (Abelson and Chung, 2005) in the overlapping period, that is, year 2003. The observations in the old series are then adjusted by multiplying the linking factor.

Appendix C

Theoretical Derivation of the Effect of House Prices on Fertility

Max $U = U\,(N, L_w)$

s.t. $P_N N + P_H H(N) + W_w L_w \leq Y + W_w L_0$

Maximise the Lagrangian expression,

$$U\,(N, L_w) + \lambda(Y + W_w L_0 - P_N N - P_H H(N) - W_w L_w)$$

Find the first order conditions,

$U_N - \lambda P_N - \lambda P_H H'(N) = 0$
$U_{Lw} - \lambda W_w = 0$
$Y + W_w L_0 - P_N N - P_H H(N) - W_w L_w = 0$

Take the total differentials of the first order conditions to obtain the following simultaneous linear differential equations written in the matrix form:

$$\begin{vmatrix} U_{NN} - \lambda P_H H''(N) & U_{NLw} & -P_N - P_H H'(N) \\ U_{LwN} & U_{LwLw} & -W_W \\ -P_N - P_H H'(N) & -W_W & 0 \end{vmatrix} \begin{vmatrix} dN \\ dL_W \\ d\lambda \end{vmatrix} = \begin{vmatrix} \lambda dP_N + \lambda H'(N) dP_H \\ \lambda dW_w \\ N dP_N + H(N) dP_H + (L_w - L_0) dW_W - dY \end{vmatrix}$$

Solve for the differentials dN based on Cramer's Rule,

$$dN = \begin{vmatrix} \lambda dP_N + \lambda H'(N) dP_H & U_{NLw} & -P_N - P_H H'(N) \\ \lambda dW_W & U_{LwLw} & -W_W \\ N dP_N + H(N) dP_H + (L_W - L_0) dW_W - dY & -W_w & 0 \end{vmatrix} \div \begin{vmatrix} U_{NN} - \lambda P_H H''(N) & U_{NLw} & -P_N - P_H H'(N) \\ U_{LwN} & U_{LwLw} & -W_W \\ -P_N - P_H H'(N) & -W_W & 0 \end{vmatrix}$$

$$dN = (\lambda dP_N + \lambda H'(N) dP_H) \frac{|\Delta_{11}|}{|\Delta|} - \lambda dW_W \frac{|\Delta_{21}|}{|\Delta|} + [N dP_N + H(N) dP_H + (L_W - L_0) dW_W - dY] \frac{|\Delta_{31}|}{|\Delta|}$$

The comparative statistic of the number of children with respect to house prices is constructed by rearranging the equation:

$$\frac{dN}{dP_H} = \lambda H'(N) \frac{|\Delta_{11}|}{|\Delta|} + H(N) \frac{|\Delta_{31}|}{|\Delta|}$$
$$= \lambda H'(N) \frac{|\Delta_{11}|}{|\Delta|} - H(N) \frac{dN}{dY} < 0$$

where $|\Delta|$ is the determinant of the bordered Hessian matrix and it is positive given the sufficient condition for a negative semi-definite matrix with a local maximisation; $|\Delta_{11}|$ is the cofactor of the bordered Hessian matrix of the *1st* element and it is equal to $-W_w{}^2 < 0$; $\frac{|\Delta_{31}|}{|\Delta|} = -\frac{dN}{dY}$ and it is negative given children are normal goods; and $H(N)$ and $H'(N)$ are postive. Therefore, the comparative statistic gives a total negative impact of house prices on fertility.

Chapter Three
Fertility and Housing Wealth

1. Introduction

Employing time series evidence, the previous chapter highlights a long-term tendency for fertility rates and house prices to move together at the aggregate level. A more comprehensive investigation on household decision-making and heterogeneity in household behaviours requires an investigation on the relationship between fertility and housing at the individual and household level. This will enable a more nuanced understanding of the relationship between fertility and house prices and greater insight into the underlying causal relationship. Using rich microdata, the next two chapters exploit the variation in demographic and socioeconomic characteristics as well as housing conditions faced by households, to explore the interconnection between household fertility decision-making and housing market developments.

The large and sustained increase in the price of housing across a range of developed countries over the past few decades has initiated increasing interest in the behavioural implications of such developments. A range of studies has examined how changes in housing wealth have impacted the wellbeing and behaviour of individuals. In conjunction with the substantial increase in house prices, a number of developed countries have also experienced a decline in their fertility rates (OECD 2018a). In Australia for example the total fertility rate has been below the replacement rate since the late 1970s. Over the same period the real price of housing has more than tripled (OECD 2018b). While fertility patterns generally reflect the effects of a range of social and economic developments in a country, as a potentially major cost of childbearing, housing may also impact on fertility decisions. This chapter attempts to investigate the implication of fluctuations in house prices and housing wealth on fertility.

There are sound theoretical reasons to expect that fertility and housing are closely linked. The model developed by Becker (1960) considers the fertility decision using a lifetime framework in which a family maximises its expected lifetime level of utility by choosing the optimal number of children and other consumption goods, subject to lifetime wealth constraints and time constraints. In general, it is assumed that children and housing are normal goods and that the cost of housing represents an important component of the cost of raising children. This microeconomic model of fertility posits that changes in the price of housing have both an income or wealth effect, and a substitution effect on fertility related decisions. The net effect of an increase in the price of housing on fertility will depend on the responsiveness of the family to the positive wealth effect relative to the negative price effect.

A number of empirical studies have used aggregate-level house prices to test the effect of changes in house prices on fertility and have identified evidence of a significant impact of housing markets on fertility decisions. For the United States, Dettling and Kearney (2014) used data at the Metropolitan Statistical Area level during the 1997-2006 housing boom and found a positive effect of house price increases on fertility rates among owners and a negative effect among non-owners. Aksoy (2016) used county-level data from England covering the period 1996-2014 and identified a similar pattern. Clark and Ferrer (2016) examine aggregate data for Canada and showed a positive association between lagged housing prices and fertility for homeowners. In addition, they find no significant association between fertility and house prices for renters.[7]

The empirical challenge in the estimation of the relationship between house prices and fertility is the identification of conditionally exogenous changes in house prices with respect to fertility decisions. Housing and fertility decisions are likely to be simultaneously affected by unobserved preferences and selection effects that may plague causal inferences on the relationship. To address this problem, Lovenheim and Mumford (2013) exploit variation in house prices to examine the connection between childbearing decisions and housing markets in the United States, controlling for local macroeconomic conditions and state or regional fixed effects. The evidence in that paper suggests that there is a significant positive association between housing wealth and fertility decisions among homeowners. This finding is similar to that identified by Mizutani (2015) in the study of the effect of housing wealth on fertility during the economic downturn of 1993-2011 in Japan.

[7] Clark and Ferrer (2016) use aggregate data for 123 areas across Canada corresponding to the geographical boundaries of Real Estate Boards which operate the multiple listing service in the local market.

This chapter presents evidence on the causal impact of house prices on fertility by providing empirical evidence from Australia. The analysis exploits the geographic and temporal variation in housing prices to examine the effect of changes in housing wealth on fertility decisions using first-difference models. The rich longitudinal microdata allows for the control for selection of families with different fertility patterns into housing markets with different growth rates. The key identification assumption is that the geographic variation in the scale and timing of house price movements is conditionally exogenous to fertility decisions.

The analysis contributes to the growing literature on the implications of housing markets for household behaviors in a number of ways. First, the responses of both actual fertility decisions and fertility intentions to family housing wealth are explored. Fertility intentions may be more reflective of fertility decision-making and long-term family planning (Vidal, Huinink, and Feldhaus 2017), and a number of studies have acknowledged the challenge in using actual birth to measure the fertility decision-making process (Michielin and Mulder 2008; Öst 2012). There is evidence in the existing literature of the predictive value of women's fertility intention in determining their actual fertility outcomes (Ajzen and Klobas 2013; Miller and Pasta 1995; Quesnel-Vallée and Morgan 2003; Rindfuss, Morgan, and Swicegood 1988; Schoen et al. 1999; Tan and Tey 1994; Thomson 1997; Westoff and Ryder 1977; Morgan and Rackin 2010). In addition, fertility intentions may be less susceptible to external factors such as miscarriages and infertility (Risse 2010). Hence, the results relating behavioural intentions with respect to childbearing provide additional evidence on the relationship between fertility decision and housing markets.

Second, the development of housing market in Australia over the analytical period, along with the distinctive Australia economic context, assists in the identification of housing wealth effect. Relative to many other developed countries, Australia has a high level of homeownership. Approximately two-thirds of Australian households reside in owner-occupied housing in 2015, marginally higher than that in the United States and the United Kingdom. Moreover, Australian households carry relatively high levels of mortgage debt, and in contrast to the United States, most mortgages are adjustable rate mortgages (Badarinza, Campbell, and Ramadorai 2016). Australian households also show a higher marginal propensity to consume out of their illiquid assets than households in either the United States or the United Kingdom (Aron et al. 2012). The combined effect of these characteristics implies that the impact of the substantial temporal and spatial variation in house prices over the observation period is likely to be particularly salient to Australian households.

The main results indicate that house price changes have important implications on the fertility outcomes and fertility intentions of Australian families. In particular, an AUD$100,000 increase in housing wealth among homeowners is associated with a 10.4 percent increase in the probability of having a child. In contrast, there is no evidence of an effect of local housing price growth on the fertility outcomes of renters. There is however evidence that renters lower fertility intentions significantly in response to house price inflation in the local housing market. There is also significant heterogeneity in the effect of housing wealth by age group, marital status, parental status, family income, homeownership status, and the nature of liquidity constraints faced by households.

The remainder of this chapter is set out as follows. In the next section, a brief review of the theoretical and empirical literature that examines the relationship between housing markets and fertility decisions is presented. The data used in the analysis is described in section three, followed by the empirical specification. Section five contains the estimation results, including main effects, robustness checks, and heterogeneity responses. A concluding section summarises the key findings.

2. Literature Review

Early empirical studies were mainly centred on the association between family growth and the demand for housing tenure, type, size, and location. Some studies rely on cross-sectional analysis (Clark, Deurloo, and Dieleman 1984, 1994; Deurloo, Clark, and Dieleman 1994; Dieleman and Everaers 1994; Henretta 1987; Kendig 1984; Mulder and Hooimeijer 1995; Murphy and Sullivan 1985; Weinberg 1979), while others use longitudinal data, which enables the control for unobserved heterogeneity and the joint determination of fertility and housing (Feijten and Mulder 2002; Kulu and Vikat 2008; Morrow-Jones 1988; Mulder and Wagner 1998, 2001; Withers 1998; Ström 2010; Vignoli, Rinesi, and Mussino 2013; Ermisch and Di Salvo 1997). Existing empirical evidence has highlighted the interconnection between fertility related decisions and housing conditions.

Developments in housing markets and in particular the rapid increase in house prices experienced in some countries precipitated the research on the effect of housing market developments on fertility decisions (Clark and Huang 2003; Courgeau and Lelièvre 1992; Clark 2012; Simon and Tamura 2009; Aksoy 2016; Lovenheim and Mumford 2013; Laeven and Popov 2017; Clark and Ferrer 2016; Dettling and Kearney 2014; Clark, Deurloo, and Dieleman 1994, 1997). Rapidly increasing housing costs may constrain the ability of households to adjust housing consumption to family growth so that women may respond by postponing or reducing childbearing (Courgeau and Lelièvre 1992; Clark and Huang 2003; Kulu and Steele 2013).

The identification of the causal relationship between childbearing and home prices hinges on the exogenous source of variation in housing price relative to fertility decisions. The concerns over the potential endogeneity issue has been widely acknowledged in the literature (Aksoy 2016; Clark and Ferrer 2016; Dettling and Kearney 2014; Laeven and Popov 2017; Lovenheim and Mumford 2013; Simon and Tamura 2009). At the microeconomic level, housing selection is potentially jointly determined with childbearing decisions. The selection of women into housing market with differential fertility preferences can bias the estimate on the relationship between house prices and fertility choice upwards or downwards. Households with a lower underlying fertility intention but a higher preference for central locations might sort into high-valued housing markets. Alternatively, families with higher demand for child quality might select into expensive housing markets where good schools are located. At the macroeconomic level, both fertility rates and housing market may be closely related to local economic dynamics. Existing evidence indicates that geographic patterns of housing prices are closely related to local economic conditions. At the same time, if fertility simultaneously responds to macroeconomic dynamics, women may select into childbearing at different stages of economic cycle. For example, women may choose to work and defer fertility when labour market conditions are strong and the opportunity cost of childbearing is high.

A number of recent empirical studies have used aggregate-level housing prices to measure the effect of changes in housing prices on fertility. Using regional price data at the Metropolitan Statistical Area (MSA)-level for the United States over the period 1997-2006, Dettling and Kearney (2014) find a decline in birth rates among non-homeowners and a net increase among owners associated with short-term increases in house prices. Using a similar specification for the period 1996 to 2014, Aksoy (2016) identifies similar patterns using data from English counties. Controlling for the unobserved individual heterogeneity of women, Clark and Ferrer (2016) estimate the effect of lagged price of housing on fertility in Canada using house prices at the Real Estate Board level over the period from 1994 to 2010. Their study finds a positive relationship between lagged housing price and birth propensity among homeowners, but no significant relationship is found among renters.

More recently, studies have exploited the variation in self-reported house prices at individual level to capture the changes in housing prices and housing wealth. Lovenheim and Mumford (2013) argue that geographic variation in the size and timing of the house price changes in the United States over the period 1985-2007 is conditionally exogenous to household childbearing decisions. Using the Panel Study of Income Dynamics (PSID), they consider the relationship between house price growth and the probability of a birth and find that a $100,000 increase in the four-year home value changes among homeowners cause a 17.8 percent increase in the probability of having a child. Focusing on a period of housing bust and economic recession, Mizutani (2015) investigates the responsiveness of fertility using data from the Japanese Panel Survey of Consumers between 1993 and 2011. They show that a 10-million-yen decrease in the two-year changes in home values lead to a 21.5 percent decrease in the probability of childbirth among homeowners with home loans. Like these two studies, this paper employs self-reported and instrumented house prices to identify the impact of an exogenous variation in housing wealth among Australian homeowners on their fertility related behaviours.

To the author's knowledge, this is the first study to consider how fertility decisions are related to developments in the housing market for Australia. There is, however, a line of literature that has documented the significant impact of housing wealth on household decisions in various dimensions, such as household consumption and saving (Case, Quigley, and Shiller 2005; Juster et al. 2006; Campbell and Cocco 2007; Bostic, Gabriel, and Painter 2009; Atalay, Whelan, and Yates 2016), retirement plans (Lusardi and Mitchell 2007; Farnham and Sevak 2007), marital stability (Rainer and Smith 2010; Farnham, Schmidt, and Sevak 2011), education choices (Lovenheim 2011; Lovenheim and Reynolds 2013), labour supply (Atalay, Barrett, and Edwards 2016; Zhao and Burge 2017), indebtedness (Hurst and Stafford 2004), health (Fichera and Gathergood 2016), and demand for long-term care insurance (Davidoff 2010).

In the case of fertility related decisions, one mechanism by which the price of housing may affect fertility decisions of homeowners takes place through a positive housing wealth effect. For existing homeowners, an increase in house prices can stimulate the consumption of households by increasing their perceived wealth or by relaxing their borrowing constraints (Campbell and Cocco 2007). Conversely, among renters who anticipate purchasing a home in the future, it may be the case that an increase in house prices leads to lower levels of actual or planned fertility.

A novel aspect of the analysis in this chapter is that a measure on fertility intentions is incorporated into the analysis on the interconnection between fertility and housing. Built upon the theory of planned behaviour (Ajzen 1985, 1991; Ajzen and Fishbein 1980; Fishbein and Ajzen 1977), a series of studies have illustrated the predictability and reliability of fertility intention measures in informing actual fertility outcomes (Ajzen and Klobas 2013; Miller and Pasta 1995; Quesnel-Vallée and Morgan 2003; Rindfuss, Morgan, and Swicegood 1988; Schoen et al. 1999; Tan and Tey 1994; Thomson 1997; Westoff and Ryder 1977; Morgan and Rackin 2010). Discrepancies between fertility intentions and actual fertility behaviours may be attributed to the time interval between reported intention and recorded behaviour (Davidson and Jaccard 1979; Dommermuth, Klobas, and Lappegård 2011; Randall and Wolff 1994) as well as changes in institutional factors and personal characteristics (Beckman 1984; Berrington 2004; Heiland, Prskawetz, and Sanderson 2008; Monnier 1989; Ajzen and Klobas 2013).

Fertility intention reflects long-term family planning (Vidal, Huinink, and Feldhaus 2017), and provides a measure at the fertility decision-making stage that precedes the realised childbirth (Michielin and Mulder 2008; Öst 2012). Most recently, the measure on fertility intention has been adopted in the studies on the relationship between fertility intention and residential mobility where they show that the expectation on future fertility, rather than the number of existing children per se, has important implications on residential mobility (Ermisch and Steele 2016; Vidal, Huinink, and Feldhaus 2017).

3. Theoretical Discussion

The theoretical discussion of fertility has its origins with Becker (1960)'s fertility model which considers fertility decision as a lifetime utility maximisation problem. According to the microeconomic theory of fertility, a family maximises its lifetime utility by choosing the optimal number of children and other consumption goods, subject to income and time constraints. The theory is further extended by Mincer (1963), Becker (1965), and Willis (1973) who additionally account for the trade-off between children quantity and quality as well as the cost of parental time, assuming children to be analogous to consumer durable goods. This approach to the economic theory of fertility provides a framework within which the conventional microeconomic theory can be applied to fertility decision-making.

As discussed in the theoretical section in Chapter Two, housing is generally considered prerequisite for family formation and growth, and hence changes in the price of housing can potentially affect total fertility or fertility timing. While a simple economic model of fertility suggests that the effect of an increase in house prices on fertility is negative, the relationship is likely to be somewhat nuanced among households. Assuming children are correctly characterised as normal goods, the net effect of an increase in the price of housing on fertility will depend on the relative size of the income or wealth and substitution effects that may differ across housing tenures and moving intentions.

For households who are currently renting and planning to purchase owner-occupied housing in the future, an increase in market housing price that leads to increases in rent or housing costs is likely to induce a negative substitution and a negative income or wealth effect on fertility. This will restrain the ability of private renters to meet a deposit on house purchase. That is, the complementarity between children and housing implies an unambiguously lower demand of private renters for children in response to higher market housing prices.

In contrast, the rise in the price of housing generates an ambiguous effect on fertility among owner-occupiers. For homeowners having secured sufficient housing and who plan a long stay in the residence, an increase in house price can potentially increase their demand for children via a housing wealth effect. There are two possible channels via which such a change may occur, either via the increase in the perceived wealth or liquidity or via the relaxation in credit constraints. Conversely, homeowners planning to relocate and procure more housing for childbearing in the future will face a combination of a positive wealth effect and a negative price effect. The net effect of house price inflation on the family size among this group of homeowners is likely to be ambiguous.

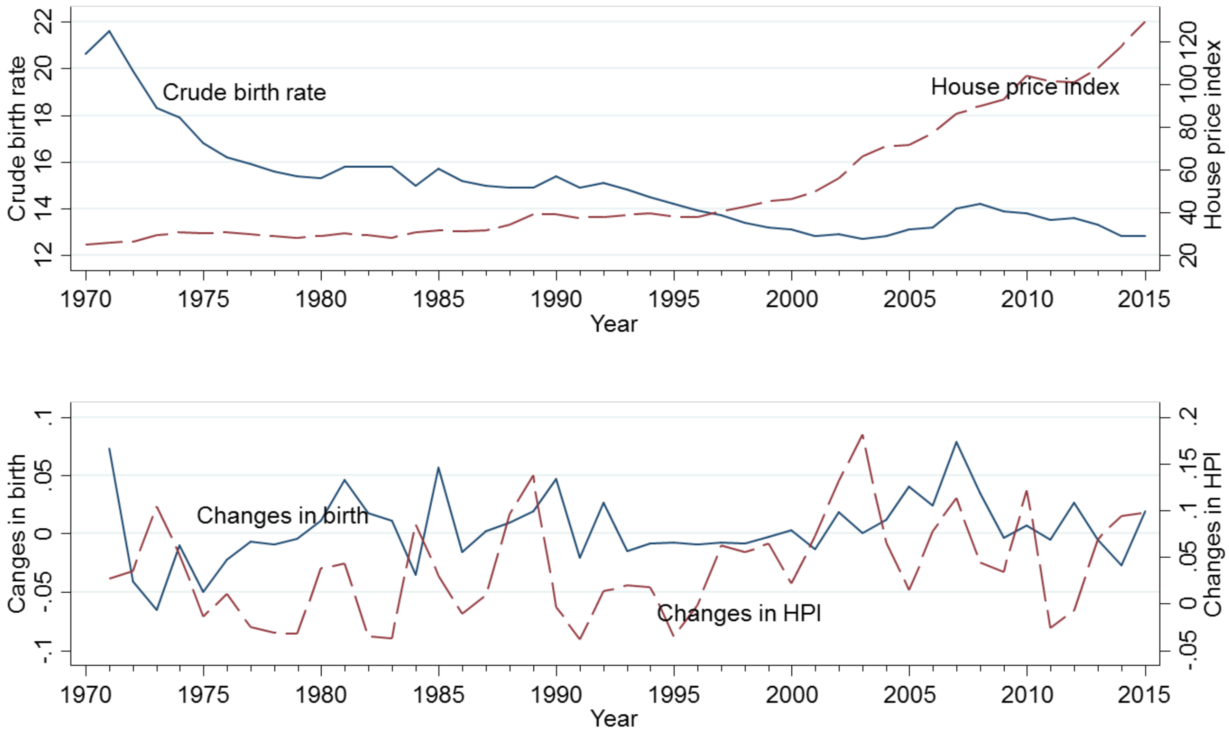
4. Data and Aggregate Trends

The historical pattern of fertility rates and house prices in Australia at the aggregate level during the period 1970-2015 is presented in Figure 3.1. The graphs in Figure 3.1 use time series data from the Australian Bureau of Statistics (ABS 2011b, 2016e).[8] The crude birth rate measures the number of live births per 1,000 estimated population, and the house price index captures changes in the prices of all established detached houses across the eight capital cities over time.[9] As discussed in Chapter Two, at the national level there is some evidence of a negative correlation between fertility rates and house prices over time (top panel in Figure 3.1). An examination of changes in the birth or fertility rate and house prices (bottom panel in Figure 3.1) suggests that changes in house prices may in fact lead changes in fertility rates by two to three years.

[8] The annual time series of housing prices is constructed by splicing the data from Abelson and Chung (2005) for the period 1971-2003, with the data reported by the ABS for the period 2003-2014.

[9] Australia consists of six States (New South Wales, Queensland, Victoria, South Australia, West Australia, and Tasmania) and two Territories (Australian Capital Territory and Northern Territory). Approximately two-thirds of all Australians reside in the capital cities of the States and Territories.

Figure 3. 1. Crude Birth Rate and House Price Index, 1970-2015



Source: ABS 2011, 2016b

For the purpose of this chapter, the micro data used for the analysis are drawn from the first fifteen waves of the Household, Income and Labour Dynamics in Australia (HILDA) survey collected between 2001 and 2015.[10] The HILDA survey is a household-based panel survey with a nationally representative sample of Australian households. Commencing in 2001, the HILDA survey covers a broad range of socio-economic domains, with particular focus on family and household formation, income and work. Participating households and individual household members are interviewed approximately one year apart. The interviews are administered to all members of the responding households aged 15 years and over, including original residents and all other new entrants who reside with the original household members.

The sample used in the present study is restricted to partnered women aged between 25 and 44 years during the period 2001-2015. The age distribution covers the prime period of fertility

[10] The Household, Income and Labour Dynamics in Australia (HILDA) Survey was initiated and is funded by the Australian Government Department of Social Services (DSS) and is managed by the Melbourne Institute of Applied Economic and Social Research (Melbourne Institute). The findings and views based on these data should not be attributed to either DSS or the Melbourne Institute.

planning and childbearing and excludes the ages with generally low birth rates.[11] The focus of the analysis is on both fertility outcomes and fertility intentions. Respondents in HILDA are asked a series of detailed questions about their past and future fertility including the total number of children they have had and future fertility intentions. These two questions are used to establish the measures on fertility outcomes and fertility intentions.

Fertility outcomes are measured by changes in the total number of children, which takes the value of one if the total number of children increased relative to the previous wave and zero otherwise. Fertility intentions are measured using the responses to the question: *'(H)ow likely are [they] to have a child/ more children in the future?'*. Respondents aged between 18 and 55 years are asked to rate their fertility intentions on a scale from 0 (very unlikely) to 10 (very likely). The question does not specify the timing of future children or the parity of children. For the purpose of empirical analysis, the self-reported intention is treated as a continuous variable in the main estimation. A similar approach is adopted by Drago et al. (2009) and Bassford and Fisher (2016). The specification that treats the intention as a categorical variable and estimates with an ordered probit model generates similar results (see Appendix Table A3).

An important feature of the HILDA dataset is that those who are residing in an owner-occupied dwelling are asked about the value of their home property in each wave. Dwelling types include separate houses, semi-detached houses, flats, and home units. The consistently recorded self-assessed property values by homeowners enable the identification of housing wealth and obviate the need to rely on house prices measured at the regional or aggregate level used in other studies (Dettling and Kearney 2014; Clark and Ferrer 2016; Clark 2012; Campbell and Cocco 2007). The reliability and consistency of the self-reported home values across time and space have been demonstrated using American survey data (Kiel and Zabel 1996; Pence and Bucks 2006; Goodman and Ittner 1992), and the HILDA survey data (Melser 2013; Cobb-Clark and Sinning 2011). The self-evaluated housing prices have been increasingly used in the related literature (Atalay, Barrett, and Edwards 2016; Cobb-Clark and Sinning 2011; Lovenheim 2011; Lovenheim and Mumford 2013).

[11] Women aged between 25 and 45 years have relatively higher fertility rates in Australia over the analytical period than younger and older age group (ABS 2014). Women above age 45 are excluded because fertility rates fall significantly after age 45 (ABS 2016a), and those below age 25 are excluded because they tend to live with their parents.

Importantly, the home values reported by HILDA respondents provide a consistent and reliable measure of housing price changes that allows the identification of housing wealth. The sample used in the analysis includes females who remained in the same residence and remained an owner-occupant or renter-occupant for at least three consecutive waves of HILDA. The construction of change in housing wealth variable results in the loss of two waves of data.[12] For the purpose of analysis, home ownership status is defined as owning a home for the previous three years.[13] Renters are defined as females who rent the property for the past three years, excluding those in the rent-buy scheme and public housing. Following Lovenheim and Mumford (2013), the market house price of renters is generated by averaging the self-reported home values of homeowners in the sample in their Local Government Area (LGA) and survey year.[14] The final sample used in the analysis consists of 8,376 and 1,556 person-year observations for owners and renters respectively, involving 2,173 unique owners and 635 renters. All the monetary values are CPI adjusted to 2015 dollars.[15]

The exploitation of the substantial temporal and spatial variation in house prices over the analytical period is central to the identification of the causal impact of housing wealth on fertility related decisions. Figure 3.2 displays the distribution of two-year home value changes among female homeowners aged 25-44 years during the period 2001-2015, and highlights the large fluctuations in house price changes that is present across the sample. Over the period analysed, Australian housing markets exhibited two important features. First, there has been a secular trend of increasing house prices over time across Australia, with significantly more positive changes reported relative to negative changes. In addition, such trends have been punctuated by periods when house prices increased or decreased rapidly in particular geographic areas. For example, housing markets such as Perth, Sydney and Melbourne experienced rapid increases in house prices in excess of 10 percent per annum in some years. Given the significant heterogeneity in property price changes across geographic regions

[12] Observations with missing information on education attainment, marital status, house prices or geographic identifiers are also dropped from the sample.

