The University of Western Australia

The Motherhood Wage Penalty & Grandparent Provided Childcare in Australia

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October 2014
Key Words: *motherhood; childcare; wage penalty*
JEL Codes: J13; J31

A dissertation submitted in partial fulfilment of the requirements for the degree of Bachelor of Commerce - Economics (Honours)
University of Western Australia

Abstract

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Daniel Payten - Bachelor of Commerce - Economics (Honours) 2014

This dissertation investigates the existence and size of the motherhood wage penalty in Australia, and analyses whether the motherhood wage penalty is influenced by access to informal childcare provided by grandparents. The motivation for this dissertation is the lack of consensus in the literature regarding the existence of the motherhood wage penalty in Australia and, limited research on the role of grandparent provided childcare. This dissertation makes two key contributions to the literature. An endogenous switching model to deal with endogeneity problems associated with analysing the motherhood wage penalty is introduced and, the impact of grandparent provided childcare availability is analysed in the context of the motherhood wage penalty.

In estimating the influence of childcare on motherhood wage penalty, there are two econometric issues that need to be addressed, namely self selection to work by mothers and non-mothers, and secondly the potential endogeneity of fertility decisions. This thesis will address the issue of self selectivity by estimating an Oaxaca decomposition model of wages, making a Heckman correction for the selection of mothers and non-mothers to work. The issue of endogeneity will be addressed using an endogenous switching model. Both methods yield broadly consistent results with international research, finding that there is a 7-10% wage penalty for having children, the majority of which can be explained by differing market returns upon the individual's characteristics such as work experience.

Finally, I explore the impact of access to grandparent provided childcare on the motherhood wage penalty, using a sample of women with children aged 0 to 14 years old. To measure the degree of access to grandparent provided childcare, the geographical distance between the child and grandparents residences is used as a proxy. We find there is no significant influence upon the motherhood wage penalty (difference in wages after controlling for observables). However, we do find a positive influence on raw wages before controlling for observables such as work experience and education. This difference in raw wages can be primarily attributed to increased labour force attachment, increased work experience and reduced time spent out of the workforce amongst those mothers with access to grandparent provided childcare

Declaration

Unless otherwise acknowledged in the text or acknowledgments, the work presented in this dissertation is my own original work.

This dissertation contains approximately 16,600 words
Extension Approved by Dr. Elisa Birch 13/10/14

Daniel Payten	Date

Acknowledgements

First and foremost, I would like to thank Professor Anu Rammohan & Assistant Professor James Key for their patient advice, encouragement and enthusiastic support. I would also like to express my gratitude towards all staff of the University of Western Australia's economics discipline for their comments and feedback.

Enormous thanks are due to my family for their support both emotional and financial. Without them I would never be in a position to undertake a project such as this, nor would I be the person I am today. I would also like to express my deep gratitude for the support of my friends both old and new in WA and the ACT.

I would also like to thank staff at the Australian National University for fostering a love of economics, in particular Professor Robert Breunig for imparting his passion for econometrics upon me in his undergraduate class.

Finally, thanks are due to the Australian taxpayers for contributing towards the costs of higher education.

This dissertation uses unit record data from the Household, Income and Labour Dynamics in Australia (HILDA) Survey. The HILDA Project was initiated and is funded by the Australian Government Department of Social Services (DSS) (formerly FaHCSIA), and is managed by the Melbourne Institute of Applied Economic and Social Research (Melbourne Institute). The findings and views reported in this paper, however, are those of the author and should not be attributed to either DSS or the Melbourne Institute.

The data used in this paper was extracted using the Add-On package "PanelWhiz" for Stata®. PanelWhiz (http://www.PanelWhiz.eu) was written by Dr. John P. Haisken-DeNew. See Hahn and Haisken-DeNew (2013) and Haisken-DeNew and Hahn (2010) for details. The PanelWhiz generated DO file to retrieve the data used here is available from me upon request. Any data or computational errors in this paper are my own.

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The Motherhood Wage Penalty & Grandparent Provided Childcare in Australia

Introduction

The aim of this dissertation is to identify the existence and dynamics of any motherhood wage penalty in Australia; and to explore the potential effects of access to grandparent provided childcare upon the wage penalty. That is, if a mother has access to childcare provided by the child's grandparents, does this have a role in reducing the wage penalty associated with motherhood?

In Australia, grandparent provided childcare makes up the majority of non-parental childcare. Most recent data shows that 38.6% of children aged 0-12 usually attend informal (non-commercial) care which is primarily provided by grandparents, compared to only 23.7% of children who usually attend formal childcare (ABS 2011). In the current context of intense political interest regarding future childcare policy (Nash 2013) and a productivity commission review into Australia's childcare policy (P.C. 2014), this dissertation seeks to help inform political debate regarding the importance of childcare and grandparent provided childcare in particular.

This dissertation will be divided into two parts; firstly I undertake an analysis of