[13] Homeowners contain females who legally own the property, share the ownership with other household members, or live with the legal owner of the property. Home ownership is entered in the form of lagged measures because of the possible endogeneity of home ownership status in the current survey year. Results are quantitatively and qualitatively similar when defining home ownership as owning a home in the current survey year or previous years.

[14] Local Government Areas (LGA) cover administrative regions of local governing bodies that represent legally designated parts of a State or Territory in Australia. The LGA is the smallest administrative district and the most local tier of government in Australia. As in the 2016 Australian Statistical Geography Standard (ASGS), there are 564 Australian Bureau of Statistics defined Local Government areas (ABS 2017).

[15] CPI series are drawn from the ABS 6401.0 (ABS 2016d).

observed in the sample, many owner-occupiers might experience substantial increases in housing wealth.

Figure 3. 2. The Distribution of Two-Year Home Value Changes in HILDA, 2001-2015

Source: Author's own calculation using waves 1-15 of HILDA.

Summary statistics for the sample consisting of homeowners and renters used in the empirical analysis are presented in Table 3.1. Consistent with a priori expectations, observations in private rental sectors show lower birth rates than those owning a dwelling (0.061 versus 0.081). In Australia, housing careers are often characterised by the transition from rental accommodation to owner-occupation around significant life-events such as partnering and the birth of children. Interestingly, the reported intention to have children, measured on a 0-10 point scale is higher among renters (3.35) compared to homeowners (2.40). Such a pattern most likely reflects family life cycle considerations. Relative to homeowners, renters tend to be younger and have higher childbearing intentions. The demographic and socioeconomic characteristics of owner-occupiers and those in rental accommodation also reflect family developments over the life course. Relative to renters, homeowners are more likely to be married, older, more educated, and they tend to have given birth to more children. Homeowners also tend to have higher income compared to rental residents. Among homeowners, the average self-reported value of residential property is around AUD$549,000. The two-year home value change has a mean of AUD$41,000.[16]

Table 3. 1. Summary Statistics for Homeowners and Renters

	Home Owners				Renters			
	Mean	S.D.	Min	Max	Mean	S.D.	Min	Max
Birth probability	0.08	0.27	0.00	1	0.06	0.24	0.00	1
Fertility intention	2.40	3.56	0.00	10	3.35	3.81	0.00	10
Home value ($100,000)	5.49	2.80	0.79	24.00	6.00	2.58	0.88	18.13
2-year home value change ($100,000)	0.41	0.96	-2.12	4.67	0.39	0.84	-2.08	3.27
Married	0.80	0.40	0.00	1	0.44	0.50	0.00	1
De-Facto	0.10	0.30	0.00	1	0.24	0.43	0.00	1
Number of children	1.79	1.17	0.00	11.00	1.47	1.30	0.00	8.00
Age (years)	37.89	5.04	25.00	44.92	35.39	5.47	25.00	44.92
Years of education	12.99	2.17	8.00	17.00	12.26	2.17	8.00	17.00
Family income ($100,000)	1.36	0.89	-3.60	31.24	0.88	0.50	-0.32	3.91
Outright owner	0.21	0.41	0.00	1	-	-	-	-
Owner with mortgage	0.79	0.41	0.00	1	-	-	-	-
LGA-level unemployment	5.46	1.89	0.90	14.00	5.69	2.04	0.90	15.90
Log (LGA-level average income)	10.87	0.17	10.38	11.81	10.90	0.19	10.39	11.80
Number of Observations	8,376				1,556			
Number of Individuals	2,173				635			

Source: Author's own calculation using waves 1-15 of HILDA.

5. Empirical Methodology

To identify the causal effect of housing wealth on fertility intentions and fertility outcomes, a series of models are estimated that relate the likelihood of the birth of a child in the past year, or the intention of having a child/more children in the future, to the changes in self-reported house prices over the previous two-year period.[17] A priori changes in house prices are expected

[16] Observations with extreme house price changes (bottom and top 1% of the house price changes) are excluded. Specifications which include those observations lead to results that are similar to those reported below.
[17] Estimates using three-year home value changes leave the results similar in a quantitative sense.

to affect homeowners and renters differently, with heterogeneous responses across demographic and socio-economic groups. Hence, the models incorporate a number of covariates suggested by existing research that are closely associated with the progression in family life cycle and important in determining fertility related decisions.

Following Lovenheim and Mumford (2013), fertility outcomes (1) and fertility intentions (2) are modelled as follows:

$$\Pr(Birth_{iat} = 1) = \beta_0 + \beta_1 \Delta P_{iat} + \beta_2 X_{iat} + \beta_3 X_{iat-1} + \beta_4 X_{iat-2} + \theta_a + \gamma_t + u_{iat} \quad (1)$$

$$Intention_{iat} = \beta_0 + \beta_1 \Delta P_{iat} + \beta_2 X_{iat} + \theta_a + \gamma_t + u_{iat} \quad (2)$$

where *i* indexes the individual; *a* indexes the local government area; and *t* indexes the survey year. The variable P_{iat} represents self-reported home values for homeowners and LGA market average housing prices for renters; X_{iat} is a vector of key observable fertility determinants; θ_a are LGA fixed effects; γ_t are year fixed effects; and u_{iat} are the stochastic errors. Both equations are estimated using OLS and contain the same set of covariates. The housing wealth measure ΔP_{iat} is constructed by second differencing the values of the home reported by the owner-occupier.

Exogenous variation in house prices is central to understanding the causal relationship between house price changes and fertility related decisions. The control for local and time varying characteristics facilitates the identification of changes in home values that are arguably exogenous to the fertility decisions of individuals. In a similar fashion to Lovenheim and Mumford (2013), identification is derived from temporal and spatial variation in house prices that affected homeowners and renters differentially across localities over time. During the analytical period, homeowners residing in some areas of Australia experienced significant increases in household wealth driven by the increase in house prices over certain periods relative to others in areas with moderate house price growth.

The differenced housing prices capture a wealth effect on which homeowners can capitalise. Moreover, accumulated housing wealth driven by the increase in housing prices increases households' perceived housing wealth and borrowing capability. Together with the financial deregulation that widens access to housing wealth, the increase in housing wealth can potentially stimulate the consumption expenditure of families. The increase in the housing wealth enables young couples to finance renovations to the current home, the purchase of the next home, and any other child-related expenses, or provides financial insurance in meeting future child-related cost outlays (Wood and Nygaard, 2010). These imply the potential increase in fertility intentions and outcomes.

Traditionally, to release housing equity, households had to sell their homes and move to another owner-occupied or rental property. Developments in mortgage markets over the past few decades have meant that housing mortgage withdrawal through home equity loans or lines of credit allow home owners to unlock housing equity by taking on more debt secured against their property without selling their current homes and moving to a new house. The cases of housing equity withdrawal has increased from 13 percent in 2001 to 18 percent in 2010 in Australia, and the majority of the cases is through mortgage equity withdrawal (Ong et al. 2014). Mortgage equity withdrawal became the dominant method of housing equity withdrawal in the last decade especially among those under pension age, while the traditional forms of housing equity withdrawal, mainly downsizing or selling up, are more prevalent for elderly home owners most likely to finance retirement (Ong et al. 2014).

The empirical specifications include a range of demographic and socio-economic characteristics to control for the heterogeneity in fertility. The vector X_{iat} contains age in polynomials (cubic terms), marital status, years of education, family income, the number of children aged below 25, and regional macroeconomic conditions in the form of local unemployment rates and average wage/salary income in the local area. The variables are entered as values in the current year, values lagged by one year, and values lagged by two years.[18] Lagged measures take into account the fertility decision-making process that occurs at the time of pregnancy, prior to the birth of the child. The inclusion of families' characteristics at year "*t*", year "*t-1*", and year "*t-2*" accounts for the most relevant and comprehensive information on their economic conditions prior to the birth and allows for a sufficiently long time horizon during which the fertility decisions are formed.[19] Family income and marital status are potentially endogenous as both labour force participation and familial union tend to

[18] Total number of children in the fertility model is only included as lagged values because including the number of children at both t and t-1 would capture the equivalent information of the dependent variable.
[19] Models are also estimated with only current period controls, or with only 2-year lag controls. These nested specifications yield stronger results than those reported in Table 3.2.

be simultaneously determined with childbearing plans, and hence the causal interpretation of these variables warrants caution.

During the period of analysis, there was significant variation in house prices across regions in Australia. While national house prices have been trending up, this masks substantial regional variation. For example, there had been some rapid growth in house prices in Sydney and Melbourne – Australia's two largest housing markets -- in early 2000s and early 2010s. During these periods, house price growth exceeded ten percent per annum, more than double that of other capital cities. In Perth during the mid-2000s, house price growth exceeded 25 per cent per annum spurred by the natural resource boom (Yates 2011). Arguably, such changes in house prices were unanticipated and exogenous to the fertility related decisions for existing homeowners who remained in the same residence for at least three years. That is, it is less likely for those households to select on such economic shocks in housing markets. Provided that the magnitude and timing of home price variation are sufficiently different across geographic regions in Australia during the period 2001-2015, such variation can provide an opportunity to identify the causal impact of house prices on fertility related decisions.

The inclusion of regional economic conditions and LGA-by-year fixed effects further controls for the time invariant location specific considerations and trends over time that may be associated with fertility. The measures on average wage/salary income and unemployment rate at the LGA level provide geographic information at a relatively fine level. The empirical specification effectively controls for the possibility that women select into childbearing during economic downturns or choose to postpone having children when the opportunity cost of leaving employment is relatively high. The labour market information on annual unemployment rates at the LGA level is collected from the ABS National Regional Profile series (ABS 2016e), and merged into the HILDA data using LGA identifiers. LGA fixed effects and year fixed effects are also included to further capture common unobserved factors within the locality and year that may be associated with fertility decisions, such as the selection of families into school districts or the periods when child care and family support policies were introduced. The estimates on the effect of changes in house prices on the fertility of renters provide an additional check on the bias from any confounding macroeconomic influences.

Failing to account for the structure of the errors can lead to invalid inferences on the estimators. Main estimates in the study cluster errors at the LGA level, which allows the errors to be correlated across periods within a LGA. Models with the standard errors adjusted at the individual level and the Major Statistical Region (MSR) level are also estimated, yielding similar results[20].

6. Results

6.1 Fertility Decisions for Homeowners and Renters

The results from estimating Equation (1) and (2) are reported in Table 3.2. Full results are presented in Appendix Table A3.1. The specification includes demographic and socio-economic covariates, macroeconomic controls, and year and location (LGA) fixed effects. The first two columns present the results of estimating Equation (1) which examines fertility outcomes. The last two columns report the results from models that examine fertility intentions specified in Equation (2). Homeowners and private renters are estimated separately. For homeowners, changes in self-reported home values are used to identify housing wealth, and for private renters, changes in the LGA-by-year average market housing prices are used to measure the effect of housing prices on fertility related decisions and behaviours.

[20] One Major Statistical Regions (MSR) consists of the capital city and the balance of the State. Each of the five larger States of New South Wales, Victoria, Queensland, South Australia and Western Australia covers two MSRs, and the other States and Territories have one MSR each covering the entire area (ABS 2011b).

Table 3. 2. Estimates of the Effect of Housing Prices on Fertility Outcome and Intention

	(1) **Fertility Outcome**	(2) **Fertility Intention (0 - 10)**
Homeowners		
2-year home value change ($100,000)	0.0077**	0.0489
	(0.0037)	(0.0414)
Covariates at t, t-1 and t-2 (exc. health index)	Yes	Yes
LGA and year fixed effects	Yes	Yes
Observations	8,376	7,531
R^2	0.1461	0.4783
Renters		
2-year home value change ($100,000)	-0.0041	-0.2400
	(0.0096)	(0.1530)
Covariates at t, t-1 and t-2 (exc. health index)	Yes	Yes
LGA and year fixed effects	Yes	Yes
Observations	1,557	1,455
R^2	0.1844	0.5998

Notes: Full results are reported in Appendix Table A3.1. The sample is comprised of women aged 25-44 who did not change address in the last three years. Fertility outcome is a binary variable that takes the value of 1 if gave birth in the previous year. Fertility intentions is a number between 0 and 10. All estimates include marital status (married, de-facto, divorced or single), number of kids, age in cubic terms, family income, years of education, LGA-level unemployment rate, and LGA-level log of average income. The number of kids at t is excluded from the controls in the fertility outcome regressions. Column 2 and 4 additionally include an index of own physical health and mental health constructed from the SF-36 questionnaire completed by the respondents in each wave of the HILDA Survey. The physical and mental health indices are scaled from 0-100, with a higher score corresponding to better health. Standard errors clustered at the LGA level are reported in parentheses. * significant at the 1% level, * p<0.1, ** p<0.05, *** p<0.01. Models using a probit specification and an ordered probit respectively for Equation 1 and 2 produce similar results (see Appendix Table A3.3). Source: 2001-2015 HILDA survey data.

The results from the estimation of the fertility outcome model in columns (1) in the upper panel of Table 3.2 indicate a positive and sizeable housing wealth effect on childbirth among homeowners. The estimate is slightly larger in magnitude after including measures of physical and mental health. Using the estimate in column (1), a $100,000 increase in two-year house price changes is associated with 0.0077 percentage points increase in the likelihood of having a child in the past year, significant at the 5% level. Relative to the mean birth rate of 0.08 for female homeowners aged 25-44 in the sample, a $100,000 increase in housing wealth increases the likelihood of giving birth by around 9.6 percent. This implies a housing wealth elasticity of fertility of approximately 0.35.[21] Columns (2) report the results from estimating the responsiveness of fertility intention, measured by the self-reported likelihood to have children in the future on a scale from 0 (very unlikely) to 10 (highly likely). The point estimates of the effect of the two-year home value changes on fertility intention among female homeowners are positive but insignificant.

Fertility responses of female renters are reported in the bottom panel. In the fertility outcome model, the estimated effect of house price changes on the likelihood of having a child for renters is insignificant. That is, the current results do not show any evidence of females currently residing in rental tenure changing their fertility in response to changes in local house prices. In fact, the estimates in the fertility intention model suggest a negative (albeit insignificant) relationship between intention to have children and house price changes after controlling for the physical and mental health of the respondent. This suggests that women who experienced rising local housing prices may lower their intention to start a family or increase family size. Since both homeowners and renters experience the effect of unobserved macroeconomic conditions, the negative response among renters alleviates, to some extent, the concern that unobserved macroeconomic conditions drive up the estimates on housing market growth.

The coefficient estimates of other fertility determinants are in general consistent with a priori expectations. The demographic variables are statistically significant with expected signs. For example, female homeowners in a partnership are more likely to have higher birth probabilities and stronger fertility intentions, with married women revealing a much higher fertility intention than de facto couples (ABS 2012). Family income in the current year is insignificant. However, one-year lagged family income is positive and significant in predicting fertility intention of both homeowners and renters, and two-year lagged family income is positive and significant in predicting birth outcomes for homeowners. The significant lagged family income variables suggest that families may evaluate their financial resources prior to conception during the childbirth planning stage, and their incomes may be affected following the pregnancy.

[21] Relative to the average home equity of $339,000 for homeowners in the sample, a $100,000 increase in the home value is equivalent to a 29.50 percent increase. Together with the 9.6 percent increase in the fertility rate associated with a $100,000 increase in home value, the housing wealth elasticity of fertility is approximately 0.35.

Women's education level tends to be negatively correlated with fertility outcome (ABS 2008). Having additional children aged below 25 years is associated with lower fertility intentions and actual births. In general, the estimates on the LGA-level unemployment rate and the LGA-level average income are negative but insignificant. The fact that the housing wealth effect remained significant after controlling for LGA-unemployment and LGA-average wage suggests that the effect of house price growth is not merely a proxy for regional economic conditions. The sizable positive and significant year dummy of 2005 in the birth intention model may be reflective of an exogenous change in policy announced in 2004. In particular, the positive impact of the Baby Bonus policy announced in May 2004 whereby parents of children born after July 2004 received a universal payment of AUD$3000.[22]

The potential endogeneity of homeownership status is addressed in Appendix Table A3.2. Although the analysis uses three-year homeownership status to assign tenure status, there may be a concern regarding endogeneity of respondents' homeownership status. In particular, homeownership status may be endogenous if those individuals who planned to have children or who have higher fertility intentions are also more likely to be homeowners.[23] As an additional robustness check on this possibility, multivariate matching is used on various demographic controls to predict homeownership. In particular, the multivariate matching model includes birth cohort, marital status, education, household income, indicators for major statistical region, satisfaction about the neighbourhood, and feeling part of the community as explanatory variables. These are the key controls for determining the demand for homeownership. This method creates a predicted homeownership status, with the predicted ownership probability above 0.5 assigned as homeowners and below 0.5 assigned as renters. Changes in LGA-average housing prices are used to construct the housing wealth measure for predicted homeowners. The positive housing wealth effect remains controlling for the predicted homeownership status (see Appendix Table A3.2).

6.2 Response Heterogeneity

[22] The estimated coefficient on wave 5 is 0.839, with standard error of 0.207, significant at the 1% level.
[23] Aksoy (2016) also discusses another potential reason of endogeneity of house prices. He argues that due to fix short-term supply of housing, families with children might demand larger houses which can result in the direction of causation to run from children to house prices. For Australia, McLaughlin (2012) shows that due to new land use policies, short-run elasticity of new supply of buildings are comparably larger.

The estimates reported in Table 3.2 suggest some heterogeneity in the fertility response across females. To explore this possibility, Table 3.3 reports the estimates from specifications (1) and (2) across women within different age groups, marital status, parental status, family income, homeownership status, and liquidity constraints. Each specification conditions on the circumstances that exist at the fertility decision-making point, that is, for example the liquidity or borrowing constraints lagged two years rather than the contemporaneous situation.

The results in the first panel of Table 3.3 indicate that the increase in fertility among homeowners is largely concentrated among women under 35 years of age. The estimated coefficient for women aged 25-34 years is 0.0170, statistically significant at the 10 percent level. This implies that a $100,000 increase in housing wealth increases the likelihood of giving birth among women aged 25-34 years by 0.0170 percentage points. This represents an increase of a 9.4 percent based on the mean birth rate of 0.18 among the cohorts. An increase in home prices of this order raises the intention of young female homeowners to have children by 0.145 point on a scale of 0-10, or 2.78 percent. In contrast, the housing wealth effect for the 35-45 age group who are more constrained by fertility timing is insignificant at the standard levels of significance, suggesting a low housing wealth elasticity of fertility among older female homeowners. There is some evidence that renters are discouraged from fertility by the increasing housing prices, which may prevent them from achieving homeownership.

In the second panel of Table 3.3, the results of housing wealth estimates on fertility decisions for women by marital status are presented. Notwithstanding an increased number of births outside of registered marriages, it remains the case that a majority of births occur within a formal marriage in Australia (ABS 2016a). The result is suggestive of a positive housing wealth effect on fertility among married homeowners: an increase in home prices by $100,000 leads to 0.0075 percentage points, or 8.3 percent (0.0075/0.09) increase in the probability of having a child. Consistent with the birth outcome estimates, an increase in housing wealth causes a significant increase in the intention of married couples to have children in the future. In comparison, there is no evidence of cohabitating couples responding to the changes in home values.

Table 3. 3. Response Heterogeneity

		Home Owners		Renters	
		Fertility Outcome	Fertility Intention	Fertility Outcome	Fertility Intention
Age Group	25≤Age<35	0.0170*	0.1450*	0.0044	-0.5400**
		(0.0093)	(0.0833)	(0.0143)	(0.2480)
	35≤Age<45	0.0031	-0.0276	-0.0212	0.2320
		(0.0026)	(0.0357)	(0.0143)	(0.1800)
Marital Status	Married	0.0075**	0.0752*	-0.0111	-0.5250***
		(0.0037)	(0.0443)	(0.0156)	(0.1880)
	De-facto	0.0122	-0.2080	-0.0458	-0.3120
		(0.0159)	(0.1250)	(0.0335)	(0.3890)
	Single	-0.0110	-0.3060	-0.0054	-0.0550
		(0.0088)	(0.2110)	(0.0065)	(0.2990)
Parental Status	No Kids	0.0237*	0.1770	0.0056	-0.2630
		(0.0122)	(0.1150)	(0.0179)	(0.3690)
	Have Kids	0.0038	-0.0142	-0.0155	-0.3930**
		(0.0035)	(0.0361)	(0.0134)	(0.1520)
Family Income	Top Quartile	0.0130*	0.0448	0.0013	-0.4640
		(0.0067)	(0.0690)	(0.0801)	(0.6150)
	Third Quartile	0.0064	-0.0068	0.0010	-0.4180
		(0.0062)	(0.0547)	(0.0237)	(0.3070)
	Second Quartile	0.0061	0.0268	-0.0138	0.0139
		(0.0067)	(0.1050)	(0.0188)	(0.2690)
	Bottom Quartile	-0.0024	-0.1170	0.0250	-0.1090
		(0.0138)	(0.1990)	(0.0270)	(0.3560)
Homeownership Status	Outright Owners	-0.0057	0.0416	-	-
		(0.0051)	(0.0650)		
	Mortgage Owners	0.0107**	0.0417	-	-
		(0.0044)	(0.0476)		
Loan to Value Ratio	0<LVR<=0.25	-0.0048	0.0439	-	-
		(0.0049)	(0.0615)		
	0.25<LVR<=0.5	0.0141**	0.1180	-	-
		(0.0069)	(0.0778)		
	0.5<LVR<=0.75	0.0105	0.0022	-	-
		(0.0105)	(0.1340)		
	LVR>0.75	0.0193	0.1650	-	-
		(0.0142)	(0.1290)		

Notes: The sample is comprised of women aged 25-44 who did not change address in the last three years. Fertility outcome is a binary variable that takes the value of 1 if gave birth in the previous year. Fertility intentions is a number between 0 and 10. All regressions include controls used in Table 3.2 column (1). Standard errors clustered at the individual are reported in parentheses. * p<0.1, ** p<0.05, *** p<0.01. Source: 2001-2015 HILDA survey data.

Results by parental status are reported in the third panel of Table 3.3. Childless women exhibit a pronounced positive and significant response to the increase in housing wealth. A $100,000 increase in the housing wealth increases the likelihood of women giving birth to the first child by 0.0237 percentage points, or 17.7 percent (0.0237/0.13), suggesting that increases in housing wealth or the relaxation of liquidity constraints associated with house price growth increases the demand for children. The effect of housing wealth on homeowners' fertility intention is also positive but is statistically insignificant. In contrast, there is evidence that higher market house prices reduce the fertility intentions among private renters with at least one child.

The next panel shows the estimated effect of housing wealth on fertility by family income. Families in the top quartile of the income distribution prior to conception exhibit the largest responsiveness to housing wealth changes. Families in the second and third income quartile also positively respond to the increase in housing wealth although in an insignificant manner. Homeowners in the bottom income quartile are found to respond negatively (albeit insignificantly), to house price inflation. During 2015-16, the amount of debt held by Australian households in the highest quintile is more than seven times that for households in the lowest quintile (ABS 2015-16a). There is no evidence of fertility response to housing market fluctuations for either low-income or high-income renters.

Focusing on homeowners, the remaining panels in Table 3.3 present the results of heterogeneity in homeownership status and liquidity constraints. Relative to outright owners whose fertility is not affected by changes in home prices, owner-occupiers with a mortgage significantly increase their fertility in response to an increase in house price. Such a response may reflect either a direct wealth or a collateral effect. The increase in the housing wealth may relax the credit constraint faced by households and enhances their borrowing capability (Atalay, Whelan, and Yates 2016; Campbell and Cocco 2007). The different responses between outright and mortgaged owners may also reflect differences in fertility aspirations between young groups, the majority of whom are mortgage owners, and older groups who are generally outright homeowners and more likely to have completed their fertility. Across loan to value ratios (LVR), women who are moderately liquidity constrained with a LVR of 0.25-0.5 exhibit the strongest response to changes in housing wealth.[24] This may be consistent with a pattern whereby households with higher income and more equity have easier access to loans provided by lenders (ABS 2015-16a). Owning relatively more equity in the property allows households to withdraw equity or refinance their mortgage in a way that supports household expansion. Accompanied by lower loan rates and relaxed lending rules, the increase in housing wealth increases the capacity of households who are otherwise liquidity constrained to extract equity from their housing assets and fund their child-related consumption.

7. Conclusion

The analysis in this chapter has examined the fertility response of Australian women to house price fluctuations. The empirical results indicate a positive association between the growth in the price of housing and the fertility of homeowners. Such a relationship is supported by recent findings from the United Kingdom (Aksoy 2016), the United States (Lovenheim and Mumford 2013), and Canada (Clark and Ferrer 2016). The analysis in this chapter contributes to this literature by drawing on rich microdata that contain information on self-assessed home values, fertility outcomes and fertility intentions. Heterogeneous responses are observed across marital status, parental status, family income, residential areas, home ownership status, and liquidity constraints.

The results show that an increase in housing prices increases the intended and actual fertility of homeowners and reduces the fertility intentions of renters. With falling rates of homeownership during the recent years in Australia (ABS 2011, 2016), the persistent and high rate of hosing price appreciation may negatively impact fertility rates among renters. Alternatively, relative to outright owners whose fertility intentions and outcomes is not affected by changes in home prices, owner occupiers with mortgage loans achieve significantly higher fertility in response to increases in home prices. This may imply that a collateral effect may be

[24] LVR is constructed by dividing the value of the mortgage outstanding over the self-reported home value of the homeowners. In Australia households are generally allowed to take on a mortgage loan up to LVR of 80% without the purchase of mortgage insurance.

in place, from which households benefit as their borrowing capability expands following an increase in house prices.

In Australia over the past decade, there has been increasing concern among policymakers and others about housing affordability. Specifically, the rapid increase in house prices has led to concerns around the impact on the housing careers of younger Australians and the potential for increasing polarisation across generations. The analysis in this chapter suggests that such developments may also have important implications for fertility related decisions and outcomes. In an environment in which Australia and other countries are faced with an ageing population, the empirical results point to an additional challenge for policymakers. Specifically, increases in housing costs may impact directly on fertility which over the long term may have significant fiscal implications. Moreover, policies designed to increase fertility may be ineffective if complementary housing policies that support households to achieve housing for childbearing plans are not put in place.

One potentially important dimension that connects fertility decisions and developments in housing markets is geographical mobility. The demand for fertility often involves an increase in housing consumption, in terms of either housing attributes or residential environment, which can trigger residential relocation. While the growth in family size or the intention to have children may induce the anticipated or adaptive residential adjustments, the realisation of this adjustment is conditional on housing market conditions and household characteristics such as financial resources and local social capital. Housing market developments may affect the ability of households to adjust their housing situation to family growth. In the next chapter, the questions around whether fertility intention will promote residential relocation and how fertility-induced relocation varies with housing market conditions and moving distances will be investigated in detail.

Appendix

Table A3. 1. Estimates of the Effect of Housing Prices on Fertility Outcome and Intention

	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
	Homeowners				**Renters**			
	Fertility Outcome		**Fertility Intention**		**Fertility Outcome**		**Fertility Intention**	
2-yr home value change	0.008**	0.008**	0.049	0.040	-	-	-	-
	(0.004)	(0.004)	(0.041)	(0.044)				
2-yr LGA home value change	-	-	-	-	-0.0041	0.003	-0.240	-0.287*
					(0.010)	(0.013)	(0.153)	(0.155)
Number of kids	-	-	-0.238*	-0.087	-	-	-0.621**	-0.726**
			(0.123)	(0.146)			(0.245)	(0.303)
Married	0.061**	0.041	1.787***	1.861***	-0.031	-0.022	3.411***	3.642***
	(0.029)	(0.027)	(0.353)	(0.347)	(0.058)	(0.073)	(0.625)	(0.661)
De facto	0.061**	0.055**	0.650*	0.458	-0.004	-0.031	1.767***	1.567***
	(0.029)	(0.027)	(0.371)	(0.381)	(0.034)	(0.053)	(0.575)	(0.533)
Divorced	0.041**	0.0401*	0.3300	-0.0760	0.0136	-0.0221	0.1570	0.2510
	(0.021)	(0.022)	(0.406)	(0.291)	(0.045)	(0.058)	(0.832)	(0.936)
Age	-3.520*	-2.9870	-1.777	-2.972	-4.284	2.264	46.820	46.870
	(1.939)	(2.514)	(18.850)	(22.150)	(4.127)	(5.957)	(48.800)	(54.800)
Age^2	103.700*	91.570	9.488	66.000	127.000	-57.270	-1336.100	-1440.600
	(52.860)	(68.200)	(518.800)	(604.400)	(120.900)	(171.400)	(1405.500)	(1589.000)
Age^3	-0.979**	-0.887	0.122	-0.637	-1.254	0.432	12.430	14.330
	(0.473)	(0.608)	(4.691)	(5.440)	(1.159)	(1.613)	(13.340)	(15.090)
Family income	0.003	-0.000	0.044	-0.081	0.020	0.0251	-0.6510**	-0.7210
	(0.005)	(0.008)	(0.066)	(0.072)	(0.038)	(0.052)	(0.300)	(0.440)
Years of education	-0.013	-0.0168*	0.0015	-0.0694	-0.004	-0.005	0.187	0.177
	(0.009)	(0.010)	(0.120)	(0.144)	(0.015)	(0.017)	(0.222)	(0.221)
LGA unemployment rate	0.005	0.004	0.048	0.056	-0.007	-0.010	0.104	0.079
	(0.004)	(0.004)	(0.041)	(0.045)	(0.009)	(0.010)	(0.134)	(0.177)
Log LGA average income	-0.112	-0.141	-3.179*	-1.994	0.144	0.230	-6.495	-6.193
	(0.154)	(0.167)	(1.807)	(2.007)	(0.314)	(0.349)	(4.328)	(5.726)
L1.Number of kids	-0.101***	0.089***	0.225**	0.147	0.085***	0.089***	-0.080	0.194
	(0.012)	(0.013)	(0.102)	(0.125)	(0.021)	(0.026)	(0.232)	(0.291)

Table A3. 1. Estimates of the Effect of Housing Prices on Fertility Outcome and Intention (cont.)

L1.Married	0.089**	0.095**	-0.006	0.246	0.211**	0.202*	-1.169	-1.564*
	(0.039)	(0.040)	(0.319)	(0.323)	(0.090)	(0.111)	(0.861)	(0.910)
L1.Defacto	-0.034	-0.023	-0.383	-0.120	0.067*	0.060	-0.441	-0.099
	(0.0381)	(0.038)	(0.379)	(0.364)	(0.038)	(0.057)	(0.607)	(0.547)
L1.Divorced	-0.007	-0.033	-0.177	0.254	-0.041	-0.014	-0.437	0.370
	(0.033)	(0.026)	(0.320)	(0.341)	(0.052)	(0.081)	(0.813)	(0.800)
L1.Age	3.842**	3.925*	-5.635	-9.875	-0.356	-5.290	-31.030	-41.890
	(1.810)	(2.359)	(19.890)	(22.970)	(4.441)	(5.802)	(33.880)	(49.750)
L1.Age^2	113.300**	117.800*	130.800	226.100	-0.330	139.500	1062.400	1392.900
	(50.710)	(65.910)	(563.100)	(649.600)	(130.600)	(169.800)	(992.100)	(1468.300)
L1.Age^3	1.072**	1.130*	-0.957	-1.626	0.096	-1.187	-11.270	-14.450
	(0.468)	(0.607)	(5.217)	(6.020)	(1.257)	(1.623)	(9.587)	(14.110)
L1.Family income	-0.006	-0.014	0.073	0.206**	-0.061**	-0.056*	0.855**	1.261**
	(0.005)	(0.008)	(0.069)	(0.090)	(0.029)	(0.030)	(0.411)	(0.573)
L1.Years of education	0.008	0.012	0.117	0.192	-0.021	-0.019	-0.061	-0.074
	(0.013)	(0.015)	(0.110)	(0.129)	(0.018)	(0.021)	(0.253)	(0.223)
L1.LGA unemployment rate	-0.002	-0.004	0.103***	0.113***	0.010	0.005	-0.117	-0.166
	(0.003)	(0.004)	(0.030)	(0.034)	(0.009)	(0.009)	(0.102)	(0.124)
L1.ln_LGA average income	-0.080	-0.056	2.178	0.082	0.296	-0.003	-4.275	-7.104
	(0.182)	(0.196)	(1.920)	(2.131)	(0.336)	(0.374)	(3.603)	(4.774)
L2.Number of kids	0.066***	0.058***	-0.812***	-0.853***	0.075***	0.077***	-0.347	-0.470*
	(0.011)	(0.012)	(0.114)	(0.130)	(0.021)	(0.026)	(0.239)	(0.275)
L2.Married	-0.044	-0.033	1.536***	1.631***	-0.086	-0.070	-1.431**	-1.400*
	(0.030)	(0.035)	(0.351)	(0.376)	(0.069)	(0.082)	(0.698)	(0.824)
L2.Defacto	0.013	0.012	-0.134	-0.181	0.043	0.084**	-0.327	-0.549
	(0.035)	(0.041)	(0.367)	(0.394)	(0.030)	(0.034)	(0.527)	(0.580)
L2.Divorced	0.018	0.050*	-0.037	0.125	0.068	0.095	-0.379	-0.856
	(0.031)	(0.026)	(0.329)	(0.378)	(0.085)	(0.118)	(0.699)	(0.845)
L2.Age	-0.053	-0.672	10.190	14.710	4.232	3.056	-7.179	1.920
	(1.635)	(2.050)	(17.360)	(21.460)	(3.622)	(4.575)	(34.950)	(43.750)
L2.Age^2	-1.185	16.550	-248.600	-379.300	-121.800	-83.290	56.300	-122.500
	(47.820)	(59.250)	(505.900)	(627.400)	(107.000)	(134.900)	(1074.500)	(1314.500)
L2.Age^3	0.036	-0.132	2.000	3.292	1.177	0.770	0.595	1.359
	(0.457)	(0.560)	(4.832)	(6.003)	(1.046)	(1.294)	(10.790)	(12.930)
L2.Family income	0.014**	0.027***	0.028	-0.005	0.023	0.010	0.301	0.435
	(0.006)	(0.009)	(0.054)	(0.098)	(0.038)	(0.047)	(0.372)	(0.514)

Table A3. 1. Estimates of the Effect of Housing Prices on Fertility Outcome and Intention (cont.)

L2.Years of education	0.009	0.010	0.033***	0.031*	-0.046	-0.042	0.005	0.026
	(0.011)	(0.012)	(0.107)	(0.139)	(0.013)	(0.017)	(0.219)	(0.228)
L2.LGA unemployment rate	-0.0010	-0.002	0.006	-0.013	-0.005	-0.005	0.163*	0.121
	(0.003)	(0.003)	(0.007)	(0.007)	(0.030)	(0.031)	(0.087)	(0.098)
L2.ln_LGA average income	0.097	0.045	-2.326	-1.968	-0.319	-0.258	4.668	4.998
	(0.155)	(0.168)	(1.545)	(1.697)	(0.354)	(0.440)	(4.581)	(6.446)
Physical health	-	0.002***	-	0.010***	-	0.001	-	-0.007
		(0.000)		(0.001)		(0.004)		(0.008)
Mental health	-	0.001***	-	0.008**	-	-0.001	-	0.005
		(0.0003)		(0.003)		(0.001)		(0.007)
L1.Physical health	-	0.002***	-	0.006**	-	-0.001	-	0.011*
		-0.000		-0.001		-0.003		-0.007
L1.Mental health	-	0.001***	-	-0.004	-	0.001	-	0.0140
		(0.000)		(0.003)		(0.001)		(0.007)
L2.Physical health	-	0.001***	-	0.008***	-	0.001*	-	-0.004
		(0.000)		(0.001)		(0.003)		(0.009)
L2.Mental health	-	-0.0001	-	-0.008**	-	-0.000	-	-0.005
		(0.000)		(-0.001)		(0.003)		(0.007)
Observations	8376	6884	7531	6174	1557	1179	1455	1090

Notes: All models include year and LGA fixed effects. The sample is comprised of women aged 25-44 who did not change address in the last three years. Fertility outcome is a binary variable that takes the value of 1 if gave birth in the previous year. Fertility intentions is a number between 0 and 10. * p<0.1, ** p<0.05, *** p<0.01. Source: 2001-2015 HILDA survey data.

Table A3. 2. Estimates of the Effect of Housing Prices on Fertility Using Predicted Homeowners

	(1)	(2)	(3)	(4)
	Fertility Outcome		**Fertility Intention (0 - 10)**	
	Homeowner	Renter	Homeowner	Renter
Predicted homeowners				
2-year LGA-average housing price change ($100,000)	0.0046***	-0.0029	-0.0089	-0.1680
	(0.0013)	(0.0217)	(0.0198)	(0.1810)
Observations	8597	7074	7711	6322
R^2	0.1345	0.1475	0.4866	0.4911

Notes: * p<0.1, ** p<0.05, *** p<0.01.

Table A3. 3. Estimates from Probit and Ordered Probit Models of Fertility Outcome and Intention

	(1)	(2)	(3)	(4)
	Fertility Outcome		**Fertility Intentions (0 - 10)**	
	Probit Model (Average Marginal Effect)		Ordered Probit Model (Coefficient)	
A - Homeowners				
2-year home value change ($100,000)	0.0093***	0.0103**	0.0186	0.0172
	(0.0042)	(0.0052)	(0.0183)	(0.0203)
Covariates at t, t-1 and t-2 (exc. health index)	Yes	Yes	Yes	Yes
Health index at t, t-1 and t-2	No	Yes	No	Yes
LGA and year fixed effects	Yes	Yes	Yes	Yes
Observations	7,387	5,620	7,531	6,174
Pseudo R^2	0.2393	0.2509	0.1893	0.1931
B - Renters				
2-year home value change ($100,000)	-0.0120	0.0120	-0.149***	-0.192***
	(0.0193)	(0.0208)	(0.0563)	(0.0672)
Covariates at t, t-1 and t-2 (exc. health index)	Yes	Yes	Yes	Yes
Health index at t, t-1 and t-2	No	Yes	No	Yes
LGA and year fixed effects	Yes	Yes	Yes	Yes
Observations	736	496	1,455	1,090
Pseudo R^2	0.2817	0.3731	0.2478	0.2651

Notes: * p<0.1, ** p<0.05, *** p<0.01.

Chapter Four
Fertility, Fertility Intentions and Residential Relocation

1. Introduction

The analysis in Chapter Three considered how decisions around fertility are affected by developments in housing markets and in particular, house prices. In this chapter, the relationship between fertility and housing decisions is further explored by examining how residential mobility - one potential channel via which households adjust housing circumstances to family growth - and fertility decisions are connected. Applying a variety of modelling strategies, this chapter investigates how the residential mobility of households is shaped by fertility and fertility intentions of individuals. Understanding the nature of this relationship, namely whether and where households relocate to fulfil their fertility aspirations, will enrich the understanding on how housing and fertility are connected through the mechanism of residential mobility.

While fertility requires the adjustment of housing consumptions which may trigger residential relocation, it is also the case that the difficulty in the realisation of a move may delay or impede childbearing plans. The ability of households to realise fertility intentions via fertility related relocations has significant implications in the Australian context. As described in Chapter Three, the fertility rate in Australia has remained below the replacement level since 1976. This low fertility rate, combined with population aging and a shrinking workforce, may have adverse social and economic consequences over time. Along with the falling fertility rate, we observe persistent and at times rapid rises in the price of housing in many regions over time. In this environment, residential mobility may play an important role in facilitating the adjustment of housing needs over the course of the life-cycle, especially around the time of the birth of a child and the associated increase in family or household size.

Strong associations between fertility intention and residential relocation have policy implications. Difficulty in accessing homeownership or relocating to acquire sufficient housing may delay childbearing or reduce total fertility. This is of significant policy concern in the current Australian context where low fertility and an ageing population have been in the forefront of policy debates over government spending and revenue. Moreover, how residential mobility is shaped by fertility related decisions will also be valuable for local government planning the development and maintenance of economic and social infrastructure.

A number of previous studies have established the connection between changes in housing tenure, size and location and family events such as childbirth (Clark, Deurloo, and Dieleman 1994; Kendig 1984; Mulder and Hooimeijer 1995; Feijten and Mulder 2002; Kulu and Vikat 2008; Morrow-Jones 1988; Weinberg 1979; Dieleman and Everaers 1994). There is evidence that the birth of a child is associated with a number of housing related outcomes, including moves into owner occupancy (Mulder and Wagner 1998, 2001; Murphy and Sullivan 1985); moves into single-family dwellings (Feijten and Mulder 2002; Kulu and Vikat 2008); and relocation to suburban and rural areas (Kulu, Vikat, and Andersson 2007; Kulu and Boyle 2009). For example, there is some evidence that residential relocations are likely to take place during pregnancy, and the likelihood of having a child increases some months after a residential move in the Netherlands (Michielin and Mulder 2008). Further, there is evidence in Austria that households relocate from expensive urban areas to more affordable rural areas to achieve desired housing for childbearing (Kulu 2008). Existing evidence suggests that those in rural areas and small towns move in anticipation of family changes, while those in larger cities tend to move to single-family houses following the birth of children (Kulu and Steele 2013). Previous studies on fertility induced residential relocation have in general focussed on mobility around the occurrence of conception or the birth of a child (Clark and Withers 2009; Kulu and Steele 2013; Michielin and Mulder 2008).

This chapter explores residential relocation as a product of fertility decision-making with the extensive information on fertility history and fertility intention available in the HILDA dataset. As noted in Chapter Three, fertility intention is consistently recorded in each wave in the HILDA dataset and serves as a direct measure of the anticipation of childbirth that is otherwise problematic to define. Using the measure on the subjective planning around reproductive behaviour, in this chapter we examine the impact of fertility intention and expectation on residential relocations. In adopting this approach, the analysis in this chapter provides the first evidence in Australia on the relationship between childbearing intention and residential moves. The study provides additional insight into the mechanism of housing transition triggered by fertility and the potential influence of behavioural intention of households on key life cycle events such as residential mobility.

The panel nature of the HILDA dataset along with the rich set of covariates available provides an opportunity to undertake analysis that can control for both observed and unobserved factors that explain decisions around fertility, housing and geographical mobility. Accounting for unobserved influences (in addition to observed characteristics) is likely to be critical for understanding the relationships of interest. Existing research on the connection between family events and the mobility process has highlighted the interdependence of fertility and mobility events and the potential simultaneity of outcomes (Öst 2012; Courgeau and Lelièvre 1992; Kulu and Steele 2013; Clark and Withers 2009). This endogeneity of fertility decisions with respect to housing consumption creates complexity when disentangling the causal relationship between the two events. Families with different fertility and location preferences may select into different housing types and locations.

Unobserved heterogeneity and the joint determination of housing and fertility decisions are accounted for by using several different modelling approaches in this chapter. First, a correlated random effects model is estimated. This allows individual fixed effects to be controlled for in a parametric fashion. Next, to accommodate the possible correlation between the unobserved time-varying components associated with processes that characterise mobility and fertility models, a simultaneous equation model is applied. Following this, the endogeneity issue is addressed using an instrumental variable strategy by exploiting the introduction of Australian government family policy in the form of the Baby Bonus Scheme. Finally, a discrete-time event history analysis is presented to shed light on the heterogeneity in mobility behaviour across relocation distances.

The research makes several contributions to the literature. First, complementing existing studies on the relationship between fertility and mobility, this study incorporates a direct measure of fertility intention. Lacking a direct measure on fertility expectation, previous studies have in general isolated the period prior to and after the fertility event, or used future behaviour, as a proxy for the anticipatory analysis (Hoem and Kreyenfeld 2006a, 2006b). Rather than relying on the observed births, the analysis presented in this chapter examines fertility-induced relocation using the subjective expectation around childbearing. To the extent that residential adjustment is considered as a product of fertility planning, fertility intention provides a more direct and arguably more pertinent measure of fertility decision making that takes into account the potential lag between the decision to have a child and the actual birth. That is, the analysis highlights the influence of behavioural intentions on household life-cycle behaviours.

Second, the analysis utilises a rich dataset that contain individual or household level information, along with a comprehensive set of controls that capture local economic conditions. Hence, in addition to the standard demographic and socio-economic characteristics associated with the life cycle of households, indirect measures of social capital, local house prices and economic conditions are also included in the empirical specification. Such contextual features are likely to be important factors in understanding mobility and fertility decisions. Considerations such as local employment and housing market conditions are likely to be highly relevant when shaping residential mobility decisions.

This chapter explores residential relocation as a product of fertility decision-making using the extensive information on fertility history and fertility intention available in the Household, Income and Labour Dynamics in Australia (HILDA) survey. The panel nature of the HILDA data along with the rich set of covariates available provides an opportunity to undertake an analysis that allows for observed and unobserved influences to explain the decisions around fertility and housing demand. Fertility intention questions are consistently recorded and finely defined (on a scale of 0 to 10) in each wave, which serves as a direct and detailed measure on the anticipation of childbirth that is otherwise problematic to define.

The study provides additional insight into the mechanism in which subjective intention of households on life-course events triggers behaviours in residential moves across housing market situations and relocation distances. Allowing for the correlation between unmeasured selection on mobility and fertility decisions, the results suggest that fertility intentions have a significant impact on the residential behaviours of Australian couples, with large heterogeneity across housing markets and relocation distances. There is evidence that fertility-induced moves were only observed for households residing in the housing markets with low affordability pressures and often occur intra-regionally across local government areas.

It is important to note that households may also adjust housing consumption by renovations and improvements, especially during periods of high interest rates and in areas of high house prices (RBA 2012). The type of renovations carried out for family expansion is mostly likely to be dwelling extensions. According to ABS (2002), households undertaking dwelling extensions spent an average of $30,000 during the period 1998-1999, or approximately $23,954 per year in 2015 dollars. The HILDA survey asked the amount of household annual expenditure on home repairs/renovations/maintenance in the Self-Completed Questionnaires. Although beyond the scope of the current study, future work on such mechanism would be of value.

The remainder of this chapter is structured as follows. In the next section, a literature review of studies that have examined mobility and fertility decisions is presented. Following this in section three, a discussion of the theoretical model is presented. The data used in the analysis are described in Section four, followed by a discussion of the empirical specification and several estimation strategies in Section five. The results from various empirical methodologies are reported in Section six. The discussion in Section seven concludes the chapter.

2. Literature Review

This section first reviews the research on the effects of family changes on housing transitions, and the joint decision-making around fertility and housing. Following this, key factors identified in the literature as important determinants of residential mobility and fertility decisions are discussed. The main variables identified in the review are included in the empirical specification described in section five.

2.1 Residential Mobility and Fertility

The classic economic theories of utility optimisation predicts that the decision to move reflects a comparison of the level of utility expected from the relocated dwelling relative to the level of utility derived from the current dwelling, subject to monetary and nonmonetary constraints (Bartel 1979; Graves and Linneman 1979; Mincer 1978; Sjaastad 1962; Speare 1974). At various stages of the life cycle, life course events such as exiting from the parental home, union formation and dissolution, and childbearing may trigger dissatisfaction with current housing arrangements. A typology of reasons for residential mobility and the importance of life course progress in explaining household relocations have been comprehensively evaluated in the literature (Clark, Deurloo, and Dieleman 1984; Clark and Onaka 1983; Dieleman 2001; Quigley and Weinberg 1977). Fertility is one of the key life course events that lead to changes in the demand for housing. An actual or desired increase in family size may lead to a mismatch between current and desired housing circumstances that in turn results in the adjustment of housing conditions and the residential environment.

Early studies that examine the association between housing and fertility outcomes generally utilised a cross-sectional framework. A series of studies have described the influence of changes in family composition on changes in housing tenure, size and location, especially over short distances (Clark, Deurloo, and Dieleman 1984, 1994; Deurloo, Clark, and Dieleman 1994; Dieleman and Everaers 1994; Henretta 1987; Kendig 1984; Mulder and Hooimeijer 1995; Murphy and Sullivan 1985; Weinberg 1979). A limitation of the use of cross sectional data to analyse residential transition is that it potentially fails to incorporate the temporal order of the life course events. Further, it is likely that the decision to move is simultaneously determined with the life-course events that are associated with the change in the demand for housing (Clark and Withers 2009; Kulu and Steele 2013; Kulu and Vikat 2008). Hence, in general, the studies using cross-sectional data that fail to control for unobserved heterogeneity and selection find it difficult to identify the causal relationship.

The availability of longitudinal data allows for a life-course approach in which the interdependence of family life-course events can be analysed. Employing event history analysis, some studies have focused on the timing of moves in relationship to childbirth by comparing the residential location prior to and following the birth of a child. Deurloo, Clark, and Dieleman (1994) suggest that moving to an owner-occupied dwelling with larger space is associated with a higher likelihood of becoming a parent. Kulu (2008) provided an analysis of the effect of childbearing on spatial mobility by birth order and across locations, and found that the first pregnancy increases the likelihood of moving to a rural or small-urban destination. High levels of fertility in suburbs and rural areas has also been confirmed by Kulu and Boyle (2009).

Of particular importance in the context of housing debates in Australia, some studies have shown that the cost of home ownership impacts on decisions around fertility (Anderson et al. 2003; Clark and Drever 2000; Courgeau and Lelièvre 1992; Mulder and Wagner 1998, 2001). Such patterns have been identified in an international context. There is evidence from Finland, for example, that households may relocate from expensive urban areas to more affordable suburban or rural areas to accommodate growth in family size (Kulu and Vikat 2008). Similarly, Courgeau and Lelièvre (1992) found evidence in France that the high costs of being a homeowner may increase the cost of rearing children so that in some cases fertility is delayed.

Neglecting unobserved heterogeneity and the joint determination of fertility and residential mobility may yield inconsistent and biased estimates on the relationship between fertility and housing decisions. More recent research has begun to consider the synchrony between mobility and fertility careers within the framework of a simultaneous equation model. Öst (2012) investigated the synchronicity of housing choice and childbirth using pooled cross-section data in 1981, 1989 and 1999 in Sweden. The analysis in that paper pointed to evidence of simultaneity in the decisions of becoming a homeowner and becoming a parent, and this simultaneity is more obvious for young cohorts whose childbearing decisions are more likely to be affected by the cost of housing than those of older cohorts. Moreover, the findings indicate that the cost of being a homeowner is more crucial for the childbearing decision for young cohorts.

Using data for the period between 1926 and 1993 for the Netherlands, Michielin and Mulder (2008) examined the interrelationship between fertility and residential mobility. The analysis from the simultaneous-equations indicated that residential relocations are likely to take place before the birth of a child during pregnancy (the residential mobility equation), and the likelihood of having a child increases some months after a residential move (the fertility equation). The interdependency between fertility and residential mobility is also confirmed by Kulu and Steele (2013) using register longitudinal data among partnered women from Finland during the period 1988-2000. By jointly modelling conception and housing transitions, they found a significant correlation between these two processes. In particular, they argue that facing lower housing costs, couples in rural areas and small towns move before or when planning to have a child, whereas couples in large cities move to single-family houses following the birth of a child.

Previous research on the anticipatory moves related to fertility tends to rely on the measure of observed births. Some studies have acknowledged the challenge in the empirical definition of fertility decision-making and the restrictiveness of their measures on the anticipation of births (Michielin and Mulder 2008; Öst 2012). Residential relocation can be a product of fertility aspiration at the family planning stage before the actual birth. Lacking direct measures on fertility intentions or expectations, previous studies on anticipatory moves have neglected the lag between the time when fertility decisions were made and the time when these decisions were reached.

Using a binary fertility expectation measure from the British Household Panel Survey (BHPS) in five non-consecutive years from 1992 to 2008, Ermisch and Steele (2016) estimated the effect of anticipated changes in family size on residential mobility within a simultaneous-equations framework. They found that expecting to have a child in the future increases the likelihood of moving by 0.036. Vidal, Huinink, and Feldhaus (2017) examined the effect of fertility intention, measured dichotomously, on relocations within town, over short distances and over long distances using the German Family Panel for the period between 2008 and 2013. They found that rates of relocations are positively correlated with fertility intentions and pregnancy, but the association between fertility intention and residential moves is not apparent after controlling for age and parental status. This chapter adopts similar empirical strategies as these two papers.

2.2 Residential Mobility and Demographic, Socioeconomic and Locational Factors

To analyse the relationship between residential mobility and fertility intentions, characteristics related to fertility and relocation related decisions need to be controlled for. This section considers a series of covariates identified in the previous literature to be important in influencing the residential mobility and childbearing processes.

Age and marital status

Considerations around the family life cycle are widely noted in mobility studies as one of the key determinant of residential mobility patterns, with households at different stages in the life cycle exhibiting different mobility rates. Proxies of life cycle stages, such as age and marital status, have been found to be key explicators of residential mobility. For example, there is evidence that age is inversely related to mobility rates and that young adults between the ages of 20 and 35 years are the most mobile group (Clark and Onaka 1983; Quigley and Weinberg

1977; Speare 1974; Yee and Van Arsdol 1977; Clark, Deurloo, and Dieleman 1986; Dieleman 2001). In addition, some studies suggest that mobility rates decline with age at a decreasing rate (Clark and Dieleman 1996; Fredland 1974; Pickles and Davies 1991; Van der Vlist et al. 2002).

Another life course event - marriage - is closely associated with residential mobility (Clark and Huang 2003). The mobility rate of married couples decreases with duration of marriage and mobility rates tend to increase with the number of previous marriages (Speare Jr and Goldscheider 1987). A common explanation for the low mobility of married couples is strong ties and commitments to their residential location (Mulder and Wagner 1993).

Number and age of children

Also related to family life cycle stage is the number and age of children. Couples without children are considerably more mobile than couples with children, and couples with more children are less likely to move (Long 1972; Sandefur and Scott 1981). Changes in household size may also lead to changes in the demand for housing and in turn raise residential mobility (Quigley 1987; Winstanley, Thorns, and Perkins 2002; Clark and Huang 2003). Furthermore, family size is closely related to mobility by virtue of its relationship with housing type. In general, couples are observed to move to owner-occupied and single-family dwellings in the transition to forming a family (Clark, Deurloo, and Dieleman 1994; Feijten and Mulder 2002; Mulder and Wagner 1998; Withers 1998).

Regarding the age of children, households with pre-school children have higher mobility rates, with many moves being made to single-family dwellings or dwellings with more space and better neighbourhood amenities such as schools and outdoor space (Long 1972; Shauman and Xie 1996). Conversely, the probability of moving decreases with the number of school-age children as moving can disrupt the education and social relationships of children (Kulu 2008; Long 1972; Sermons and Koppelman 2001; Stapleton 1980).

Income

Factors indirectly related to the life course are also commonly identified as affecting residential mobility. Existing research identifies proxies for permanent income such as wealth, current income, and education as playing a critical role in migration and housing decisions (Henley 1998). Nonetheless, analysis of the effects of income on mobility rates remains inconclusive (Quigley and Weinberg 1977). Some studies find an inverted U-shape with the highest mobility for middle-income households (Brown and Holmes 1971); others suggest that low-income households move frequently because they are more likely to be in economic and social distress (Crowley 2003; Fitchen 1994; Lee, Oropesa, and Kanan 1994) or because the odds of being income poor is high among private renters (Kemp 2011). In some cases, studies indicate that high-income households are more likely to relocate, especially in transition to homeownership, to improve their housing situation and location quality (Helderman, Mulder, and Ham 2004; South, Crowder, and Trent 1998). Recognising different relocation patterns across housing tenures, some studies suggest that income may be more relevant in explaining residential mobility in the home occupation market than the rental market (Van der Vlist et al. 2002).

Increases in income and wealth are consistently identified as having a positive impact on residential mobility. Gains in income can facilitate the relocation of households to higher quality housing and neighbourhood (Clark, Deurloo, and Dieleman 2006; Clark and Drever 2000; McCarthy 1976; Weinberg, Friedman, and Mayo 1981); and households with increased wealth are generally less credit-constrained (Van der Vlist et al. 2002).

Education

The role of education attainment in residential mobility remains ambiguous. Some studies report a positive association between education and mobility (Ioannides 1987; South and Deane 1993) as highly educated individuals are more likely to have more information about nonlocal job opportunities, and have higher labour market adaptability and fluidity (Bartel 1979). To the extent that higher education is associated with greater residential mobility, this most likely reflects job-related mobility, especially over long distances (Bauernschuster et al. 2014; Fell, Dodds, and King 2004; Long 1988; Sánchez and Andrews 2011; Shumaker and Stokols 1982; Speare Jr and Goldscheider 1987; Van Ommeren, Rietveld, and Nijkamp 1997). However, there are studies suggesting a negative or no association between education and residential mobility (Varady 1983; Speare 1974; Weinberg 1979). These studies show that the impact of education on residential mobility disappears after controlling for income.

Housing tenure

In general, housing careers mirror the life cycle of households. While patterns differ across countries, younger individuals often move from rental accommodation to home ownership over the course of the life cycle. Such a pattern is related to the costs associated different types of accommodations. There is overwhelming evidence that homeowners are less mobile than renters (Clark, Deurloo, and Dieleman 2006; Clark and Huang 2003; Rohe and Stewart 1996; South and Crowder 1997; Speare 1974; Van Ham and Clark 2009). One explanation is that the financial and social cost of relocation for homeowners, such as transaction costs, mortgage repayment[25], and accumulated social capital, are larger. In general, it might be expected that significant changes in the expected benefit or cost are required to induce the residential mobility of home occupiers (Böheim and Taylor 2002). Further, renters are generally younger than homeowners and thus more likely to move. It is also true that homeownership reflects a choice of long-term locational commitment and for this reason homeowners tend to be less mobile (Böheim and Taylor 2002). Henley (1998) argues that the immobility of homeowners, especially mortgage holders, may also be observed among households with negative equity because of the difficulty in finding a satisfactory selling price.

Employment

Employment status and changes in employment status are found to be linked to residential mobility. Evidence from the United Kingdom, the United States, and Sweden indicates that the unemployed have a higher propensity to move relative to the employed; mobility rates of the unemployed fall with unemployment duration; and mobility rates of the employed decline with length on the job (Waddell 1996; Fischer and Malmberg 2001; Böheim and Taylor 2002). The unemployed are not spatially constrained by the work and may be more likely to move in search of jobs. Moreover, local moves are found to be most correlated with employment status

[25] Mortgage holders need to repay their loans and may also have reduced access to more credit.

changes, and intra- and inter-regional moves are most correlated with employer changes (Clark and Davies Withers 1999). Nevertheless, the effect of changes in employment status on residential mobility is likely to depend on housing tenure. There is evidence that homeowners are more likely to find local jobs (Munch, Rosholm, and Svarer 2006), and less likely to move for job changes (Oswald 1996; Henley 1998). In contrast, a job change is associated with a significant increase in the likelihood of residential relocation among renters (Clark and Davies Withers 1999).

Of increasing importance given socio-demographic patterns that have seen increased female labour force activity across countries over time, the effect of dual workers on residential mobility of households is ambiguous. The constraints of spatiality and commuting time of two jobs may lower mobility (Van Ommeren, Rietveld, and Nijkamp 1998). Alternatively, multiple-worker households have higher probability of job changes, thus promoting more chances of relocation (Waddell 1996).

Local social capital and length of residence

The inverse relationship between the length of residence and residential mobility is extensively documented in the literature (Glaeser, Laibson, and Sacerdote 2002; Lee, Oropesa, and Kanan 1994; Quigley and Weinberg 1977; Van der Vlist et al. 2002). The inertia of long-term dwellers in the neighbourhood may be attributed to the commitment and attachment to the locality, developed through a range of factors including economic investment such as homeownership, the length of residence, the length of employment in the local workplace, social involvement with the community, and social ties to friends and relatives living in the neighbourhood. This is a process of local social capital accumulation. The location-specific feature of local social capital implies that residential mobility will cause the depreciation of its value (David, Janiak, and Wasmer 2010).

Previous studies have identified the local social capital with indirect measures, such as local community participation and involvement in schools and churches (Furstenberg Jr and Hughes 1995); the number and type of organisation memberships (Glaeser, Laibson, and Sacerdote 2002); the presence of friends and relatives within an hour’s drive (Myers 2000); and, the frequency of social contacts with friends and neighbours (David, Janiak, and Wasmer 2010).

Furthermore, the perception of social cohesion and support and the satisfaction about neighbourhood can also provide measures on the local social capital (Dassopoulos and Monnat 2011).

Ethnicity

Some studies find that the foreign-born population are more residentially mobile than the native population, (Bonvalet, Carpenter, and White 1995; Clark and Drever 2000; Fitchen 1994), while others show that immigrants tend to be spatially clustered especially in metropolitan areas (Pamuk 2004; Allen and Turner 2005) . There is also evidence that residential mobility among the minority ethnic groups with a high level of education is more likely to resemble that among the native majority over time (Bolt and Van Kempen 2010; Fitchen 1994). Studies also highlight differences in the nature of relocation across racial groups. For example, some studies suggest that black Americans are more likely to move from the suburbs to cities (Alba and Logan 1991; South and Crowder 1997), and are less likely than any other ethnic groups to move to better neighbourhoods (Logan et al. 1996; Sharkey 2008). Dieleman (2001) argues that cultural and socio-economic differences across ethnic groups may explain the variation in their mobility patterns.

Local housing market conditions

Existing research suggests that the majority of fertility-related moves entail a move that is geographically short in nature (Clark, Deurloo, and Dieleman 1986; Clark, Deurloo, and Dieleman 1994; Deurloo, Clark, and Dieleman 1994; Dieleman and Everaers 1994; Henretta 1987; Mulder and Hooimeijer 1995). However, the translation of fertility intention into residential relocation can be constrained by economic and housing market circumstances. For transitions from rental to owner occupation, the cost of homeownership in a housing market featured by high housing prices and more demanding mortgage policies reduces the probability that households transition to owner occupation (Dieleman, Clark, and Deurloo 2000). In turn, the constrained capability to reconcile current housing arrangements with desired housing outcomes may have repercussions on the progress of the family life course, such as family formation and expansion (Clark and Huang 2003). For existing homeowners, the increased liquidity associated with house price inflation may increases the borrowing capability of households, which facilitates residential mobility (Henley 1998; Van der Vlist et al. 2002). Alternatively, housing price inflation may induce existing homeowners to stay at the current location with the expectation that the value of their property will appreciate (Böheim and Taylor 2002).

Local labour markets

An important macroeconomic factor is the labour market condition. The level of regional unemployment is generally negatively correlated with local housing market conditions (Henley 1998; Hughes and McCormick 1987). There is some evidence that households in regions experiencing low wages and high unemployment are more likely to relocate to the regions with high labour demand (Böheim and Taylor 2002; Jackman and Savouri 1992). Nevertheless, the effect of labour market conditions on mobility is likely to be conditional on housing market performance and housing tenure (Head and Lloyd-Ellis 2012; Hughes and McCormick 1994). A well-functioning housing market enables easy liquidation of property, which allows households to efficiently match jobs and home locations. In contrast, sluggish housing market activity and residential property transactions constrain the mobility of homeowners in response to changes in labour market conditions. The relationship between labour markets and residential mobility may also be affected by housing tenure. There is some evidence that homeownership may hamper regional labour market outcomes at the aggregate level because of the immobility of homeowners (Oswald 1996; Green and Hendershott 2001), although evidence based on individual-level data shows that homeowners have higher local employment rates than renters (Munch, Rosholm, and Svarer 2006; Coulson and Fisher 2002).

3. Theoretical Discussion

Beginning with Rossi (1955), a substantial literature has emerged providing a theoretical framework to explain the residential mobility of households. Sociologists and geographers consider residential mobility the primary means to adjust housing consumption to housing needs or desired housing outcomes.[26] In turn, they have formulated a residential satisfaction model in which a move is initiated by the increase in dissatisfaction beyond a person's threshold level (Brown and Holmes 1971; Clark and Onaka 1983; Golant 1971; Kendig 1984; Quigley and Weinberg 1977; Speare 1974; Wolpert 1965). The dissatisfaction can result from changes in household composition such as family growth; changes in household environment such as housing market and institutional conditions; or changes in the standards used to evaluate the level of satisfaction resulting from changes in social status (Speare 1974).

In the geography literature, residential mobility is modelled as a two-stage process in which in the first stage, a person or a household considers moving given the level of satisfaction with their current location relative to that at an alternative location. Conditional on the outcomes in the first stage, the second stage is to search for a vacancy in the housing market, and following this, the person or household makes a move if a suitable dwelling is identified. If no suitable dwelling is found, the household may either adjust their needs or restructure the current dwelling (Dieleman 2001).

Economists view residential mobility in a utility maximisation framework. The decision to move depends on a comparison of the costs and benefits associated with moving in which the present value of the benefits from the alternative locations is compared to the cost of moving (Bartel 1979; Mincer 1978; Sjaastad 1962). The decision is considered in an optimising framework in which households maximise lifetime utility by evaluating the monetary and nonmonetary value of future perceived benefits from moving and the costs of moving, subject to expected income and time constraints. A decision to move is made only if the benefit stream from moving is greater than or equal to the cost associated with moving.

The standard theoretical model of the residential or geographical mobility of households is formulated within a random utility framework (Graves and Linneman 1979; Mincer 1978; Haynes and Martinez 2015; Öst 2012). A household makes the decision to move by comparing the relative satisfaction of the alternative location to that of the current location. From an empirical perspective, the utility associated with the different choices facing the household is not observed directly. Rather, one simply observes a move when it actually occurs.

[26] Sociologists and geographers have also developed theories of residential segregation due to discriminatory barriers to residential mobility (Massey 1985; Massey and Denton 1988).

Let U_{it}^* be the latent net utility associated with the decision to move, and M_{it} be the observed mobility that is assumed to be a binary choice variable determined by the expected net utility. M_{it} takes on the value of 1 if the household is observed to move to a new house and the value of 0 if the household is not observed to move. Mobility takes place if the expected utility associated with moving home is larger than the utility associated with remaining at the current location. A household therefore chooses to move when the latent net utility from moving is positive. The mobility decision is summarised as follows:

$$M_{it} = 1 \quad if\ U_{it}^* > 0 \tag{1}$$

The decision to move is likely to be dependent on a range of considerations including household characteristics, location characteristics, housing market and institutional influences. As discussed above, a range of background characteristics of households and local macroeconomic conditions have been identified as being important correlates in earlier studies of residential mobility. These include proxies for family life cycle such as age, marital status, the number and age of children; proxies for lifetime income such as family wealth, market income, and education level; labour market status and changes in employment; mobility history such as length of current tenure and locational attachment; and local economic, employment, and housing conditions. In general, these factors are incorporated in the empirical specification described in section five.

4. Data

This chapter applies the same dataset as the one used in Chapter Three, namely the Household, Income and Labour Dynamics in Australia (HILDA) survey for the period between 2001 and 2015. The panel nature of the data is explored by focussing on residential mobility history and its relationship with fertility behaviours and intentions. Section 4.1 details the sample construction process. This is followed by a discussion of the consistency between the intention and behaviour measures in section 4.2. In section 4.3, summary statistics are set out.

4.1 Sample Construction

The sample analysed in this chapter consists of females aged 20-44 years in at least one of the 15 waves of the data collected during 2001 and 2015 who have complete information on the covariates used in the empirical specification. This age segment covers women who are in the prime period of fertility and who are asked fertility intention questions in the HILDA survey. The sample is restricted to those who were cohabitating or married, defined as couples in registered marriage or living with someone in a relationship if not married. While limiting the sample size, this restriction allows the focus on the residential moves related to childbearing rather than parental home exit or partnership formation. Existing evidence highlights that married or de facto couples are more likely to be at risk of giving birth to a child and relocating for childbearing reasons, and their pregnancies tend to be planned within the partnership. The sample also excludes those who were involved in a rent-buy scheme or lived in the dwelling with life tenure, such as public housing. Individuals residing in need-based tenures generally exhibit distinct patterns of mobility.[27]

Respondents in HILDA are asked a detailed set of questions about their past history and future intentions regarding both mobility and fertility. Importantly, such questions are consistently asked over the course of the survey. In particular, in each wave, the respondents aged 18-55 years[28] are asked the question :*"(H)ow likely are you to have a child/more children in the future"* without specifying the timing of future conception. As discussed in Chapter Three, women's self-reported likelihood of having children in the future is recorded on a 0 (very unlikely) to 10 (very likely) scale. The response to this fertility intention question is treated as a continuous explanatory variable in the correlated random effects model and the instrumental variable model described in section five.[29] Mobility behaviour is captured using a binary indicator which takes the value of one if the respondent moved to the current address since the last interview and zero otherwise.

---

[27] Living rent free or life tenure refers to cases where individuals have a tenure contract to live in the dwelling but don't have any equity in the dwelling.

[28] In wave 5, 8, and 11, only the respondents aged 18-44 years are asked the fertility intention question. Additionally, in these three waves, whether they themselves or their partners have had a sterilisation operation or have physical or health difficulties in having children. Only individuals who were not sterilised were asked to report their fertility intentions. The results are similar using the sample without these three waves.

[29] Assuming distances between each rating scale items are equal, the correlated random effects model treats fertility intention as a continuous variable for the purpose of empirical analysis. A similar approach is adopted by Drago et al. (2009) and Bassford and Fisher (2016) . Fertility intention is treated as a continuous variable in the instrumental variables model to avoid the issue of forbidden regression (Angrist and Pischke 2008).

Respondents in HILDA who report moving between waves are asked to identify the main reasons for moving. The reasons for moving specified in HILDA cover an array of voluntary and involuntary life events and housing situations that may impel a relocation, including accommodation reasons, education reasons, employment reasons, facility or neighbourhood reasons, partnership related reasons, and forced eviction. In Appendix Table A4.1, a series of reasons for moving asked in the question are listed and grouped by factor analysis.

4.2 Consistency of Intention and Behaviour

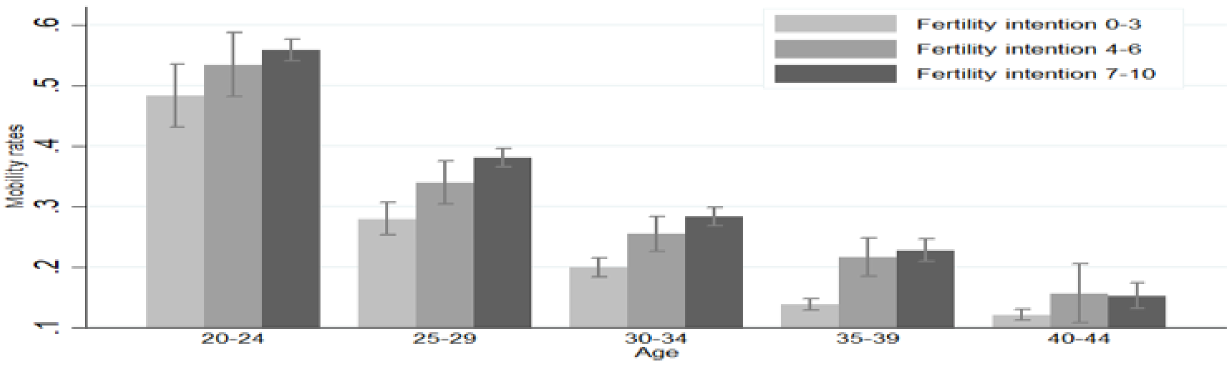
Fertility intention measures display reasonable predictability in the sample, with the planned intention and actual outcome of fertility showing a relatively high degree of consistency. Among women reporting the likelihood of having children in the future of above five on a scale of 0-10 in year t, 80.8 percent gave birth in the following two years and 93.9 percent gave birth in the following five years. Fertility intention is also closely related with the intention to move in the next year. Among women with high propensity to have a child/more children at t (reported a score above 5), 58.0 percent had strong intention to move (reported likely or very likely to move) at t or $(t + 1)$.

There is increasing evidence that measures of intentions reported by individuals are reliable predictors of actual behaviour. Building upon the application of the theory of planned behaviour (Ajzen 1985, 1991; Ajzen and Fishbein 1980; Fishbein and Ajzen 1977), many studies have illustrated the predictability and reliability of fertility intention measures (Ajzen and Klobas 2013; Miller and Pasta 1995; Quesnel-Vallée and Morgan 2003; Rindfuss, Morgan, and Swicegood 1988; Schoen et al. 1999; Tan and Tey 1994; Thomson 1997; Westoff and Ryder 1977; Morgan and Rackin 2010). The discrepancy between fertility intention and actual fertility behaviour can be attributed to the time interval between reported intention and recorded behaviour (Davidson and Jaccard 1979; Dommermuth, Klobas, and Lappegård 2011; Randall and Wolff 1994), and subsequent changes in socio-demographic characteristics and national policies (Beckman 1984; Berrington 2004; Heiland, Prskawetz, and Sanderson 2008; Monnier 1989; Ajzen and Klobas 2013).

4.3 Summary Statistics

The relationship between residential mobility and fertility intention is examined graphically by considering the changes in annual mobility rates across women of varying ages with different reported fertility intentions. Figure 4.1 shows how responding females with different expectations around childbearing exhibit distinct mobility behaviours. In particular, the probability of moving declines over time, and women reporting high fertility intentions have significantly higher mobility rates with lower variation than those reporting low fertility intentions. This suggests that women who indicate an intention to have children in the future are consistently more likely to move. Overall, the average mobility rate (the percent of women who were observed moving at least once over the study time frame) is more than twice as high among those with high fertility intention (7-10) as among those with low fertility intention (0-3), at 0.35 versus 0.16. This descriptive evidence is suggestive of a strong nexus between fertility and mobility related decisions.

Figure 4. 1. Graphical Mobility over Ages by Fertility Intention



Notes: The mobility rate is defined as the number of moves observed divided by the total number of observations over the study timeframe. Source: Authors own calculation using waves 1-15 of HILDA.

Descriptive statistics of the covariates in the analytical sample are presented in Table 4.1. The first four columns summarise the full sample and the next five pairs of columns provide the statistics for the subsamples categorised by relocation distances. As noted, the sample consists of women aged between 20 and 44 who were in a cohabitating or married partnership during the period 2001-2015. The analytical sample includes 6,048 women in 30,428 person-year observations. Women were on average observed for 5.03 years. Women who stayed in the same residence in the previous year reported an average fertility intention of 3.80, while those who moved had an average fertility intention of 6.08. Among respondents during the observation period, 26.0 percent of women were observed moving at least once and 13.6 percent of women observed moving per year.

Among observed moves, the mean of the distance moved since last wave was 164.9 kilometres but the median was only 6 kilometres. Most moves are local in nature, with 52.5 percent of the moves that occurred being within a Local Government Area (LGA); 32.3 percent across Local Government Areas within a Major Statistical Region (MSR); 5.6 percent across Major Statistical Regions within a State or Territory; and 9.6 percent across States or Territories.[30] This pattern is well established in the literature (Clark 2013; Wilkens et al. 2010; ABS 2010; Ermisch and Steele 2016). Many of the patterns in Table 4.1 likely reflect socio-economic circumstances and life-cycle considerations. Non-movers tend to be older, married, satisfied with neighbourhood, and employed. They also tend to be outright homeowners, have a longer tenure in their current residence, live with an employed partner, and have pre-school or school-age children. Women and their partners with higher levels of education are more likely to move over long distances.

[30] Local Government Areas (LGA) cover administrative regions of local governing bodies that represent legally designated parts of a State or Territory in Australia. As in the 2016 Australian Statistical Geography Standard, there are 564 Australian Bureau of Statistics defined Local Government areas. Major Statistical Regions (MSR) divide New South Wales, Victoria, Queensland, South Australia and Western Australia into two geographical regions: the capital city and the remainder of the State. Tasmania, the Northern Territory, and the Australian Capital Territory each consist of only one MSR covering the entire area. State or Territory is the largest unit. Six States and two Territories are New South Wales, Victoria, Queensland, South Australia, Western Australia, Tasmania, the Northern Territory, and the Australian Capital Territory.

Table 4. 1. Summary Statistics by Relocation Distances

	Full sample				No move		Intra-LGA move		Intra-MSR move		Intra-State move		Inter-State move	
Moved	0.26	0.44	0	1	0.00	0.00	0.11	0.32	0.07	0.26	0.01	0.11	0.02	0.14
Mobility intention	2.09	1.42	1	5	1.96	1.34	2.29	1.50	2.43	1.56	2.63	1.58	2.86	1.57
Fertility intention	4.40	4.24	0	10	3.80	4.15	5.52	4.15	6.46	3.90	5.60	4.05	5.73	4.11
Age 20-24	0.12	0.33	0	1	0.07	0.26	0.24	0.43	0.24	0.43	0.24	0.43	0.15	0.36
Age 25-29	0.19	0.40	0	1	0.17	0.37	0.24	0.43	0.29	0.46	0.26	0.44	0.28	0.45
Age 30-34	0.22	0.42	0	1	0.23	0.42	0.22	0.41	0.22	0.42	0.21	0.41	0.27	0.45
Age 35-39	0.25	0.43	0	1	0.28	0.45	0.18	0.39	0.15	0.36	0.19	0.39	0.19	0.39
Age 40-44	0.21	0.41	0	1	0.25	0.43	0.12	0.33	0.09	0.29	0.11	0.31	0.10	0.31
Married	0.67	0.47	0	1	0.74	0.44	0.52	0.50	0.49	0.50	0.53	0.50	0.55	0.50
Family income ($1000)	128.47	87.28	-359.63	3124.22	130.52	87.52	119.88	80.44	124.06	93.76	119.12	82.03	130.47	82.28
Outright owner	0.13	0.33	0	1	0.15	0.36	0.05	0.23	0.05	0.22	0.07	0.25	0.05	0.21
Mortgage owner	0.54	0.50	0	1	0.61	0.49	0.40	0.49	0.38	0.49	0.32	0.47	0.24	0.43
Renter	0.33	0.47	0	1	0.24	0.43	0.54	0.50	0.56	0.50	0.62	0.49	0.71	0.45
Childless	0.32	0.47	0	1	0.26	0.44	0.41	0.49	0.53	0.50	0.43	0.50	0.48	0.50
Children aged 0-4	0.38	0.49	0	1	0.40	0.49	0.38	0.49	0.32	0.47	0.40	0.49	0.38	0.49
Children aged 5-14	0.42	0.49	0	1	0.48	0.50	0.31	0.46	0.21	0.41	0.28	0.45	0.25	0.43
Children aged 15-24	0.11	0.31	0	1	0.13	0.34	0.07	0.26	0.05	0.21	0.06	0.24	0.05	0.23
Total children	1.49	1.35	0	12	1.65	1.33	1.25	1.35	0.94	1.25	1.22	1.34	1.11	1.39
No. bedrooms	3.28	0.94	0	11	3.35	0.91	3.21	0.96	3.05	0.99	3.19	0.95	2.99	1.06
Length of stay	4.30	4.59	0	77.05	5.51	4.68	0.86	1.57	0.83	1.57	0.76	1.22	0.59	0.69
Satisfaction about neighbourhood	7.81	1.74	0	10	7.81	1.73	7.91	1.72	7.74	1.81	7.70	1.84	7.67	1.83
Feeling being part of community	6.71	2.05	0	10	6.83	1.99	6.60	2.11	6.22	2.14	6.26	2.17	6.01	2.24
University degree	0.34	0.48	0	1	0.35	0.48	0.27	0.44	0.39	0.49	0.34	0.48	0.44	0.50
Employment status	0.73	0.45	0	1	0.73	0.44	0.71	0.45	0.74	0.44	0.63	0.48	0.63	0.48
Partner’s university degree	0.28	0.45	0	1	0.28	0.45	0.23	0.42	0.33	0.47	0.27	0.44	0.36	0.48
Partner’s employment status	0.85	0.35	0	1	0.87	0.34	0.82	0.39	0.82	0.39	0.80	0.40	0.79	0.41
Born abroad	0.80	0.40	0	1	0.79	0.41	0.84	0.37	0.80	0.40	0.87	0.34	0.83	0.37
LGA average house price ($1000)	449.98	235.82	21.10	2735.68	445.82	235.47	440.46	226.28	504.72	265.49	388.88	157.82	465.73	214.21
LGA unemployment rate	5.61	2.01	0.30	16.10	5.65	1.99	5.57	2.06	5.35	2.12	5.64	2.12	5.34	2.08
Observations	30428				22516		3291		2022		351		604	

Notes: The analytical sample consists of females aged 20-44 years in at least one of the 15 waves of the collected data who were cohabitating or married. All the monetary values are adjusted to 2015 dollars. The State or Territory is the largest unit, followed by Major Statistical Regions (MSR) and Local Government Areas (LGA). Source: Author’s own calculation using waves 1-15 of HILDA.

5. Empirical Methodology

The examination on the relationship between fertility and housing requires the use of modelling techniques that can account for unobserved heterogeneity and the selection around fertility and mobility decisions. A series of estimation strategies are adopted in this chapter to address the challenges associated with modelling the relationship between these two decisions. The first approach is a correlated random effect probit model that estimates the impact of fertility intention on mobility decisions captured as a simple dichotomous variable. A limitation of this approach is that it fails to take account of the potential correlation of time-varying components between fertility and mobility decisions. An alternative approach uses a simultaneous equation structure that models the decision to move and the intention to have children jointly. It allows the simultaneity between the decision making of childbearing and relocation arising from time-invariant tastes or time-varying shocks to be explicitly modelled. Further, to address the endogeneity of fertility intention with respect to housing decisions, an instrumental variable approach is considered. Finally, a multinomial logit model is presented to examine another residential mobility related question, that is, how the impact of fertility intentions differs across distances of relocation.

Correlated Random Effects Model

Initially, residential mobility is studied using a correlated random effects model in which mobility is captured using a dichotomous variable. The rich information on household characteristics, housing and neighbourhood features, and local economic conditions allows for the statistical models to incorporate a variety of measures that capture the heterogeneity in the residential mobility patterns over the life-cycle and across housing market cycles. As discussed in section three, whether a move is observed depends on the latent utility associated with the move so that a move takes place if the latent net mobility utility is larger than zero. The mobility decision is modelled as follows:

$$U_{it}^{*} = \gamma F_{it} + \beta' X_{it} + a_i + e_{it} \qquad (2)$$

where F_{it} is the self-reported fertility intention measured on a scale from 0 to 10 and treated as continuous; the vector X_{it} contains the time-varying and time-invariant observed variables that explain the heterogeneity in residential mobility; a_i is respondent-specific effects; and e_{it} captures the unobserved time-varying mobility shocks that are assumed to have a standard normal distribution in the random effects probit model. The parameter γ is the coefficient of main interest that measures the impact of fertility intention on mobility behaviour.

The conventional random effects model treats individual heterogeneity a_i as a random variable that is independent and identically distributed. Instead, the correlated random effects model, proposed by Mundlak (1978) and extended by Chamberlain (1982), allows for the correlations between individual-specific effects and observed variables in a restrictive and parametric fashion. Several studies on residential mobility have followed such an empirical approach (Rabe and Taylor 2010; Ermisch and Steele 2016; Isebaert 2013; Baker et al. 2016).

The correlated random effects model accounts for the dependence between observed covariates and unobserved influences by specifying a distribution for unobserved individual effects. The distribution of individual heterogeneity is assumed to be a linear function of the individual means of all the time varying covariates in Equation (2), that is, $E[a_i|F_{it}, X_{it}]$ is linear in $\bar{F}_i$ and $\bar{X}_i$. The correlated random effects model of mobility takes the following form:

$$U_{it}{}^{*} = \gamma F_{it} + \beta' X_{it} + \bar{F}_i + \bar{X}_i + e_{it} \quad (3)$$

A range of demographic and socioeconomic characteristics of the household that are generally associated with mobility are included in the vector X_{it}. These covariates are intended to capture a range of influences that impact on mobility decisions, including the respondent's age; marital status (married or de facto); family income; housing tenure (outright homeowner, mortgaged homeowner, or private renter); indirect measures of local social capital (satisfaction about neighbourhood and feeling of being part of community reported on a scale from 0 (totally dissatisfied) to 10 (totally satisfied)); presence of school aged children (binary variable coded as 1 if children aged 5-14 present); number of bedrooms; length of residence; immigration status (binary variable coded as 1 if Australian-born); employment status of the woman and her partner (binary variables coded as 1 if employed); and, education level of the partner (binary variable coded as 1 if obtained a bachelor degree or above).[31] To control for macroeconomic conditions, a variety of aggregate measures are included in the specification including local unemployment rates; local house prices; and, year fixed effects. In each case, the included variables capture measures that have been identified previously as being important for understanding mobility decisions.

All economic and social characteristics are measured in year $(t-1)$ for the moving behaviour between year $(t-1)$ and year t. The measures at $(t-1)$ capture the economic conditions prior to the move and avoid the effect of relocation on family financial resources or other family characteristics. This specification has been adopted in a number of previous studies including Ermisch and Jenkins (1999), Böheim and Taylor (2002), Helderman, Mulder, and Ham (2004), Kan (2007), and Ermisch and Steele (2016).

Instrumental Variable Model

From an empirical perspective, a key challenge in estimating housing and fertility decisions is that the intention to have children may be endogenous with respect to housing decisions. In particular, households with higher preference for family-oriented life or (more) children tend to have tastes for residential stability or select into certain residential locations. Such unobserved time-invariant preferences or time-varying influences may be associated with both residential mobility and fertility related behaviours. While Model (3) accounts for the unobserved individual heterogeneity in a parametric fashion, there may be time-varying shocks to mobility that are correlated with fertility intentions.

To control for the selection and explore the causal relationship between fertility intentions and mobility decisions, an instrumental variable strategy is used. The instruments or IVs selected are required to be relevant and valid. That is, a good instrument should have significant correlation with the endogenous variable but no direct correlation with any other determinants of the dependent variable. This implies that the instruments excluded from the mobility

[31] The correlated random effects model doesn't include the education attainment of the woman because of the insignificance of the variable. The variable is instead included as one of the excluded covariates in the fertility equation in the simultaneous-equation model and the instrumental variable model.

equation should be highly correlated with fertility intention and insignificantly impacting on residential mobility. The relevance assumption can be examined in the first stage by testing if the instrument is significantly different from zero in the fertility model. Following Ermisch and Steele (2016), the validity assumption is indirectly tested by adding the instrument into the mobility equation and checking its significance. In the case of multiple instruments, over-identification can be tested using Sargan-Hansen test under the null hypothesis that all instruments are uncorrelated with the error term from the Two-Stage Least Squares regression (2SLS). A rejection of the null hypothesis casts doubt on the validity of the instruments.

For the analysis in this chapter, the potential instrumental variables considered are the educational attainment of females, the Baby Bonus policy, and the interactions between the policy and employment status, and the interactions between the policy and employer sectors. The instrumental variables strategy utilises the variation in fertility intention that is associated with the exogenous variation in the instruments. The relevance and validity of the instrument candidates are discussed and tested below.

The first instrumental variable considered is women's education attainment, defined as a binary variable that takes on the value of 1 if the woman achieved at least a bachelor degree and zero otherwise. As discussed previously, the effect of education on mobility is ambiguous. Some studies find that higher education may be associated with a positive effect that follows from higher levels of education enhancing job opportunities and providing access to better job information (Bartel 1979; South and Deane 1993). Other studies show that stronger attachment to a job, larger contribution to family earnings, and lower chance of layoffs can deter the mobility of women with higher levels of education (Bartel and Borjas 1977; Mincer 1978).

However, there are also studies suggesting that women's education may be irrelevant in mobility when other variables that are highly correlated with education are included (Quigley and Weinberg 1977), or when husbands' contribution to family income is larger (Lichter 1982). In their study on the relationship between fertility intention and residential mobility, Ermisch and Steele (2016) found that women's educational qualification has no significant effect on residential mobility in the mobility model and is added in the fertility intention model as one of the excluded covariates.

The second IV is provided by the introduction of the Baby Bonus policy in Australia. Announced on 12^{nd} May 2004 in the Federal Budget, the Baby Bonus scheme was designed in part to encourage women to have more children (Budget 2004-05). The scheme went into effect on 1^{st} July 2004 with a cash payment universally available to all women following the birth of a new child or a new adoption. The scheme granted a lump sum non-taxable payment of $3,000 for each new child born, which was progressively increased to $4,000 and $5,000 as of 1^{st} July 2006 and 1^{st} July 2008 respectively. Initially, the payment was not means tested or adjusted based on the number of previous children born. From 1^{st} July 2008, the payment for additional children after the firstborn child was reduced to $3,000. As of 1^{st} January 2009, a $75,000 family income limit was applied, and the payment of the bonus was switched from being paid as a lump sum to being paid in 13 fortnightly instalments. The government announced the proposed abolition of the payment on 14^{th} May 2013 and officially abolished the policy as of 1^{st} March 2014.

The positive impact of the Baby Bonus payment on the intention to have children, family size, and the timing of births has been demonstrated in a number of studies (Drago et al. 2011; Guest and Parr 2010; Lain et al. 2009; Langridge et al. 2010; Risse 2010). The universal cash payment creates exogenous variation in fertility intention and is arguably independent of mobility decisions of women. The Baby Bonus policy indicator is captured by a series of year dummies that assigned the value of one for the period between 12^{nd} May 2004 and 14^{th} May 2013.

To exploit the differential responses of women across employment status and employer types to the Baby Bonus scheme, two interaction terms are constructed as additional IVs. The flat rate payment should generate a larger income shock to women with lower income and lower opportunity costs of childbearing. This implies that the scheme can potentially have different degrees of impacts on the fertility intentions of women working part-time, full-time, and those who are unemployed or not in the labour force. Arguably, the strongest response to the government-funded scheme is likely to occur among women who are unemployed or not in the labour force. Following this, the interaction between the scheme dummy and the labour market status is considered to be one of the IV candidates.

In a similar vein, the differential responses of women working in the private sector, public sector, and those unemployed or not in the labour force to the scheme can also serve as a potential instrumental variable. Bassford and Fisher (2016) used the differential impacts of Australia's Paid Parental Leave for women in the public and private sectors as the instrument in the study of the effect of access to paid parental leave on fertility intentions among employed women. The rationale behind the interaction term reflects the likelihood that the majority of public sector employees have already had access to employer-funded child benefits such as maternity leave so that women employed in the public sector tend to be less responsive to the scheme relative to those in the private sector.[32] It follows that the interaction between the scheme dummy and job sectors is another instrument to be considered.

Table 4.2 presents the relevance and validity tests for the instruments. Both mobility and fertility equations are estimated by a fixed effects model with clustered errors at the individual level. In the tests for the relevance of the IVs, high F-statistics are preferred to produce asymptotically consistent 2SLS estimators that reduce asymptotic biases and the magnitude of standard errors (Angrist and Pischke 2008). Following the commonly-viewed threshold of F statistics above 10 as the safe zone in the relevance test, the F-statistic in the first-stage regression (column 1) indicates that most of the instruments are significant and highly relevant in explaining fertility intentions, although the Baby Bonus scheme and the interaction between the scheme and employer sectors may be considered as weak instruments. [33]

[32] A detailed discussion is available in Bassford and Fisher (2016).

[33] Alternatively, the Baby Bonus policy is defined based on the variation in the eligibility over years. The specification is constructed as follows:

1) The variable is assigned the value of $3,000 for the period between May 2004 and May 2008;
2) The variable is assigned the value of $3,000 for the period between May 2009 and May 2013 if family income during the past year is below $150,000 and $0 if family income is equal to or above $150,000;
3) The variable is assigned the valued of $3,000 for the period between May 2013 and May 2014 if it is for the first children and family income is below $150,000, $1,800 if it is for the second and subsequent children and family income is below $150,000, and $0 if family income is equal to or above $150,000;
4) The variable is assigned the value of $0 for the period before May 2004 and after May 2014.

This specification makes no significant difference to the results. The variable remains statistically insignificant in the first stage.

Table 4. 2. Relevance and Validity Checks on Instruments

	Relevance H_0: weak IVs	**Validity** H_0: valid IVs	
	First-stage	Structural eq	Over-identification
	F-stat	F-stat	Chi-sq
Instruments	(p-value)	(p-value)	(p-value)
IV1: Women's education attainment	25.60* (0.00)	1.54^ (0.21)	
IV2: Baby Bonus scheme	1.83 (0.17)	2.60^ (0.11)	
IV3: Baby Bonus scheme*Employer sectors	2.26 (0.10)	4.81 (0.01)	
IV4: Baby Bonus scheme*Employment status	13.72* (0.00)	4.68 (0.01)	
IV1, IV2	13.66* (0.00)	2.10^ (0.12)	2.98^ (0.08)
IV1, IV2, IV3	5.39 (0.00)	3.27 (0.02)	7.09 (0.03)
IV1, IV2, IV4	12.89* (0.00)	3.19 (0.02)	12.48 (0.00)
IV1, IV2, IV3, IV4	9.70* (0.00)	2.52 (0.04)	12.55 (0.01)

Notes: * indicates rejecting H_0 with F-stat above 10 and p-value less than 0.05 in the relevance test, suggesting IV is relevant. ^ indicates failing to reject H_0 with p-value bigger than 0.05 in the validity test, suggesting IVs are valid.

The instruments are valid if any correlation between the mobility and the instrument is through the effect of the instrument on fertility intentions, and hence the instruments should not have any predictive power in the structural equation, that is the mobility equation. The validity of the instruments is indirectly tested by adding them to the mobility equation. The empirical results (column 2) indicate that the interaction terms between the scheme and employment status and between the scheme and employer sectors may not be valid instruments as they are significant in the mobility equation. In the test of over-identification of multiple instruments (column 3), the test statistic for women's education and the policy indicator are not statistically significant, a result supporting the validity of these two IVs. In comparison, the interaction terms produce highly significant test statistics in the over-identification tests, which suggests that the interaction terms may not be strong instruments.

Overall, given the relevance and validity test results, women's education level and the Baby Bonus scheme are chosen as the excluded instruments in the instrumental variable model and the simultaneous equation model. The relevance test for the selected IVs shows a high F statistic of 13.66; and the indirect validity test and over-identification test have the statistics of 2.01 and 2.98 respectively. The test statistics indicate that women's education level and the Baby Bonus scheme are reasonably relevant and valid instruments. Nonetheless, it is important to stress that the empirical results should be interpreted in light of the challenge of finding a valid and robust instrumental variable.

Simultaneous Equation Model

An alternative approach adopts a simultaneous-equations approach and uses maximum-likelihood estimation. It is likely that the decision to move and to have children are made jointly. To investigate the simultaneity of fertility and mobility decisions, the mobility equation is modelled jointly with the fertility equation in a simultaneous-equation structure.[34] Such modelling approach has been adopted in several previous studies on family and childbearing studies (Öst 2012; Ermisch and Steele 2016; Kulu and Steele 2013; Vignoli, Rinesi, and Mussino 2013; Steele et al. 2005). The joint modelling of fertility and mobility processes allows for the correlation of time-invariant and time-varying unobservables across fertility and mobility decisions. The formulation of the simultaneous decisions is given by:

$$U_{it}{}^{*} = \gamma F_{it} + \beta' X_{it} + \bar{F}_i + \bar{X}_i + e_{it} \tag{3}$$

$$F_{it}{}^{*} = \delta' Z_{it} + \bar{Z}_i + \varepsilon_{it} \tag{4}$$

where $F_{it}{}^{*}$ is the latent utility associated with each observed fertility intention reported by woman *i* in year *t* that F_{it} takes on the value of k (k = 0, 1, ..., 10) if the $k-1^{th}$ cut-off point < $F_{it}{}^{*}$< the k^{th} cut-off point; Z_{it} include demographic, socioeconomic, and local macroeconomic factors that associated with residential mobility and fertility intentions, along with the IVs identified in the last section; $\bar{Z}_i$ are individual means of time-varying variables in

[34] The simultaneous equations is modelled using Stata module CMP (Roodman 2018).

the fertility equation; and e_{it} and ε_{it} are the time-varying residuals to relocation and fertility events that are assumed to follow a bivariate normal distribution with nonzero cross-equation correlation coefficient ρ, i.e. $[e_{it}, \varepsilon_{it}] \sim N[0,0,1,1,\rho]$. The term ρ measures the degree of simultaneity between two decisions associated with unobserved time-varying components. The positive (negative) correlation of time-varying residuals indicates that the shocks that increase the childbearing intention of a woman will increase (decrease) her residential mobility. The mobility Equation (3) is estimated as a probit model and fertility Equation (4) is estimated as an ordered probit model.[35] Both equations include the individual means of the time-varying observed variables to control for the selection of households associated with individual heterogeneity.

Multiple Choices of Residential Mobility

One limitation of the analysis described above is that all moves are treated in a similar manner. The mechanism in which childbearing intentions shape residential mobility patterns may be nuanced for relocations over different distances. Using a competing risk model, some research has highlighted the difference in migration patterns across types of relocations (Kulu 2008; Vidal, Huinink, and Feldhaus 2017; South and Crowder 1998; Mulder and Wagner 1993; Withers 1998; Kulu and Steele 2013). The discrete-time competing risks model used in these studies are essentially a multinomial model in which the individual's residential mobility status is recorded for each period (Steele, Diamond, and Wang 1996).

To take account of the heterogeneity in observed moves over different distances, four types of residential relocations are considered. Each move is recorded a within-LGA move, a within-MSR move, an intrastate move, or an interstate move. To account for unobserved heterogeneity across individuals, the model allows for shared time-invariant individual random effects across types of relocation. The competing risk discrete-time event history model of residential moves is considered as follows:

[35] An ordered probit model is applied to Equation (4) considering the issues around non-recursive models and convergence. Risse (2010) applies an ordered probit model to the estimation of the effect of the Baby Bonus policy on Australian women' fertility intention.

$$log(\frac{H_{it}^{R}}{H_{it}^{0}}) = \alpha(t)^R + \gamma^R F_{it}^R + \beta^R X_{it}^R + \nu_i,\ R = 1, 2, 3, 4 \quad (5)$$

where H_{it}^{R} is the probability of housing transition of type R made by woman i at residential episode j given no earlier occurrence of such move within the episode; $\alpha(t)^R$ is the baseline profile of hazard over time that captures the time-dependency of an individual's mobility rates; F_{it}^R is a measure of fertility intention; the vector X_{it}^R includes the number of moves occurred since the data began[36], pregnancy status (binary variable coded as 1 if pregnant), education attainment of women (binary variable coded as 1 if obtained bachelor degree or above), and observed time-varying and time-invariant covariates that explain the heterogeneity in the mobility behaviours specified in Equations (3); and ν_i is individual-specific random effects that allow for shared unobserved individual heterogeneity across types of relocation (Hill, Axinn, and Thornton 1993). The baseline hazard function $\alpha(t)^R$ captures the duration of residence since the start of an episode that is specified as dummy variables for residence duration of one year, two years, three years, four years, five years, and at least six years.[37]

6. Results

6.1 Model Comparison

Table 4.3 presents the results from estimating various specifications of binary mobility decisions consistent with the assumptions made about $cov[F_{it}\ a_i]$ and $cov[F_{it}\ e_{it}]$ described in section five. The most restrictive model that assumes no correlation between time-invariant and time-varying components across equations is the random effects probit model, presented in Model 1. Model 2 is a correlated random effects probit model that allows for the correlation between time-invariant components across equations by including the individual means of the time-varying explanatory variables. Model 3 and Model 4 consider simultaneous-equations models in which the equations for mobility and fertility are estimated jointly in the form of

[36] The left censoring creates bias on the total number of moves that have ever occurred since the housing periods can start before the survey date. The model does include the duration of stay to capture the mobility history of households.
[37] Staying for at least six years is grouped into one category. The specification of one dummy variable for each residence duration leads to highly singular variance matrix of the coefficients.

correlated random effects models. Model 3 maintains the same assumption as Model 2. Model 4 allows for the unobserved time-invariant and time-varying components associated with relocation and fertility to be correlated.

Table 4. 3. Model Comparison

Model	1	2	3	4	5
	Probit RE	**Probit CRE**	**Joint CRE**	**Joint CRE**	**IV(IV1,2)**
Assumptions	$cov[F_{it}\, a_i]=0$ $cov[F_{it}\, e_{it}]=0$	$cov[F_{it}\, a_i]\neq 0$ $cov[F_{it}\, e_{it}]=0$	$cov[F_{it}\, a_i]\neq 0$ $cov[F_{it}\, e_{it}]=0$	$cov[F_{it}\, a_i]\neq 0$ $cov[F_{it}\, e_{it}]\neq 0$	$cov[F_{it}\, a_i]\neq 0$ $cov[F_{it}\, e_{it}]\neq 0$
Fertility Intention γ (se)	0.0019** (0.0009)	0.0030*** (0.0012)	0.0030*** (0.0011)	0.0043* (0.0012)	0.0018 (0.0141)
Log-likelihood	-8826.66	-7696.16	-32320.73	-32297.77	-60984.78
Chi-sq Model 1 vs 2 (df; p-value)	2261.36 (17; 0.00)				
Chi-sq Model 3 vs 4 (df; p-value)			24.23 (1; 0.00)		
$cov(e_{it}\, \varepsilon_{it})$ (se)				-0.0228 (0.0149)	

Notes: Notes: Model 1 is a standard random effects model of mobility. Model 2 is a correlated random effects model of mobility that includes additionally the individual means of time-varying variables in the mobility equation. Model 3 is a simultaneous-equations model of mobility and fertility in the form of correlated random effects model that restricts the cross-equation correction of time varying errors to be zero. Compared to Model 3, Model 4 allows the unobserved time-varying components in mobility and fertility processes to be correlated. A likelihood ratio test comparing Model 1 and 2 rejects Model 1, and a likelihood ratio test comparing Model 3 and 4 rejects Model 3. Model 5 is IV estimation with Baby Bonus scheme and women's education as instruments. * p<0.1, ** p<0.05, *** p<0.01.

Comparing Model 2 with Model 1, the likelihood ratio test rejects Model 1 at the one percent significance level, suggesting that the inclusion of individual means of the time-varying mobility covariates significantly improves the model fit. The model comparison test also indicates the presence of correlation between unobserved time-invariant influences and observed predictors in Model 1. Note that the magnitude of the fertility intention estimates increases from Model 1 to Model 2, suggesting that women who have a higher preference for fertility on average display a lower propensity to move.[38] This implies that omission of the individual heterogeneity would lead to a downward bias in the estimated impact on fertility intention.

[38] Ermisch and Steele (2016) found a negative correlation between unmeasured woman-level influences on mobility and fertility expectation in Britain during late 1990s and early 2000s.

Model 3 presents a simultaneous-equations extension of the correlated random effects probit model (Model 2). As expected, the estimates on the fertility intention γ in Model 2 and 3 are of the similar magnitude. Relative to Model 3, Model 4 allows for the correlation of time-varying error terms across fertility and mobility equations. A likelihood ratio test that compares Model 3 with Model 4 rejects the former, which suggests that the least restricted simultaneous-equations model has better model fit. The estimate of $cov\,[e_{it}\ \varepsilon_{it}]$ is negative but insignificant.[39] The negative albeit insignificant correlation of the residuals in fertility and mobility equations indicates that the shocks that increase the childbearing intentions of a woman decrease her residential mobility. The negative estimate of $cov\,[e_{it}\ \varepsilon_{it}]$ leads to a larger estimate of γ in Model 4. Allowing for the negative correlation between the disturbances of two equations leads to an increase in the estimated effect of fertility intention on mobility.

Model 5 presents the instrumental variable model that takes an alternative approach to addressing the endogeneity issue. The two-stage least squares procedure is performed by replacing the endogenous variable fertility intention in the structural equation by the fitted values obtained from the first-stage regression. The consistency of the estimates in the instrumental variable model depends on theoretically sound and statistically reliable instrumental variables. As discussed, given the test results in the relevance and validity checks in Table 4.2, women's education and the Baby Bonus scheme are selected as instruments. The estimated coefficient of main interest is not statistically significant in the IV estimation.

All the models consistently report a positive relationship between fertility intention and residential move. The results on the estimated average marginal effect of fertility intention indicate that an intention to have additional children in the future is associated with an increase in the moving probability of 0.0019 percentage points in Model 1, 0.0030 in Model 2 and 3, 0.0043 in Model 4, and 0.0018 in Model 5. Since there is evidence of correlation between unobserved influences in mobility and fertility decisions, Model 2 and 4 are selected for further interpretation.

[39] Ermisch and Steele (2016) estimated the relationship between fertility expectation and residential mobility in Britain using yes/no fertility expectation questions and found a negative but insignificant correlation of cross-equation residuals.

6.2 Correlated Random Effects Model for Residential Mobility

The parameter estimates of Model 2 are reported in Table 4.4. The correlated random effects model yields an average marginal effect of fertility intention of 0.0030, significant at the one percent level. The positive and significant estimate on the impact of fertility intention on residential mobility indicates that a one unit increase in the expectation to have an additional child in the future on a scale of 0-10 increases the probability of moving by 0.0030 percentage points. Relative to the annual mobility rate of 0.14, a one unit higher fertility intention reported is associated with a 0.022 percent increase in the likelihood of moving house. Assuming the equal distance between adjacent ratings in the fertility intention question, the changes from very unlikely to very likely to have an additional child increase the probability of moving by 0.030 percentage points, which is similar to the result reported in a British study by Ermisch and Steele (2016) using a dichotomous measure on fertility expectations.

The results suggest that demographic characteristics and housing conditions are important factors in relocation decisions. Consistent with a priori expectations, people in the early 20s are the most mobile and mobility rates decline gradually with age. Private renters are more mobile than homeowners, a pattern that likely reflects the costs of moving across different tenures. Although having children at any ages below 24 years is negatively correlated with residential mobility, only the coefficient on the presence of children aged 5-14, who are likely to be at school, is highly statistically significant. The accumulation of local social capital, measured by length of residence, satisfaction about the neighbourhood, and involvement in the community, is associated with a decline in residential mobility. Couples living in an expensive local housing market are less likely to exhibit mobility although the estimated coefficient is very small. There is no significant difference in mobility probability between married and de-facto couples, nor between those with and without a university degree.

Table 4. 4. Correlated Random Effect Probit Model for Residential Mobility (Model 2)

Variable	Average Marginal Effect	S.D.
Fertility Intention	0.0030**	0.0012
Pregnant	0.0057	0.0087
Age 20-24	0.1559***	0.0245
Age 25-29	0.0938***	0.0188
Age 30-34	0.0756***	0.0137
Age 35-39	0.0401***	0.0097
Married	-0.0020	0.0104
Family income ($1,000)	0.0001***	0.0000
Mortgage owner	-0.2026***	0.0102
Renter	0.0456***	0.0110
Satisfied with neighbourhood	-0.0177***	0.0019
Feeling part of community	-0.0037**	0.0018
Children aged 0-4	-0.0006	0.0064
Children aged 5-14	-0.0397***	0.0080
Children aged 15-24	-0.0094	0.0119
No. bedrooms	-0.0411***	0.0042
Length of residence	0.0357***	0.0013
LGA house price ($1,000)	-0.0000*	0.0000
LGA unemployment	-0.0007	0.0020
Employed	-0.0086	0.0080
Partner employed	-0.0065	0.0118
University degree	-0.0423	0.0267
Partner university degree	0.0247	0.0265
Australian-born	0.0114*	0.0065

Notes: All economic and social characteristics are measured in year *t-1* for the moving behaviour between year *t-1* and year t. The reference groups for age groups, partnership status, and housing tenure are 40-44 age group, de facto relationship and outright homeowners respectively. * p<0.1, ** p<0.05, *** p<0.01.

Additional results on the relationship between residential mobility and fertility intentions are presented in Table 4.5 where heterogeneity across housing tenures and parental status is reported. The results indicate that fertility intention induced moves are more prevalent among private renters than homeowners, with mortgage homeowners being the least responsive group. Relative to the mean mobility rate of each housing tenure group in the sample, a one point increase in fertility intention rating increases the probability of moving by 2.01 percent (0.0024/0.12) for outright homeowners, 1.15 percent (0.0020/0.17) for homeowners with a mortgage, and 1.05 percent (0.0048/0.46) for private renters.

Furthermore, couples with no children display a higher average marginal effect of fertility intentions. A one point increase in the expectation to have children is associated with an increase in the relocation likelihood by 0.89 percent (0.0036/0.41) for those without children, and 1.36 percent (0.0026/0.19) for those who already have children. Note that although childless couples on average are more likely to move than family couples, the mobility rate is almost twice as high for childless couples with fertility intention rated above 5 (0.44) as for those with fertility intention rated below 5 (0.26).

Table 4. 5. Estimates of the Effect of Fertility Intention on Residential Mobility by Housing Tenure and Parental Status

	Average Marginal Effects	S.D.
Housing Tenure		
Outright homeowner	0.0024***	0.0009
Mortgage homeowner	0.0020***	0.0007
Private renter	0.0048***	0.0017
Parental status		
Childless couple	0.0036***	0.0013
Family couple	0.0026***	0.0009

Notes: *** p<0.01.

6.3 Simultaneous Equation Model for Residential Mobility and Fertility Intention

The correlated random effects model does not account for the possibility that shared influences of mobility and fertility can be time varying. Simultaneous-equations models explicitly consider the simultaneity between housing and fertility decisions that are associated with time-varying shocks. A likelihood ratio test that compares a simultaneous-equations model of residential mobility and fertility intention that assumes $cov[e_{it}\ \varepsilon_{it}] = 0$ (Model 3) and one that allows $cov\ [e_{it}\ \varepsilon_{it}] \neq 0$ (Model 4) rejects Model 3, suggesting that the least restricted simultaneous-equations model has better model fit (column 3, Table 4.3).

Some studies suggest that the simultaneous effects of becoming parents and becoming homeowners is greater when housing market and economic conditions pose challenges to homeownership entry among young adults (Öst 2012). One of the significant features of Australian housing market is the substantial and sustained housing price growth in Sydney and Melbourne relative to other markets over the analytical period. Almost two-thirds of Australia's population reside in the capital cities (ABS 2015-16b); and of the capital cities, Melbourne and Sydney have exhibited the largest population growth in Australia over the past decade (ABS 2016b). Since the 1990s, the increase in national property prices has been mainly driven by Sydney and Melbourne -- the two largest and most expensive housing markets (ABS 2016f; CoreLogic 2015, 2017a). Consequently, housing affordability has deteriorated most significantly in Sydney and Melbourne relative to the remaining MSRs (CoreLogic 2017b; AIHW 2017). [40]

Table 4.6 reports the main results from estimating the simultaneous equation models of residential mobility and fertility intention for Australia as a whole, for the two largest housing markets – Sydney and Melbourne, and for the remaining regions. The cross-equations correlation of time-varying residuals is positive in Sydney and Melbourne and negative in other housing markets. The significant cross-equations correlations suggest that the decision to move and the intention to have children are mutually dependent and simultaneously determined. The positive correlation in Sydney and Melbourne implies that common shocks which increase the probability of moving for households are associated with an increase in their fertility intentions. In contrast, for remaining MSRs, the shocks that increase the residential mobility of households tend to decrease their childbearing intentions.

[40] Housing affordability is measured as price to income ratio, years of household income required for the deposit, and percentage of households income required to service a mortgage.

Table 4. 6. Simultaneous Equation Model for Residential Mobility and Fertility Intention (Model 4)

	Australia	Sydney, Melbourne	Remaining MSRs
Residential Mobility Equation Average marginal effect (SE)			
Fertility Intention	0.0043***	-0.0000	0.0048***
	(0.0012)	(0.0019)	(0.0015)
Pregnant	0.0055	0.0014	0.0085
	(0.0087)	(0.0136)	(0.0112)
Age2024	0.1515***	0.1509***	0.1116***
	(0.0244)	(0.0407)	(0.0308)
Age2529	0.0889***	0.1082***	0.0541**
	(0.0190)	(0.0313)	(0.0244)
Age3034	0.0720***	0.0726***	0.0593***
	(0.0137)	(0.0228)	(0.0174)
Age3539	0.0386***	0.0535***	0.0222*
	(0.0100)	(0.0161)	(0.0120)
Married	-0.0016	0.0169	-0.0037
	(0.0104)	(0.0174)	(0.0132)
Family income ($1,000)	0.0001***	0.0001**	0.0001**
	(0.0000)	(0.0001)	(0.0001)
Mortgage owner	-0.2027***	-0.0986***	-0.0822***
	(0.0102)	(0.0209)	(0.0158)
Renter	0.0460***	0.1734***	0.1734***
	(0.0110)	(0.0235)	(0.0175)
Satisfied with neighbourhood	-0.0176***	-0.0138***	-0.0183***
	(0.0019)	(0.0034)	(0.0024)
Feeling part of community	-0.0038**	-0.0045	-0.0035
	(0.0018)	(0.0032)	(0.0023)
Children aged 0-4	0.0011	0.0132	-0.0039
	(0.0064)	(0.0110)	(0.0079)
Children aged 5-14	-0.0383***	-0.0424***	-0.0355***
	(0.0079)	(0.0140)	(0.0100)
Children aged 15-24	-0.0093	-0.0306	-0.0041
	(0.0118)	(0.0220)	(0.0141)
No. bedrooms	-0.0409***	-0.0411***	-0.0429***
	(0.0042)	(0.0070)	(0.0055)
Length of residence	0.0356***	0.0384***	0.0367***
	(0.0013)	(0.0021)	(0.0016)
LGA house price ($1,000)	-0.0000*	0.0000	-0.0002***
	(0.0000)	(0.0000)	(0.0000)
LGA unemployment	-0.0006	-0.0033	-0.0003
	(0.0021)	(0.0039)	(0.0025)
Employed	-0.0092	0.0180	-0.0224**
	(0.0080)	(0.0133)	(0.0101)
Partner employed	-0.0067	-0.0170	0.0129
	(0.0118)	(0.0225)	(0.0145)
Partner university degree	0.0226	0.0002	0.0046
	(0.0264)	(0.0089)	(0.0080)
Australian born	0.0112*	0.0170*	0.0035
	(0.0064)	(0.0094)	(0.0090)

Table 4.6. Simultaneous Equation Model for Residential Mobility and Fertility Intention (cont.)

	Australia	Sydney, Melbourne	Remaining MSRs
Fertility Intention Equation Coefficient (SE)			
Age2024	1.2493*** (0.2048)	1.1207*** (0.3212)	1.3390*** (0.2630)
Age2529	1.2689*** (0.1586)	1.2239*** (0.2448)	1.2875*** (0.2078)
Age3034	1.1326*** (0.1119)	1.1779*** (0.1750)	1.0951*** (0.1463)
Age3539	0.6649*** (0.0756)	0.7542*** (0.1179)	0.6103*** (0.0985)
Married	-0.2894*** (0.0961)	-0.2878* (0.1514)	-0.3047*** (0.1228)
Family income ($1,000)	0.0002 (0.0004)	0.0005 (0.0006)	0.0001 (0.0006)
Total children	-1.0051*** (0.0522)	-1.0818*** (0.0824)	-0.9868*** (0.0241)
LGA house price ($1,000)	-0.0000 (0.0002)	0.0000 (0.0003)	-0.0003 (0.0004)
LGA unemployment	-0.0058 (0.0177)	0.0123 (0.0306)	-0.0009 (0.0223)
Employed	-0.1432** (0.0702)	-0.2011* (0.1113)	0.1206 (0.0913)
Partner employed	-0.0231 (0.0991)	-0.0388 (0.1758)	0.0350 (0.1275)
Partner university degree	-0.2438 (0.2544)	-0.0227 (0.0714)	0.1170 (0.0718)
University degree	0.1647 (0.2467)	0.0962 (0.0724)	0.3587*** (0.0668)
Baby Bonus	0.0206 (0.0560)	0.0200 (0.0914)	0.0458 (0.0834)
Cross-eq correlation	-0.0228 (0.0149)	0.0438* (0.0264)	-0.0353* (0.0192)
No. observations	20,811	7192	13030

Notes: All economic and social characteristics are measured in year *t-1* for the moving behaviour between year *t-1* and year t. Fertility intention and pregnancy status are measured in year t. Sydney and Melbourne are the two largest Major Statistical Regions (MSR). The remaining MSRs include the balance of New South Wales and Victoria, Queensland, South Australia and Western Australia, Tasmania, the Northern Territory, and the Australian Capital Territory. * p<0.1, ** p<0.05, *** p<0.01.

Another significant difference across housing markets in Australia in Table 4.6 is the estimated coefficients on fertility intention. The estimated result in the simultaneous equations shows that on average in Australia, for an extra point of fertility intention, the likelihood of a partnered woman moving tends to increase by 0.0043 percentage points, or 3.16 percent (0.0043/0.14). For Sydney and Melbourne, the estimated coefficient on fertility intention is -0.0000 and statistically insignificant. In comparison, for the remaining MSRs, it is equal to 0.0048 and highly significant. For those MSRs, a one point increase in the intention to have children increases the propensity to move by 0.0048 percentage points, or 3.22 percent (0.0048/0.15). The insignificant effect of fertility intention on residential mobility in Sydney and Melbourne suggests that housing market conditions may have repercussions on fertility related decisions of households. For example, households in high cost housing markets may be constrained, by tight housing markets or insufficient financial resources, to adjust their housing conditions and residential environment to the expected or desired family size.

The estimation results of the fertility intention model using an ordered probit specification are consistent with previous findings in the literature (Table 4.6 cont.). Across Australia, the intention to have children declines with age and with the total number of children already born. De-facto couples have higher expectations of having children than married couples; and employed women tend to have lower fertility intentions, especially for those residing in Sydney and Melbourne. The Baby Bonus policy is positively (although insignificantly) correlated with fertility intention in relatively less tight housing markets.

6.4 Competing Risk Model for Multiple Choices of Residential Relocation

Another important factor to consider in residential mobility studies is relocation distance. Competing risks discrete-time event history analysis is well suited to the analysis of multiple types of residential relocation. The results from estimating a competing risk random effects multinomial logit model in the form of Equation (5) are reported in Table 4.7. The model differentiates geographic mobility within a LGA, across LGAs within a MSR, across MSRs within a State or Territory, and across States or Territories within Australia. Individual specific random effects are included to account for unobserved individual heterogeneity that may lead to the dependence across relocation types for the same individual (Steele, Goldstein, and Browne 2004; Steele, Diamond, and Wang 1996). The random variance term commonly specified across relocation types is found to be statistically significant at the one percent level.

Table 4. 7. Discrete-Time Event History Model for Different Types of Residential Relocation

Average Marginal Effect	Within LGA	Within MSR	Intra-State	Inter-State
Fertility Intention	-0.0000	0.0018***	-0.0002	-0.0003
	(0.0007)	(0.0006)	(0.0002)	(0.0003)
Pregnancy	0.0096	0.0006	0.0014	-0.0018
	(0.0069)	(0.0051)	(0.0023)	(0.0034)
Age2024	0.0546***	0.0392***	0.0110***	0.0035
	(0.0099)	(0.0083)	(0.0037)	(0.0055)
Age2529	0.0036	0.0161**	0.0061*	0.0081*
	(0.0086)	(0.0072)	(0.0033)	(0.0045)
Age3034	0.0117	0.0123*	0.0063**	0.0118***
	(0.0078)	(0.0067)	(0.0031)	(0.0041)
Age3539	0.0049	0.0039	0.0068**	0.0084**
	(0.0073)	(0.0064)	(0.0030)	(0.0038)
Married	-0.0023	0.0021	0.0016	-0.0003
	(0.0050)	(0.0040)	(0.0017)	(0.0025)
Family income	0.0001***	0.0001***	0.0000**	0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Mortgage owner	-0.0764***	-0.0487***	-0.0050**	-0.0096***
	(0.0070)	(0.0056)	(0.0025)	(0.0035)
Renter	0.0328***	0.0049	0.0012	0.0028
	(0.0069)	(0.0055)	(0.0025)	(0.0035)
Satisfied with neighbourhood	-0.0025**	-0.0044***	-0.0012***	-0.0012**
	(0.0012)	(0.0010)	(0.0004)	(0.0006)
Feeling part of community	-0.0002	-0.0034***	-0.0003	-0.0022***
	(0.0011)	(0.0009)	(0.0004)	(0.0056)
Childless	-0.0084	0.0023	0.0008	0.0040
	(0.0070)	(0.0055)	(0.0025)	(0.0035)
Children aged 0-4	0.0096	-0.0104**	-0.0005	-0.0028
	(0.0059)	(0.0049)	(0.0022)	(0.0031)
Children aged 5-14	-0.0004	-0.0134***	-0.0018	-0.0063**
	(0.0060)	(0.0052)	(0.0022)	(0.0032)
No. bedrooms	-0.0160***	-0.0079***	-0.0019**	-0.0025**
	(0.0025)	(0.0020)	(0.0009)	(0.0013)
Length of residence	0.0015*	0.0012**	0.0026	-0.0004
	(0.0008)	(0.0006)	(0.0002)	(0.0005)
LGA house price	-0.0001***	0.0000*	-0.0000***	-0.0000
	(0.0000)	(0.0000)	(0.0000)	(0.0000)
LGA unemployment	0.0021*	-0.0005	0.0005	0.0000
	(0.0011)	(0.0009)	(0.0004)	(0.0006)
University degree	-0.0257***	0.0053	0.0007	0.0100***
	(0.0054)	(0.0042)	(0.0018)	(0.0027)
Partner university degree	-0.0028	0.0079*	-0.0008	0.0021
	(0.0056)	(0.0044)	(0.0019)	(0.0028)
Employed	0.0064	-0.0063	-0.0012	-0.0020
	(0.0050)	(0.0041)	(0.0018)	(0.0025)
Partner employed	0.0063	-0.0047	-0.0012	-0.0009
	(0.0075)	(0.0061)	(0.0025)	(0.0038)

Australian born	-0.0059	-0.0096**	0.0033	0.0032
	(0.0057)	(0.0045)	(0.0022)	(0.0030)
Random variance	0.1158***	0.1158***	0.1158***	0.1158***
	(0.0404)	(0.0404)	(0.0404)	(0.0404)
Observations	20643			

Notes: All economic and social characteristics are measured in year *t-1* for the moving behaviour between year *t-1* and year *t*. * p<0.1, ** p<0.05, *** p<0.01.

The results suggest that the estimated impact of fertility intention on residential mobility is positive and highly significant for intraregional moves (column 2). This suggests that households with intentions and plans about future fertility move to an alternative LGA within a MSR to achieve housing conditions and locational environment for childbearing. The estimate implies that a one point increase in the self-reported intention to have a child/more children in the future on a scale of 0-10 is associated with an increase in the probability of a within-MSR relocation of 0.0018 percentage points, *ceteris paribus*.

The probability of moving decreases with the presence of school-age children, especially for non-local moves, as moving can disrupt the education and social relationship of children (Kulu 2008; Long 1972; Sermons and Koppelman 2001; Stapleton 1980). Having a qualification from university is correlated with a decrease in residential mobility within an LGA, but an increase in the probability of an interstate move among partnered women. This positive relationship between education and long-distance moves is well documented in the literature (Bauernschuster et al. 2014; Fell, Dodds, and King 2004; Long 1988; Sánchez and Andrews 2011; Shumaker and Stokols 1982; Speare Jr and Goldscheider 1987; Van Ommeren, Rietveld, and Nijkamp 1997).

7. Conclusion

In this chapter, the relationship between residential mobility and fertility intention among partnered women in Australia has been investigated. In an economic context, mobility depends on the net utility gains from moving, subject to the economic and social costs of moving. One of the life course events that lead to the disequilibrium in housing consumption is the birth of a child. In the expectation to have children, households may relocate to adjust housing conditions and residential environment to the increase in family size. Such anticipatory moves may be restrained or postponed in an expensive and tight housing market. The results in this chapter have implications on the impact of housing markets on childbearing and residential mobility patterns.

Previous literature has documented the intricate link between childbearing and housing decisions. However, the lack of the direct measure on fertility intention and expectation has limited previous studies to examining the residential mobility in response to fertility decision-making and planning. The impact of subjective intentions in fertility on behavioural outcomes of mobility is comprehensively examined in this chapter. The analysis provides additional insight into the relationship between housing and fertility, with emphasis on the dimension of residential mobility.

The empirical challenge in estimating the relationship between fertility and residential mobility is unobserved heterogeneity and the joint determination of fertility and housing decisions, making fertility endogenous with respect to residential mobility. To address the endogeneity, this chapter considers various modelling strategies. Using the correlated random effects model, the estimation results for binary choices of mobility indicate that the intention to have children in the future increases the residential mobility of couples. The positive and statistically significant estimate on fertility intention suggest that a one point increase in self-evaluated fertility intention increases the probability of moving by 0.0030 percentage points, or 1.15 percent. Household attributes and housing conditions are important factors in affecting mobility decisions. The results are broadly consistent with previous empirical findings. Age, housing space, presence of school aged children, and local social capital are negatively correlated with residential mobility. Mortgage holders and households residing in expensive housing markets are less likely to move.

In the simultaneous equation model, the cross-equation correlation of time-varying components is positive and significant in Sydney and Melbourne. Moreover, in these two housing markets, there is no evidence of an association between fertility intention and relocations. The remaining MSRs show a significant increase in moving propensity in response to fertility intention: a one point increase in the intention to have children increases the propensity to relocate by 0.0035 percentage points, or 1.30 percent.

The impact of fertility intention across different types of relocation is examined in a competing risk random effects multinomial logit model. The results indicate that there is a positive association between fertility and geographical mobility; fertility intention induced moves occur mostly intra-regionally and among childless couples; and moves occurring during pregnancy are likely to be local and made by couples with at least one child. In particular, the increase in fertility intention by one point increases the propensity of intraregional moves across LGAs within a MSR by 0.0021 percentage points, or 3.16 percent. Being pregnant is associated with an increase in the probability to move locally by 0.0117 percentage points, or 10.81 percent. The significant common variance term suggests the presence of women-specific random effects across relocation types.

This chapter contributes to the literature in the following aspects. First, unlike earlier studies, the analysis in this chapter incorporates a direct measure of fertility intention that is measured at a relatively fine level of detail. The use of such a measure highlights the importance of the fertility decision-making process in affecting residential mobility of the household. Rather than relying on actual births, the fertility-induced relocation is examined using the subjective expectation in anticipation of future growth in family size. Second, the analysis utilises a rich dataset that contains demographic and socio-economic characteristics, indirect measures of social capital, and macroeconomic information such as local house prices and employment conditions. Third, fertility-induced moves are investigated across housing markets and types of relocation. The heterogeneity in the impact of fertility intention on residential mobility and the dependence between fertility and housing decisions provides important evidence on the ease or difficulty of households in realising fertility aspirations.

The results in this chapter have potentially important policy implications. First, the evidence on fertility-induced relocations and the dependence between fertility and housing related decisions across housing markets suggests that housing market circumstances may have repercussions on the residential mobility and childbearing patterns of households. High cost housing markets may prevent households from achieving desired housing conditions for childbearing, which may lead to delays in fertility timing or a reduction in total fertility. This may imply that policies promoting homeownership and facilitating residential mobility may encourage and support childbearing plans of young couples. In the current environment of Australia where low fertility, aging population, and shrinking working age population have been concerning policy makers, such implications are of vital significance. Housing policies may be appropriately directed to assisting the realisation of childbearing plans of households and in turn future population growth.

Second, the results on fertility induced residential mobility across areas are of substantial policy interest to regional governments and communities as it impacts infrastructure planning, labour force mobility, and demographic distribution of a region. To the extent that geographical relocation is driven by childbearing intentions, understanding when and where households move as an outcome of fertility planning is crucial to designing policies on housing development and the provision of relevant services and facilities such as childcare and schools.

Appendix

Factor Analysis of Reasons for Moving

To assess the motivation of residential mobility in the sample, factor analysis is applied to determine broad types of moves based on the answers to 28 questions about reasons for moving. Factor analysis is one of the clustering techniques to group similar variables into fewer dimensions (Costello and Osborne 2005). Assuming the existence of a few common factors that account for the originally large set of reasons for relocation, the factor analysis is undertaken to help summarise the reasons for moving with fewer underlying main triggers. The underlying triggers are linear combinations of the sub-reasons for moving weighted by their contribution to the explanation of the variation in each trigger. The confirmatory factor analysis has been increasingly used in the literature to identify major dimensions on a subset of questionnaire items (Birch et al. 2001; Brown, Cash, and Mikulka 1990; Dommermuth, Klobas, and Lappegård 2011; Floyd and Widaman 1995).

Factor analysis is used in this section to test whether reasons for residential moves can be reduced to fewer underlying mobility or fertility related triggers. The question in HILDA allows respondents to identify multiple reasons for a move. The factor loadings (or coefficients) represent how the items are weighted for each underlying factor and the correlation between the item and the factor. Table A4.1 reports the underlying structure of the relocation reasons grouped by factors analysis. The analysis selects 15 main factors out of 29 reasons. The reasons within each factor are highly correlated positively (in bold) with the corresponding factor. Of particular interest is fertility-related moves. The grouped factors that can be identifiable with fertility and fertility intention are likely to be factors 1, 2, and 5.

Table A4. 1. Factor Analysis of Reasons for Moving

	Factors														
Reasons for Moving	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
To live in a better neighbourhood	**0.33**	0.23	0.13	0.13	0.18	-0.24	-0.05	-0.25	-0.11	-0.11	-0.01	-0.08	-0.09	-0.12	-0.05
To be closer to friends/family	**0.41**	0.16	0.23	0.04	0.07	-0.02	0.05	0.24	0.09	0.04	0.03	0.17	-0.01	0.04	-0.03
To look for work	**0.56**	-0.12	-0.06	0.01	-0.07	0.17	-0.07	0.01	-0.03	-0.03	-0.05	-0.09	0.00	0.10	0.01
Seeking change of lifestyle	**0.60**	0.10	-0.05	0.10	0.16	0.04	-0.04	-0.13	0.03	-0.01	0.08	-0.04	-0.06	-0.05	-0.02
Health reasons	**0.40**	0.05	-0.07	0.03	-0.06	-0.09	-0.03	0.08	-0.08	-0.02	-0.04	0.32	-0.08	0.06	0.02
To get a larger/better place	-0.17	**0.43**	-0.11	0.33	0.27	-0.29	-0.11	-0.28	-0.39	-0.16	-0.12	-0.12	-0.09	0.00	-0.04
To be nearer place of work	-0.01	0.01	**0.60**	0.09	0.06	0.27	-0.12	0.10	0.00	-0.02	-0.07	-0.06	-0.04	-0.04	-0.01
To be close to place of study	-0.10	0.00	**0.62**	0.06	0.08	-0.07	0.03	0.00	0.03	0.03	0.06	0.05	-0.05	-0.09	0.00
To be closer to amenities/transport	0.29	0.09	**0.46**	0.02	-0.02	-0.22	0.26	-0.09	-0.02	-0.06	-0.09	-0.03	0.08	0.00	0.01
Property no longer available	-0.03	0.10	-0.04	**0.11**	-0.94	-0.02	-0.02	-0.04	-0.02	-0.01	-0.01	-0.04	-0.04	-0.06	-0.01
To get married/moved in with partner	-0.04	-0.91	-0.02	0.11	**0.12**	-0.05	-0.03	-0.06	-0.08	-0.04	-0.01	0.00	-0.04	-0.03	-0.02
To get a place of my own/our own	-0.04	0.08	-0.04	-0.95	**0.11**	-0.02	-0.03	-0.05	-0.05	-0.04	-0.01	-0.02	-0.04	-0.03	-0.02
To start a new job	0.05	0.06	0.04	0.05	0.04	**0.70**	0.06	-0.08	0.00	-0.10	-0.10	-0.02	0.18	-0.01	-0.02
To start own business	0.03	0.14	-0.06	0.05	0.14	**0.31**	-0.08	0.01	-0.16	0.22	0.07	-0.12	-0.19	-0.22	0.04
Decided to relocate own business	-0.02	0.03	0.18	-0.03	-0.04	-0.04	**0.64**	-0.14	-0.07	-0.04	-0.03	-0.03	0.05	0.16	0.02
Moved to Australia (NFI)	-0.07	-0.01	-0.16	0.09	0.07	0.09	**0.63**	-0.01	0.00	-0.04	0.05	0.02	-0.14	-0.04	-0.02
Work transfer	-0.05	0.06	0.05	0.08	0.05	-0.09	-0.12	**0.76**	-0.10	-0.12	0.00	-0.05	-0.03	0.07	0.00
To follow a spouse/parent/family	0.04	0.13	-0.16	0.12	0.09	0.20	0.36	**0.43**	-0.01	0.18	-0.01	-0.01	-0.11	-0.19	-0.03
Other	0.02	0.04	-0.07	0.05	0.10	-0.02	0.05	**0.05**	0.05	0.02	-0.05	-0.06	0.05	0.81	0.01
To get a smaller/less expensive place	-0.02	0.12	0.03	0.09	0.04	0.01	-0.06	-0.12	**0.78**	0.04	0.07	-0.09	-0.10	0.08	-0.01
NEI to classify	0.00	0.03	-0.18	0.06	0.08	-0.24	0.07	0.11	**0.43**	-0.15	-0.35	0.02	0.30	-0.34	0.00
Temporary relocation	-0.05	0.06	-0.01	0.07	0.03	0.03	-0.06	-0.15	0.10	**0.70**	-0.05	0.13	-0.07	-0.02	0.02
Married/relationship breakdown	0.05	-0.10	-0.02	0.03	0.08	-0.11	0.02	0.01	0.13	-0.04	**0.67**	-0.10	-0.07	-0.05	0.00
Evicted	-0.04	0.12	-0.04	0.01	-0.07	-0.02	0.01	0.01	-0.03	-0.06	**0.63**	0.12	0.26	-0.05	-0.01

Personal/family reasons (NFI)	-0.01	-0.02	0.00	0.01	0.06	-0.02	0.00	-0.03	-0.06	0.05	0.00	**0.82**	0.03	-0.06	0.01
Housing/neighbourhood reason (NFI)	-0.18	0.14	-0.01	0.12	0.01	0.15	-0.11	-0.09	0.13	-0.21	-0.01	**0.33**	-0.25	0.24	-0.06
Travelling/returned from overseas	-0.04	0.05	-0.02	0.07	0.06	0.13	-0.06	-0.04	-0.06	0.02	0.06	0.02	**0.79**	0.05	0.00
Work reasons (NFI)	0.01	0.00	0.01	0.01	-0.02	-0.21	0.02	0.08	-0.08	0.58	-0.03	-0.09	**0.16**	0.10	-0.07
Not answered	-0.01	0.01	0.00	0.02	0.01	-0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	**0.99**

Notes: Solutions are rotated factor loadings. The varimax orthogonal rotation assumes the factors are not correlated and attempts to maximise the squared loadings of each factor so that the reasons are as closely related to the factor as possible. Bold numbers represent reasons that are highly correlated with the factor. Source: Authors own calculation using waves 1-15 of HILDA.

Chapter Five
Conclusion

This thesis has examined the empirical relationship between fertility and housing in Australia. In Chapter Two, aggregate-level evidence on the relationship between fertility rates and house prices was examined using time series techniques. Following this, micro-econometric analysis in the form of household-level studies on the relationship between fertility related decisions and housing market developments were considered. The microdata analysis allowed a more nuanced investigation on household decision-making and provides a comprehensive understanding on the causal relationship between fertility and housing decisions.

By providing empirical evidence from Australia, this thesis complements the growing literature on the relationship between fertility and housing. The analysis has emphasised the role of housing prices in affecting fertility related decisions, and particularly how fertility, fertility intentions, and fertility related residential relocation are connected to house price movements and housing market circumstances.

The implication of housing market fluctuations on fertility choices is of particular significance in the Australian context in light of the cultural and social traditions that emphasise homeownership as a desired form of tenure. Moreover, the analysis is particularly pertinent in light of developments in the financial and housing market in the past few decades, and the increasing concerns over low fertility and population aging. A novel feature of the analysis in this thesis has been the consideration of fertility intentions. To date there has been only limited analysis on fertility intentions and how they are related to developments in housing markets. Intentions around future childbearing provides a direct and pertinent measure on fertility decision-making, which will enrich the understanding on the interdependence among various family life domains.

Existing research which examines the effect of housing market movements on fertility related decisions and outcomes have generally used aggregate or regional data on house prices. The use of home values at the household level in Chapter Three and Four provides an opportunity to identify the household-level responses to changes in house prices and housing wealth as perceived by individuals. Consistently measured home values, combined with rich information on fertility and residential mobility history, allow this thesis to examine the heterogeneous responses of households across demographic and socioeconomic characteristics, housing status, housing market conditions, and residential relocation types. Understanding the sources of heterogeneity may assist the design of more effective and efficient public policies that support and assist the fertility and housing career of households.

The thesis begins by presenting a simple theoretical model that illustrates the mechanism by which an increase in house prices may decrease the demand for children. The relationship between house prices and fertility is however potentially nuanced among households, with renters and owner occupiers likely behaving differently in response to changes in the cost of housing. Thus, it is ultimately an empirical question of the net effect of house prices on fertility. Following the theoretical discussion, an examination on the aggregate relationship between fertility rates and house prices over the period 1971-2014 was presented employing time series techniques. The analysis then turns to household decision-making at the individual and household level over the period between 2001 and 2015. Multiple dimensions of the relationship between fertility and housing related decisions are explored using panel data. The responses of fertility and fertility intention to changes in house prices, as well as the relationship between residential mobility and fertility intentions are examined across household characteristics, housing market conditions, and relocation types.

The main findings in the cointegration analysis reported in Chapter Two suggest an overall negative relationship between total fertility rates and median house prices over the last few decades, suggesting that house price inflation is associated with a decline in fertility. The negative relationship is particularly salient for high cost housing markets and the cohorts aged in their early-30s. The time-series analysis indicates the presence of long-term linkages between fertility, house prices, and employment status, with fertility rates correlating positively with male wages and negatively with female wages. There is also some evidence of a positive relationship between fertility rates and house prices for some age groups. This observed pattern may be explained by the migration of young couples planning to have children or the housing wealth effect stimulated by the periods of housing booms. However, to draw inferences concerning household behaviours, a microdata analysis is needed to provide a more comprehensive exposition on the causal relationship between fertility decision making and housing markets.

At the individual and household level, Chapter Three presents evidence that house price changes have important implications on fertility outcomes and fertility intentions of Australian families. Using microdata, the study explores both fertility intentions and outcomes for homeowners and private renters. The geographic and temporal variation in the magnitude and timing of house price changes, together with the unique economic context in Australia, facilitates the identification of an arguably exogenous housing wealth measure with respect to fertility decisions. The results in the study suggest that higher house prices increase the childbirth of homeowners yet lower the intention to have children among private renters. In particular, an AUD$100,000 increase in housing wealth among homeowners is associated with a 10.4 percent increase in the probability of having a child. The positive response exhibited by homeowners is largely driven by females who are in younger age groups (25-34 years), formally married, with no children, with mortgage loans, and moderately liquidity constrained.

Chapter Four presents a household-level study that explores residential relocation in anticipation of a growing family. Employing a variety of empirical strategies to address unobserved heterogeneity and the joint determination of fertility and housing decisions, the evidence suggests the presence of the simultaneity between fertility and housing decisions, arising from unobserved time-invariant and time-varying influences. The correlation between time-varying shocks to mobility and fertility is particularly significant for tight housing markets such as Sydney and Melbourne. The results suggest that the intention on future childbearing increases residential mobility of couples. In particular, a one unit increase in the expectation to have children in the future on a scale of 0-10 increases the probability of moving by a 1.15 percent. The positive response is largely driven by couples in private rental markets and those without children. Consistent with migration theories, lower mobility was found among older cohorts or households with more square-footage, school-age children, local social capital, or an existing mortgage. Moreover, residential mobility behaviour tends to differ across relocation distances. Childless couples planning to have the first birth are more likely to relocate within a MSR while couples who already have children are more likely to move within a LGA during pregnancy.

The thesis provides a comprehensive exploration of the relationship between housing markets and fertility related decisions in Australia. The results have important implications on housing and fertility policies. The findings suggest that house prices can impact the childbearing intentions and behaviours, and housing market conditions may potentially impact the age structure and population dynamics of a country. Especially, housing price inflation may lead to reduce the fertility intentions among private renters. Moreover, understanding how fertility and residential relocation decisions are related has important policy implications for regional and local governments. The results suggest that households in high-cost housing markets may not be able to adjust housing conditions and residential relocations by residential relocation to fulfil their fertility intentions. Consequently, difficulty in accessing homeownership and relocating to acquire expected housing conditions may delay childbearing or reduce total fertility. Providing valuable implications for infrastructure planning and housing policy design, a knowledge on when and where couples relocate to form and expand families is crucial to designing policies intended to facilitate residential relocation and develop local services and infrastructures such as health, childcare and education facilities.

There have been numerous family and housing polices administered by Australian government in the form of subsidy transfers and tax treatments in the past few decades. Housing policies, such as First Home Owners Grants and stamp duty exemptions, were introduced among States and Territories seeking to promote homeownership and improve housing affordability. The former refers to a one-off grant that payable to first homeowners under certain eligibility criteria, and the latter provides exemptions or concessions on stamp duty to first homebuyers (Australian Government 2018; Martin, Pawson, and van den Nouwelant 2016). At the same time, as one of the most inclusive family and child support policies over the past few decades, the Baby Bonus was introduced in 2004, aiming to encourage fertility by providing financial support to families with children (Budget 2004-05).

The relationship between housing market and fertility related decisions considered in this thesis highlights how the challenge of accessing housing of sufficient quality and quantity, particularly for younger adults, may delay or reduce fertility. Effective housing policies that facilitate homeownership may thus have indirect impacts on fertility. This has important implications for policy challenges around low fertility and the aging of the Australian population. In a similar fashion, it may be the case that policies ostensibly designed to increase fertility, such as the Baby Bonus and other family related policies, may be largely ineffective if complementary housing policies that support households to achieve their desired housing outcomes are not put in place.

While insightful, the analysis in this thesis could be supplemented by additional research that have been beyond the scope of this thesis. First, the current micro-level analysis focuses on the period in which the increase in house prices is substantial and sustained in Australia. Studies have suggested the asymmetric effect of house prices on consumption and saving behaviours (Engelhardt 1996; Skinner 1996; Case, Quigley, and Shiller 2011). Future studies may be needed to examine the potential repercussions of house price deflation on childbearing related decisions in Australia when more data from the period of declines in housing market are available.

Further, the results produce evidence on the interconnection between fertility intention and housing decisions. More generally, the studies demonstrate the importance of incorporating the measures on household decision-making and planning into the research on household behaviours over the life cycle. Some studies have acknowledged the challenge in using actual occurrence of the event to identify decision-making process (Michielin and Mulder 2008; Öst 2012; Ermisch and Steele 2016). Future work can take into account behavioural intentions in the research on other domains of household behaviours.

Next, the measure of fertility intention used in the analysis does not specify the timing and chances of future childbearing. Studies have shown that the discrepancy between fertility intention and actual fertility behaviour can be attributed to the time interval between reported intention and recorded behaviour (Davidson and Jaccard 1979; Dommermuth, Klobas, and Lappegård 2011; Randall and Wolff 1994), and changes in socio-demographic characteristics and contextual factors (Berrington 2004; Heiland, Prskawetz, and Sanderson 2008; Monnier 1989; Ajzen and Klobas 2013). Using intention measures with more detailed description on the timeframe and probability would improve the accuracy of the interpretation on household intention and planning.

Finally, the current analysis mostly focuses on the characteristics and responses of women. Research has found that the wife's preference is more important than the husband's preference in affecting the subsequent births (Beckman 1984; Fan and Maitra 2011). Nevertheless, further work that incorporates the attributes of men, such as the fertility intention of the husbands, is likely to be useful. Understanding gender differences in housing and mobility behaviour in response to the expectation on future childbearing would provide additional insight into the behaviour of households.

Notwithstanding the limitations identified above and potential future research, the analysis in this thesis has provided insight into an important but relatively under researched dimension of the household behaviour in the Australian context.

References

Abelson, Peter, and Demi Chung. 2005. 'The real story of housing prices in Australia from 1970 to 2003', *Australian Economic Review*, 38: 265-81.

ABS. 1974. 'Average weekly earnings', *Australian Bureau of Statistics, Reference No. 6.18*

———. 2002. 'Australian Social Trends, 2002', *Australian Bureau of Statistics, cat. no. 4102.0*.

———. 2010. 'Australian social trends, Moving house', *Australian Bureau of Statistics, cat. no. 4102.0*.

———. 2011a. 'Australian social trends', *Australian Bureau of Statistics, cat. no. 4102.0*.

———. 2011b. 'Australian standard geographical classification (ASGC)', *Australian Bureau of Statistics, cat. no. 1216.0*.

———. 2011c. 'Perspectives on regional Australia, housing arrangements - homes owned with a mortgage in local government areas', *Australian Bureau of Statistics, cat. no. 1380.0.55.012*.

———. 2011, 2016. 'Census of Population and Housing', *Australian Bureau of Statistics*.

———. 2014. 'Birth', *Australian Bureau of Statistics, cat. no. 3301.0*.

———. 2015a. 'Average weekly earnings', *Australian Bureau of Statistics, cat. no. 6302.0*.

———. 2015b. 'Labour force', *Australian Bureau of Statistics, cat. no. 6202.0*.

———. 2015-16a. 'Household income and wealth', *Australian Bureau of Statistics, cat. no. 6523.0*.

———. 2015-16b. 'Regional population growth, various years', *Australian Bureau of Statistics, cat. no. 3218.0*.

———. 2016a. 'Births', *Australian Bureau of Statistics, cat. no.3301.0*.

———. 2016b. 'Census of Population and Housing', *Australian Bureau of Statistics, cat. no. 2071.0*.

———. 2016c. 'Cenus of Population and Housing: Reflecting Australia', *Australian Bureau of Statistics, cat. no. 2071.0*.

———. 2016d. 'Consumer price index', *Australian Bureau of Statistics, cat. no. 6401.0*.

———. 2016e. 'National regional profile', *Australian Bureau of Statistics, cat. no. 1379.0.55.001*.

———. 2016f. 'Residential property price indexes: eight capital cities', *Australian Bureau of Statistics, cat. no. 6416.0*.

———. 2017. 'Australian statistical geography standard (ASGS)', *Australian Bureau of Statistics, cat. no. 1270.0.55.003*.

Adsera, Alicia. 2004. 'Changing fertility rates in developed countries. The impact of labor market institutions', *Journal of Population Economics*, 17: 17-43.

AIFS. 2013. 'Dad and Partner Pay: Implications for policy-makers and practitioners', *Australian Institute of Family Studies*, CFCA Paper No. 12.

AIHW. 2017. 'Australia's welfare', *Australian Institute of Health and Welfare*.

Ajzen, Icek. 1985. 'From intentions to actions: A theory of planned behavior.' *Action Control* (Springer).

———. 1991. 'The theory of planned behavior', *Organizational behavior and human decision processes*, 50: 179-211.

Ajzen, Icek, and Martin Fishbein. 1980. 'Understanding attitudes and predicting social behaviour'.

Ajzen, Icek, and Jane Klobas. 2013. 'Fertility intentions: An approach based on the theory of planned behavior', *Demographic Research*, 29: 203.

Aksoy, Cevat Giray. 2016. 'Short-term effects of house prices on birth rates'.

Alba, Richard D, and John R Logan. 1991. 'Variations on two themes: Racial and ethnic patterns in the attainment of suburban residence', *Demography*, 28: 431-53.

Allen, James P, and Eugene Turner. 2005. 'Ethnic residential concentrations in United States metropolitan areas', *Geographical Review*, 95: 267-85.

Anderson, Laurie M, Joseph St Charles, Mindy T Fullilove, Susan C Scrimshaw, Jonathan E Fielding, Jacques Normand, and Task Force on Community Preventive Services. 2003. 'Providing affordable family housing and reducing residential segregation by income: a systematic review', *American Journal of Preventive Medicine*, 24: 47-67.
Angrist, Joshua D, and Jörn-Steffen Pischke. 2008. *Mostly harmless econometrics: An empiricist's companion* (Princeton university press).
Aron, Janine, John V Duca, John Muellbauer, Keiko Murata, and Anthony Murphy. 2012. 'Credit, housing collateral, and consumption: Evidence from Japan, the UK, and the US', *Review of Income and Wealth*, 58: 397-423.
Atalay, Kadir, Garry Barrett, and F Edwards. 2016. "Housing wealth effects on labour supply: Evidence from Australia." University of Sydney.
Atalay, Kadir, Garry Barrett, and Rebecca Edwards. 2015. "House prices, mortgage debt and labour supply: evidence from Australian households." Australian Housing and Urban Research Institute.
Atalay, Kadir, Stephen Whelan, and Judith Yates. 2016. 'House prices, wealth and consumption: new evidence from Australia and Canada', *Review of Income and Wealth*, 62: 69-91.
Australian Government. 2018. 'First Home Owner Grant, General Information', *http://www.firsthome.gov.au/*.
Badarinza, Cristian, John Y Campbell, and Tarun Ramadorai. 2016. 'International comparative household finance', *Annual Review of Economics*, 8: 111-44.
Bahmani-Oskooee, Mohsen. 1993. 'Export growth and economic growth: An application of cointegration and error-correction modeling', *The Journal of Developing Areas*, 27: 535-42.
Baker, Emma, Rebecca Bentley, Laurence Lester, and Andrew Beer. 2016. 'Housing affordability and residential mobility as drivers of locational inequality', *Applied Geography*, 72: 65-75.
Bartel, Ann P. 1979. 'The migration decision: what role does job mobility play?', *The American Economic Review*, 69: 775-86.
Bartel, Ann P, and George J Borjas. 1977. "Middle-age job mobility: Its determinants and consequences." In.: National Bureau of Economic Research Cambridge, Mass., USA.
Bassford, Micaela, and Hayley Fisher. 2016. 'Bonus babies? The impact of paid parental leave on fertility intentions', *Life Course Centre Working Paper Series*, 2016-02.
Bauernschuster, Stefan, Oliver Falck, Stephan Heblich, Jens Suedekum, and Alfred Lameli. 2014. 'Why are educated and risk-loving persons more mobile across regions?', *Journal of Economic Behavior & Organization*, 98: 56-69.
Becker, Gary S. 1960. 'An economic analysis of fertility.' in, *Demographic and economic change in developed countries* (Columbia University Press).
———. 1965. 'A Theory of the Allocation of Time', *The economic journal*: 493-517.
———. 1981. '1991. A treatise on the family', *Cambridge, London*.
Becker, Gary S, and H Gregg Lewis. 1973. 'On the Interaction between the Quantity and Quality of Children', *Journal of political Economy*, 81: S279-S88.
Beckman, Linda J. 1984. 'Husbands' and wives' relative influence on fertility decisions and outcomes', *Population and Environment*, 7: 182-97.
Berrington, Ann. 2004. 'Perpetual postponers? Women's, men's and couple's fertility intentions and subsequent fertility behaviour', *Population trends*, 117: 9-19.
Birch, Leann L, JO Fisher, K Grimm-Thomas, CN Markey, R Sawyer, and Sl L Johnson. 2001. 'Confirmatory factor analysis of the Child Feeding Questionnaire: a measure of parental attitudes, beliefs and practices about child feeding and obesity proneness', *Appetite*, 36: 201-10.
Böheim, René, and Mark P Taylor. 2002. 'Tied down or room to move? Investigating the relationships between housing tenure, employment status and residential mobility in Britain', *Scottish Journal of Political Economy*, 49: 369-92.
Bolt, Gideon, and Ronald Van Kempen. 2010. 'Ethnic segregation and residential mobility: relocations of minority ethnic groups in the Netherlands', *Journal of Ethnic and Migration Studies*, 36: 333-54.
Bonvalet, Catherine, Juliet Carpenter, and Paul White. 1995. 'The residential mobility of ethnic minorities: a longitudinal analysis', *Urban Studies*, 32: 87-103.

Börsch-Supan, Axel. 1986. 'Household formation, housing prices, and public policy impacts', *Journal of Public Economics*, 30: 145-64.
Bostic, Raphael, Stuart Gabriel, and Gary Painter. 2009. 'Housing wealth, financial wealth, and consumption: New evidence from micro data', *Regional Science and Urban Economics*, 39: 79-89.
Bratti, Massimiliano. 2003. 'Labour force participation and marital fertility of Italian women: The role of education', *Journal of Population Economics*, 16: 525-54.
Breusch, Trevor S. 1978. 'Testing for autocorrelation in dynamic linear models', *Australian Economic Papers*, 17: 334-55.
Brown, Lawrence A, and John Holmes. 1971. 'Intra-urban migrant lifelines: a spatial view', *Demography*, 8: 103-22.
Brown, Timothy A, Thomas F Cash, and Peter J Mikulka. 1990. 'Attitudinal body-image assessment: Factor analysis of the Body-Self Relations Questionnaire', *Journal of Personality Assessment*, 55: 135-44.
Budget. 2004-05. *Australian Government*.
Campbell, John Y, and Joao F Cocco. 2007. 'How do house prices affect consumption? Evidence from micro data', *Journal of monetary Economics*, 54: 591-621.
Case, Karl E, John M Quigley, and Robert J Shiller. 2005. 'Comparing wealth effects: the stock market versus the housing market', *Advances in Macroeconomics*, 5.
———. 2011. "Wealth effects revisited 1978-2009." In.: National Bureau of Economic Research.
Chamberlain, Gary. 1982. 'Multivariate regression models for panel data', *Journal of Econometrics*, 18: 5-46.
Clark, Jeremy, and Ana Ferrer. 2016. "The Effect of House Prices on Fertility: Evidence from Canada." In.
Clark, W, and S Whiters. 2008. 'Family migration and mobility sequences in the United States: Spatial mobility in the context of the life course', *Demographic Research*, 17: 591-622.
Clark, William AV. 2012. 'Do women delay family formation in expensive housing markets?', *Demographic Research*, 27: 1.
———. 2013. 'Life course events and residential change: Unpacking age effects on the probability of moving', *Journal of Population Research*, 30: 319-34.
Clark, William AV, and Suzanne Davies Withers. 1999. 'Changing jobs and changing houses: mobility outcomes of employment transitions', *Journal of Regional Science*, 39: 653-73.
Clark, William AV, Marinus C Deurloo, and Frans M Dieleman. 1984. 'Housing consumption and residential mobility', *Annals of the Association of American Geographers*, 74: 29-43.
———. 1994. 'Tenure changes in the context of micro-level family and macro-level economic shifts', *Urban Studies*, 31: 137-54.
———. 1997. 'Entry to home-ownership in Germany: some comparisons with the United States', *Urban Studies*, 34: 7-19.
Clark, William AV, MC Deurloo, and FM Dieleman. 1986. 'Residential mobility in Dutch housing markets', *Environment and Planning A*, 18: 763-88.
Clark, William AV, and Frans M Dieleman. 1996. 'Households and housing', *Choice and Outcomes in the Housing Market*.
Clark, William AV, and Anita I Drever. 2000. 'Residential mobility in a constrained housing market: implications for ethnic populations in Germany', *Environment and Planning A*, 32: 833-46.
Clark, William AV, and Youqin Huang. 2003. 'The life course and residential mobility in British housing markets', *Environment and Planning A*, 35: 323-39.
Clark, William AV, and Clara H Mulder. 2000. 'Leaving home and entering the housing market', *Environment and Planning A*, 32: 1657-71.
Clark, William AV, and Jun L Onaka. 1983. 'Life cycle and housing adjustment as explanations of residential mobility', *Urban Studies*, 20: 47-57.
Clark, William AV, and Suzanne Davies Withers. 2009. 'Fertility, mobility and labour-force participation: A study of synchronicity', *Population, Space and Place*, 15: 305-21.
Clark, William, Marinus Deurloo, and Frans Dieleman. 2006. 'Residential mobility and neighbourhood outcomes', *Housing Studies*, 21: 323-42.

Cobb-Clark, Deborah A, and Mathias G Sinning. 2011. 'Neighborhood diversity and the appreciation of native-and immigrant-owned homes', *Regional Science and Urban Economics*, 41: 214-26.
CoreLogic. 2015. 'Value growth is still all about Sydney and Melbourne'.
———. 2017a. 'Deteriorating housing affordability in Sydney and Melbourne due to both demand and supply'.
———. 2017b. 'Perceptions of Housing Affordability Report '.
Costello, Anna B, and Jason W Osborne. 2005. 'Best practices in exploratory factor analysis: Four recommendations for getting the most from your analysis', *Practical assessment, research & evaluation*, 10: 1-9.
Coulson, N Edward, and Lynn M Fisher. 2002. 'Tenure choice and labour market outcomes', *Housing Studies*, 17: 35-49.
Courgeau, Daniel, and Eva Lelièvre. 1992. 'Interrelations between first home-ownership, constitution of the family, and professional occupation in France', *Demographic applications of event history analysis*: 120-40.
Crowley, Sheila. 2003. 'The affordable housing crisis: Residential mobility of poor families and school mobility of poor children', *Journal of Negro Education*: 22-38.
Curtis, Marah A, and Jane Waldfogel. 2009. 'Fertility timing of unmarried and married mothers: Evidence on variation across US cities from the Fragile Families and Child Wellbeing Study', *Population Research and Policy Review*, 28: 569.
D'agostino, Ralph B, Albert Belanger, and Ralph B D'Agostino Jr. 1990. 'A suggestion for using powerful and informative tests of normality', *The American Statistician*, 44: 316-21.
Dassopoulos, Andrea, and Shannon M Monnat. 2011. 'Do perceptions of social cohesion, social support, and social control mediate the effects of local community participation on neighborhood satisfaction?', *Environment and Behavior*, 43: 546-65.
David, Quentin, Alexandre Janiak, and Etienne Wasmer. 2010. 'Local social capital and geographical mobility', *Journal of Urban Economics*, 68: 191-204.
Davidoff, Thomas. 2010. 'Home equity commitment and long-term care insurance demand', *Journal of Public Economics*, 94: 44-49.
Davidson, Andrew R, and James J Jaccard. 1979. 'Variables that moderate the attitude–behavior relation: Results of a longitudinal survey', *Journal of Personality and Social Psychology*, 37: 1364.
Davidson, Russell, and James G MacKinnon. 1993. 'Estimation and inference in econometrics', *OUP Catalogue*.
Day, Creina, and Ross Guest. 2016. 'Fertility and female wages: A new link via house prices', *Economic Modelling*, 53: 121-32.
Dettling, Lisa J, and Melissa S Kearney. 2014. 'House prices and birth rates: The impact of the real estate market on the decision to have a baby', *Journal of Public Economics*, 110: 82-100.
Deurloo, Marinus C, William AV Clark, and Frans M Dieleman. 1994. 'The move to housing ownership in temporal and regional contexts', *Environment and Planning A*, 26: 1659-70.
Dickey, David A, and Wayne A Fuller. 1979. 'Distribution of the estimators for autoregressive time series with a unit root', *Journal of the American statistical Association*, 74: 427-31.
———. 1981. 'Likelihood ratio statistics for autoregressive time series with a unit root', *Econometrica: journal of the Econometric Society*: 1057-72.
Dickey, David A, Dennis W Jansen, and Daniel L Thornton. 1994. 'A Primer on Cointegration with an Application to Money and Income.' in, *Cointegration* (Springer).
Dieleman, Frans M. 2001. 'Modelling residential mobility; a review of recent trends in research', *Journal of housing and the built environment*, 16: 249-65.
Dieleman, Frans M, William AV Clark, and Marinus C Deurloo. 2000. 'The geography of residential turnover in twenty-seven large US metropolitan housing markets, 1985-95', *Urban Studies*, 37: 223-45.
Dieleman, Frans M, and Pieter CJ Everaers. 1994. 'From renting to owning: life course and housing market circumstances', *Housing Studies*, 9: 11-25.
Dommermuth, Lars, Jane Klobas, and Trude Lappegård. 2011. 'Now or later? The theory of planned behavior and timing of fertility intentions', *Advances in Life Course Research*, 16: 42-53.

Drago, Robert, Katina Sawyer, Karina M Shreffler, Diana Warren, and Mark Wooden. 2009. "Did Australia's Baby Bonus Increase the Fertility Rate?" In.: Melbourne Institute of Applied Economic and Social Research, The University of Melbourne.
———. 2011. 'Did Australia's baby bonus increase fertility intentions and births?', *Population Research and Policy Review*, 30: 381-97.
Drake, Leigh. 1993. 'Modelling UK house prices using cointegration: an application of the Johansen technique', *Applied Economics*, 25: 1225-28.
Duca, John V, John Muellbauer, and Anthony Murphy. 2011. 'House prices and credit constraints: Making sense of the US experience', *The economic journal*, 121: 533-51.
Elliott, Graham, Thomas J Rothenberg, and James H Stock. 1992. "Efficient tests for an autoregressive unit root." In.: National Bureau of Economic Research Cambridge, Mass., USA.
Engelhardt, Gary V. 1996. 'House prices and home owner saving behavior', *Regional Science and Urban Economics*, 26: 313-36.
Engelhardt, Henriette, and Alexia Prskawetz. 2004. 'On the changing correlation between fertility and female employment over space and time', *European Journal of Population/Revue européenne de Démographie*, 20: 35-62.
Engle, Robert F. 1982. 'Autoregressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation', *Econometrica: journal of the Econometric Society*: 987-1007.
Engle, Robert F, and Clive WJ Granger. 1987. 'Co-integration and error correction: representation, estimation, and testing', *Econometrica: journal of the Econometric Society*: 251-76.
Ermisch, John. 1988. 'Econometric analysis of birth rate dynamics in Britain', *The Journal of Human Resources*, 23: 563-76.
———. 1999. 'Prices, parents, and young people's household formation', *Journal of Urban Economics*, 45: 47-71.
Ermisch, John, and Pamela Di Salvo. 1997. 'The economic determinants of young people's household formation', *Economica*, 64: 627-44.
Ermisch, John, and Fiona Steele. 2016. 'Fertility expectations and residential mobility in Britain', *Demographic Research*, 35: 1561-84.
Fan, Elliott, and Pushkar Maitra. 2011. 'Women rule: preferences and fertility in Australian households', *The BE Journal of Economic Analysis & Policy*, 13: 1-30.
Farnham, Martin, Lucie Schmidt, and Purvi Sevak. 2011. 'House prices and marital stability', *American Economic Review*, 101: 615-19.
Farnham, Martin, and Purvi Sevak. 2007. 'Housing wealth and retirement timing'.
Feijten, Peteke, and Clara H Mulder. 2002. 'The timing of household events and housing events in the Netherlands: A longitudinal perspective', *Housing Studies*, 17: 773-92.
Fell, Deshayne B, Linda Dodds, and Will D King. 2004. 'Residential mobility during pregnancy', *Paediatric and perinatal epidemiology*, 18: 408-14.
Fichera, Eleonora, and John Gathergood. 2016. 'Do wealth shocks affect health? New evidence from the housing boom', *Health economics*, 25: 57-69.
Fischer, Peter A, and Gunnar Malmberg. 2001. 'Settled people don't move: On life course and (im-) mobility in Sweden', *Population, Space and Place*, 7: 357-71.
Fishbein, Martin, and Icek Ajzen. 1977. 'Belief, attitude, intention, and behavior: An introduction to theory and research'.
Fitchen, Janet M. 1994. 'Residential mobility among the rural poor', *Rural Sociology*, 59: 416-36.
Floyd, Frank J, and Keith F Widaman. 1995. 'Factor analysis in the development and refinement of clinical assessment instruments', *Psychological assessment*, 7: 286.
Fredland, Daniel R. 1974. 'Residential mobility and home purchase', *Lexington, MA: DC Heath*.
Furstenberg Jr, Frank F, and Mary Elizabeth Hughes. 1995. 'Social capital and successful development among at-risk youth', *Journal of Marriage and the Family*: 580-92.
Gallin, Joshua. 2006. 'The long-run relationship between house prices and income: evidence from local housing markets', *Real Estate Economics*, 34: 417-38.
Glaeser, Edward L, David Laibson, and Bruce Sacerdote. 2002. 'An economic approach to social capital', *The economic journal*, 112.

Godfrey, Leslie G. 1991. *Misspecification tests in econometrics: the Lagrange multiplier principle and other approaches* (Cambridge University Press).
Golant, Stephen M. 1971. 'Adjustment process in a system: a behavioral model of human movement', *Geographical Analysis*, 3: 203-20.
Gonzalo, Jesus. 1994. 'Five alternative methods of estimating long-run equilibrium relationships', *Journal of econometrics*, 60: 203-33.
Goodman, John L, and John B Ittner. 1992. 'The accuracy of home owners' estimates of house value', *Journal of housing economics*, 2: 339-57.
Graves, Philip E, and Peter D Linneman. 1979. 'Household migration: Theoretical and empirical results', *Journal of Urban Economics*, 6: 383-404.
Green, Richard K, and Patric H Hendershott. 2001. 'Home-ownership and unemployment in the US', *Urban Studies*, 38: 1509-20.
Gregory, Allan W, and Bruce E Hansen. 1996. 'Residual-based tests for cointegration in models with regime shifts', *Journal of econometrics*, 70: 99-126.
Gregory, Allan W, James M Nason, and David G Watt. 1996. 'Testing for structural breaks in cointegrated relationships', *Journal of econometrics*, 71: 321-41.
Guest, Ross, and Nick Parr. 2010. 'The effects of family benefits on childbearing decisions: A household optimising approach applied to Australia', *Economic Record*, 86: 609-19.
Hakim, Catherine. 2003. 'A new approach to explaining fertility patterns: Preference theory', *Population and development review*, 29: 349-74.
Hakkio, Craig S, and Mark Rush. 1989. 'Market efficiency and cointegration: an application to the sterling and deutschemark exchange markets', *Journal of international money and finance*, 8: 75-88.
Hargreaves, Colin. 1994. 'A review of methods of estimating cointegrating relationships', *Nonstationary time series analysis and cointegration*: 87-131.
Harris, David. 1997. 'Principal components analysis of cointegrated time series', *Econometric Theory*, 13: 529-57.
Haynes, Michele, and Arturo Martinez. 2015. "Modelling the relationships between household residential mobility and childbearing in Australia." In.
Head, Allen, and Huw Lloyd-Ellis. 2012. 'Housing liquidity, mobility, and the labour market', *Review of Economic Studies*, 79: 1559-89.
Heckman, James J, and James R Walker. 1990. 'The relationship between wages and income and the timing and spacing of births: Evidence from Swedish longitudinal data', *Econometrica: journal of the Econometric Society*: 1411-41.
Heiland, Frank, Alexia Prskawetz, and Warren C Sanderson. 2008. 'Are individuals' desired family sizes stable? Evidence from West German panel data', *European Journal of Population/Revue européenne de Démographie*, 24: 129.
Helderman, Amanda C, Clara H Mulder, and MaartenVan Ham. 2004. 'The changing effect of home ownership on residential mobility in the Netherlands, 1980–98', *Housing Studies*, 19: 601-16.
Henley, Andrew. 1998. 'Residential mobility, housing equity and the labour market', *The economic journal*, 108: 414-27.
Henretta, John C. 1987. 'Family transitions, housing market context, and first home purchase by young married households', *Social Forces*, 66: 520-36.
Hill, Daniel H, William G Axinn, and Arland Thornton. 1993. 'Competing hazards with shared unmeasured risk factors', *Sociological methodology*: 245-77.
Hoem, Jan M, and Michaela Kreyenfeld. 2006a. 'Anticipatory analysis and its alternatives in life-course research: Part 1: Education and first childbearing', *Demographic Research*, 15: 461-84.
———. 2006b. 'Anticipatory analysis and its alternatives in life-course research: Part 2: Marriage and first birth', *Demographic Research*, 15: 485-98.
Holly, Sean, and Natasha Jones. 1997. 'House prices since the 1940s: cointegration, demography and asymmetries', *Economic Modelling*, 14: 549-65.
Huang, Bwo-Nung, and Chin W Yang. 1996. 'Long-run purchasing power parity revisited: a Monte Carlo simulation', *Applied Economics*, 28: 967-74.
Hughes, Gordon, and Barry McCormick. 1987. 'Housing markets, unemployment and labour market flexibility in the UK', *European Economic Review*, 31: 615-41.

———. 1994. 'Did migration in the 1980s narrow the North-South divide?', *Economica*: 509-27.
Hurst, Erik, and Frank P Stafford. 2004. 'Home is where the equity is: Mortgage refinancing and household consumption', *Journal of money, Credit, and Banking*, 36: 985-1014.
Ioannides, Yannis M. 1987. 'Residential mobility and housing tenure choice', *Regional Science and Urban Economics*, 17: 265-87.
Isebaert, Daan. 2013. 'Housing tenure and geographical mobility in Belgium', *Faculty of economics and business administration working paper, Ghent University*.
Jackman, Richard, and Savvas Savouri. 1992. 'Regional migration in Britain: an analysis of gross flows using NHS central register data', *The economic journal*, 102: 1433-50.
Johansen, Søren. 1991. 'Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models', *Econometrica: journal of the Econometric Society*: 1551-80.
———. 1995. *Likelihood-based inference in cointegrated vector autoregressive models* (Oxford University Press on Demand).
Juster, F Thomas, Joseph P Lupton, James P Smith, and Frank Stafford. 2006. 'The decline in household saving and the wealth effect', *Review of Economics and Statistics*, 88: 20-27.
Kan, Kamhon. 2007. 'Residential mobility and social capital', *Journal of Urban Economics*, 61: 436-57.
Kemp, Peter A. 2011. 'Low-income tenants in the private rental housing market', *Housing Studies*, 26: 1019-34.
Kendig, Hal L. 1984. 'Housing careers, life cycle and residential mobility: implications for the housing market', *Urban Studies*, 21: 271-83.
Kiel, Katherine A, and Jeffrey E Zabel. 1996. 'House price differentials in US cities: Household and neighborhood racial effects', *Journal of housing economics*, 5: 143-65.
Kulu, Hill. 2008. 'Fertility and spatial mobility in the life course: evidence from Austria', *Environment and Planning A*, 40: 632-52.
Kulu, Hill, and Paul J Boyle. 2009. 'High fertility in city suburbs: compositional or contextual effects?', *European Journal of Population/Revue européenne de Démographie*, 25: 157-74.
Kulu, Hill, Paul J Boyle, and Gunnar Andersson. 2009. 'High suburban fertility: Evidence from four Northern European countries', *Demographic Research*, 21: 915.
Kulu, Hill, and Fiona Steele. 2013. 'Interrelationships between childbearing and housing transitions in the family life course', *Demography*, 50: 1687-714.
Kulu, Hill, and Andres Vikat. 2008. 'Fertility differences by housing type: an effect of housing conditions or of selective moves', *Demographic Research*, 17: 775-802.
Kulu, Hill, Andres Vikat, and Gunnar Andersson. 2007. 'Settlement size and fertility in the Nordic countries', *Population Studies*, 61: 265-85.
Laeven, Luc, and Alexander Popov. 2017. 'Waking up from the american dream: on the experience of young americans during the housing boom of the 2000s', *Journal of Money, Credit and Banking*, 49: 861-95.
Lain, Samantha J, Jane B Ford, Camille H Raynes-Greenow, Ruth M Hadfield, Judy M Simpson, Jonathan M Morris, and Christine L Roberts. 2009. 'The impact of the Baby Bonus payment in New South Wales: who is having “one for the country”?', *The medical journal of Australia*, 190: 238-41.
Langridge, Amanda T, Natasha Nassar, Jianghong Li, Peter Jacoby, and Fiona J Stanley. 2010. 'The impact of monetary incentives on general fertility rates in Western Australia', *Journal of Epidemiology & Community Health*: jech. 2009.100347.
Lee, Barrett A, R Salvador Oropesa, and James W Kanan. 1994. 'Neighborhood context and residential mobility', *Demography*, 31: 249-70.
Lichter, Daniel T. 1982. 'The migration of dual-worker families: does the wife's job matter?', *Social Science Quarterly*, 63: 48.
Logan, John R, Richard D Alba, Tom McNulty, and Brian Fisher. 1996. 'Making a place in the metropolis: Locational attainment in cities and suburbs', *Demography*, 33: 443-53.
Long, Larry. 1988. *Migration and residential mobility in the United States* (Russell Sage Foundation).
Long, Larry H. 1972. 'The influence of mumber and ages of children on residential mobility', *Demography*, 9: 371-82.

Lovenheim, Michael F. 2011. 'The effect of liquid housing wealth on college enrollment', *Journal of Labor Economics*, 29: 741-71.
Lovenheim, Michael F, and Kevin J Mumford. 2013. 'Do family wealth shocks affect fertility choices? Evidence from the housing market', *Review of Economics and Statistics,* 95: 464-75.
Lovenheim, Michael F, and C Lockwood Reynolds. 2013. 'The effect of housing wealth on college choice: Evidence from the housing boom', *Journal of Human Resources*, 48: 1-35.
Ludwig, Alexander, and Torsten Sløk. 2004. 'The relationship between stock prices, house prices and consumption in OECD countries', *Topics in Macroeconomics*, 4.
Lusardi, Annamaria, and Olivia S Mitchell. 2007. 'Baby boomer retirement security: The roles of planning, financial literacy, and housing wealth', *Journal of monetary Economics*, 54: 205-24.
Maddala, Gangadharrao S, and In-Moo Kim. 1998. *Unit roots, cointegration, and structural change* (Cambridge University Press).
Malmberg, Bo. 2010. 'Low fertility and the housing market: Evidence from Swedish regional data', *European Journal of Population/Revue européenne de Démographie*, 26: 229-44.
———. 2012. 'Fertility cycles, age structure and housing demand', *Scottish Journal of Political Economy*, 59: 467-82.
Martin, Chris, Hal Pawson, and Ryan van den Nouwelant. 2016. 'Housing policy and the housing system in Australia: an overview'.
Massey, Douglas S. 1985. 'Ethnic residential segregation: A theoretical synthesis and empirical review', *Sociology and social research*, 69: 315-50.
Massey, Douglas S, and Nancy A Denton. 1988. 'The dimensions of residential segregation', *Social Forces*, 67: 281-315.
McCarthy, Kevin F. 1976. 'The household life cycle housing choices', *Papers in Regional Science*, 37: 55-80.
McDonald, Peter. 2000. 'Gender equity in theories of fertility transition', *Population and development review*, 26: 427-39.
McLaughlin, Ralph B. 2012. 'New housing supply elasticity in Australia', *Ann Reg Sci*: 48:595-618.
Melser, Daniel. 2013. 'How Well Do Australian Home-Owners Know the Value of Their Home?', *Australian Economic Review*, 46: 31-44.
Michielin, Francesca, and Clara H Mulder. 2008. 'Family events and the residential mobility of couples', *Environment and Planning A*, 40: 2770-90.
Miller, Stephen M. 1991. 'Monetary dynamics: An application of cointegration and error-correction modeling', *Journal of Money, Credit and Banking*, 23: 139-54.
Miller, Warren B, and David J Pasta. 1995. 'Behavioral intentions: Which ones predict fertility behavior in married couples?', *Journal of Applied Social Psychology*, 25: 530-55.
Mincer, Jacob. 1963. 'Market prices, opportunity costs, and income effects', *Measurement in economics*: 67-82.
———. 1978. 'Family migration decisions', *Journal of political Economy*, 86: 749-73.
Mizutani, Noriko. 2015. 'The effects of housing wealth on fertility decisions: Evidence from Japan', *Economics Bulletin*, 35: 2710-24.
Monnier, Alain. 1989. 'Fertility intentions and actual behaviour. A longitudinal study: 1974, 1976, 1979', *Population English Selection No. 1*: 237-59.
Morgan, S Philip, and Heather Rackin. 2010. 'The correspondence between fertility intentions and behavior in the United States', *Population and development review*, 36: 91-118.
Morrow-Jones, Hazel A. 1988. 'The housing life-cycle and the transition from renting to owning a home in the United States: a multistate analysis', *Environment and Planning A*, 20: 1165-84.
Mulder, Clara H. 2006. 'Home-ownership and family formation', *Journal of housing and the built environment*, 21: 281-98.
Mulder, Clara H, and Francesco C Billari. 2010. 'Homeownership regimes and low fertility', *Housing Studies*, 25: 527-41.
Mulder, Clara H, and Pieter Hooimeijer. 1995. 'Moving into owner-occupation: compositional and contextual effects on the propensity to become a homeowner', *Journal of housing and the built environment*, 10: 5-25.

Mulder, Clara H, and Michael Wagner. 1993. 'Migration and marriage in the life course: a method for studying synchronized events', *European Journal of Population/Revue européenne de Démographie*, 9: 55-76.
———. 1998. 'First-time home-ownership in the family life course: A West German-Dutch comparison', *Urban Studies*, 35: 687-713.
———. 2001. 'The connections between family formation and first-time home ownership in the context of West Germany and the Netherlands', *European Journal of Population/Revue européenne de Démographie*, 17: 137-64.
Munch, Jakob Roland, Michael Rosholm, and Michael Svarer. 2006. 'Are homeowners really more unemployed?', *The economic journal*, 116: 991-1013.
Mundlak, Yair. 1978. 'On the pooling of time series and cross section data', *Econometrica: journal of the Econometric Society*: 69-85.
Murphy, Mike J, and Oriel Sullivan. 1985. 'Housing tenure and family formation in contemporary Britain', *European Sociological Review*, 1: 230-43.
Myers, Scott M. 2000. 'The impact of religious involvement on migration', *Social Forces*, 79: 755-83.
OECD. 2000. 'OECD thematic review of early childhood education and care policy'.
———. 2018a. 'Fertility rates (indicator)', *doi: 10.1787/8272fb01-en (Accessed on 16 January 2018)*.
———. 2018b. 'Housing (indicator)', *doi: 10.1787/63008438-en (Accessed on 16 January 2018)*

———. 2018c. 'Labour Force Statistics by sex and age (indicators) ', *http://dx.doi.org/10.1787/data-00310-en*.
Ong, Rachel, Therese Jefferson, Siobhan Austen, MEA Haffner, and GA Wood. 2014. 'Housing equity withdrawal in Australia', *AHURI Research & Policy Bulletin,(176), 2014*.
Öst, Cecilia Enström. 2012. 'Housing and children: simultaneous decisions?—a cohort study of young adults' housing and family formation decision', *Journal of Population Economics*, 25: 349-66.
Osterwald-Lenum, Michael. 1992. 'A note with quantiles of the asymptotic distribution of the maximum likelihood cointegration rank test statistics', *Oxford Bulletin of Economics and statistics*, 54: 461-72.
Oswald, Andrew J. 1996. 'A conjecture on the explanation for high unemployment in the industrialized nations: part 1'. (p. 475). Warwick, UK: Department of Economics, University of Warwick.
Pamuk, Ayse. 2004. 'Geography of immigrant clusters in global cities: a case study of San Francisco', *International Journal of Urban and Regional Research*, 28: 287-307.
Pedroni, Peter. 2004. 'Panel cointegration: asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis', *Econometric Theory*, 20: 597-625.
Pence, Karen M, and Brian Bucks. 2006. 'Do homeowners know their house values and mortgage terms?'.
Pesaran, M Hashem, and Yongcheol Shin. 1998. 'An autoregressive distributed-lag modelling approach to cointegration analysis', *Econometric Society Monographs*, 31: 371-413.
Phillips, Peter CB. 1994. 'Some exact distribution theory for maximum likelihood estimators of cointegrating coefficients in error correction models', *Econometrica: journal of the Econometric Society*: 73-93.
Phillips, Peter CB, and Mico Loretan. 1991. 'Estimating long-run economic equilibria', *The Review of Economic Studies*, 58: 407-36.
Phillips, Peter CB, and Pierre Perron. 1988. 'Testing for a unit root in time series regression', *Biometrika*, 75: 335-46.
Pickles, Andrew R, and RB Davies. 1991. 'The empirical analysis of housing careers: a review and a general statistical modelling framework', *Environment and Planning A*, 23: 465-84.
Quesnel-Vallée, Amélie, and S Philip Morgan. 2003. 'Missing the target? Correspondence of fertility intentions and behavior in the US', *Population Research and Policy Review*, 22: 497-525.
Quigley, John M. 1987. 'Interest rate variations, mortgage prepayments and household mobility', *The Review of Economics and Statistics*: 636-43.
Quigley, John M, and Daniel H Weinberg. 1977. 'Intra-urban residential mobility: a review and synthesis', *International Regional Science Review*, 2: 41-66.

Rabe, Birgitta, and Mark Taylor. 2010. 'Residential mobility, quality of neighbourhood and life course events', *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 173: 531-55.

Rainer, Helmut, and Ian Smith. 2010. 'Staying together for the sake of the home?: house price shocks and partnership dissolution in the UK', *Journal of the Royal Statistical Society: Series A (Statistics in Society)*, 173: 557-74.

Randall, Donna M, and James A Wolff. 1994. 'The time interval in the intention-behaviour relationship: Meta-analysis', *British Journal of Social Psychology*, 33: 405-18.

Rao, B Bhaskara. 1997. *Cointegration for the applied economist* (Allied Publishers).

RBA. 2012. 'The Outlook for Dwelling Investment', *Reserve Bank of Australia*.

———. 2015. 'Long-run trends in housing price growth', *Reserve Bank Bulletin*: 21-30.

Rindfuss, Ronald R, S Philip Morgan, and Gray Swicegood. 1988. *First births in America: Changes in the timing of parenthood* (Univ of California Press).

Risse, Leonora. 2010. '‘… And one for the country’The effect of the baby bonus on Australian women’s childbearing intentions', *Journal of Population Research*, 27: 213-40.

Rohe, William M, and Leslie S Stewart. 1996. 'Homeownership and neighborhood stability', *Housing Policy Debate*, 7: 37-81.

Roodman, David. 2018. 'CMP: Stata module to implement conditional (recursive) mixed process estimator'.

Rossi, Peter Henry. 1955. *Why families move: A study in the social psychology of urban residential mobility* (Free Press).

Sánchez, Aida Caldera, and Dan Andrews. 2011. 'To move or not to move: What drives residential mobility Rates in the OECD?'. No. 846. OECD Publishing, 2011.

Sandefur, Gary D, and Wilbur J Scott. 1981. 'A dynamic analysis of migration: an assessment of the effects of age, family and career variables', *Demography*, 18: 355-68.

Sato, Yasuhiro. 2007. 'Economic geography, fertility and migration', *Journal of Urban Economics*, 61: 372-87.

Schoen, Robert, Nan Marie Astone, Young J Kim, Constance A Nathanson, and Jason M Fields. 1999. 'Do fertility intentions affect fertility behavior?', *Journal of Marriage and the Family*: 790-99.

Schwert, G William. 2002. 'Tests for unit roots: A Monte Carlo investigation', *Journal of Business & Economic Statistics*, 20: 5-17.

Sermons, M William, and Frank S Koppelman. 2001. 'Representing the differences between female and male commute behavior in residential location choice models', *Journal of Transport Geography*, 9: 101-10.

Sharkey, Patrick. 2008. 'The intergenerational transmission of context', *American Journal of Sociology*, 113: 931-69.

Shauman, Kimberlee A, and Yu Xie. 1996. 'Geographic mobility of scientists: Sex differences and family constraints', *Demography*, 33: 455-68.

Shumaker, Sally Ann, and Daniel Stokols. 1982. 'Residential mobility as a social issue and research topic', *Journal of Social Issues*, 38: 1-19.

Simon, Curtis J, and Robert Tamura. 2009. 'Do higher rents discourage fertility? Evidence from US cities, 1940–2000', *Regional Science and Urban Economics*, 39: 33-42.

Sjaastad, Larry A. 1962. 'The costs and returns of human migration', *Journal of political Economy*, 70: 80-93.

Skinner, Jonathan S. 1996. 'Is housing wealth a sideshow?' in, *Advances in the Economics of Aging* (University of Chicago Press).

South, Scott J, and Kyle D Crowder. 1997. 'Residential mobility between cities and suburbs: Race, suburbanization, and back-to-the-city moves', *Demography*, 34: 525-38.

———. 1998. 'Avenues and barriers to residential mobility among single mothers', *Journal of Marriage and the Family*: 866-77.

South, Scott J, Kyle D Crowder, and Katherine Trent. 1998. 'Children's residential mobility and neighborhood environment following parental divorce and remarriage', *Social Forces*, 77: 667-93.

South, Scott J, and Glenn D Deane. 1993. 'Race and residential mobility: Individual determinants and structural constraints', *Social Forces*, 72: 147-67.

Speare, Alden. 1974. 'Residential satisfaction as an intervening variable in residential mobility', *Demography*, 11: 173-88.
Speare Jr, Alden, and Frances Kobrin Goldscheider. 1987. 'Effects of marital status change on residential mobility', *Journal of Marriage and the Family*: 455-64.
Stapleton, Clare M. 1980. 'Reformulation of the family life-cycle concept: implications for residential mobility', *Environment and Planning A*, 12: 1103-18.
Steele, Fiona, Ian Diamond, and Duolao Wang. 1996. 'The determinants of the duration of contraceptive use in China: A multilevel multinomial discrete-hazards mdeling approach', *Demography*, 33: 12-23.
Steele, Fiona, Harvey Goldstein, and William Browne. 2004. 'A general multilevel multistate competing risks model for event history data, with an application to a study of contraceptive use dynamics', *Statistical Modelling*, 4: 145-59.
Steele, Fiona, Constantinos Kallis, Harvey Goldstein, and Heather Joshi. 2005. 'The relationship between childbearing and transitions from marriage and cohabitation in Britain', *Demography*, 42: 647-73.
Stock, James H, and Mark W Watson. 1988. 'Testing for common trends', *Journal of the American Statistical Association*, 83: 1097-107.
Ström, Sara. 2010. 'Housing and first births in Sweden, 1972–2005', *Housing Studies*, 25: 509-26.
Tan, Poo Chang, and Nai Peng Tey. 1994. 'Do fertility intentions predict subsequent behavior? Evidence from Peninsular Malaysia', *Studies in Family Planning*: 222-31.
Thomson, Elizabeth. 1997. 'Couple childbearing desires, intentions, and births', *Demography*, 34: 343-54.
Van der Vlist, Arno J, Cees Gorter, Peter Nijkamp, and Piet Rietveld. 2002. 'Residential mobility and local housing-market differences', *Environment and Planning A*, 34: 1147-64.
Van Ham, Maarten, and William AV Clark. 2009. 'Neighbourhood mobility in context: household moves and changing neighbourhoods in the Netherlands', *Environment and Planning A*, 41: 1442-59.
Van Ommeren, Jos N, Piet Rietveld, and Peter Nijkamp. 1998. 'Spatial moving behavior of two-earner households', *Journal of Regional Science*, 38: 23-41.
Van Ommeren, Jos, Piet Rietveld, and Peter Nijkamp. 1997. 'Commuting: in search of jobs and residences', *Journal of Urban Economics*, 42: 402-21.
Varady, David P. 1983. 'Determinants of residential mobility decisions the role of government services in relation to other factors', *Journal of the American Planning Association*, 49: 184-99.
Vidal, Sergi, Johannes Huinink, and Michael Feldhaus. 2017. 'Fertility Intentions and Residential Relocations', *Demography*, 54: 1305-30.
Vignoli, Daniele, Francesca Rinesi, and Eleonora Mussino. 2013. 'A home to plan the first child? Fertility intentions and housing conditions in Italy', *Population, Space and Place*, 19: 60-71.
Waddell, Paul. 1996. "Accessibility and residential location: the interaction of workplace, residential mobility, tenure, and location choices." In *Lincoln Land Institute TRED Conference*, 11-12.
Weinberg, Daniel H. 1979. 'The determinants of intra-urban household mobility', *Regional Science and Urban Economics*, 9: 219-46.
Weinberg, Daniel H, Joseph Friedman, and Stephen K Mayo. 1981. 'Intraurban residential mobility: The role of transactions costs, market imperfections, and household disequilibrium', *Journal of Urban Economics*, 9: 332-48.
Westoff, Charles F, and Norman B Ryder. 1977. 'The predictive validity of reproductive intentions', *Demography*, 14: 431-53.
Wilkens, R, D Warren, M Hahn, and B Houng. 2010. 'Families, incomes and jobs, vol. 5: A statistical report on waves 1–7 of the household, income and labour dynamics in Australia Survey', *Melbourne: University of Melbourne, Melbourne Institute of Applied Economic and Social Research*.
Willis, Robert J. 1973. 'A new approach to the economic theory of fertility behavior', *Journal of Political Economy*, 81: S14-S64.
Winstanley, Ann, David C Thorns, and Harvey C Perkins. 2002. 'Moving house, creating home: Exploring residential mobility', *Housing Studies*, 17: 813-32.

Withers, S Davies. 1998. 'Linking household transitions and housing transitions: a longitudinal analysis of renters', *Environment and Planning A*, 30: 615-30.
Wolpert, Julian. 1965. 'Behavioral aspects of the decision to migrate', *Papers in Regional Science*, 15: 159-69.
Yates, Judith. 2011. "Housing in Australia in the 2000s: On the Agenda Too Late?" In *The Australian Economy in the 2000*, 261-96. Sydney: Reserve Bank of Australia.
Yee, William, and Maurice D. Van Arsdol. 1977. 'Residential Mobility, Age, and the Life Cycle1', *Journal of Gerontology*, 32: 211-21.
Yi, Junjian, and Junsen Zhang. 2010. 'The effect of house price on fertility: Evidence from Hong Kong', *Economic Inquiry*, 48: 635-50.
Zhao, Lingxiao, and Gregory Burge. 2017. 'Housing Wealth, Property Taxes, and Labor Supply among the Elderly', *Journal of Labor Economics*, 35: 227-63.
Zivot, Eric, and Donald W K Andrews. 2002. 'Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis', *Journal of Business & Economic Statistics*, 20: 25-44.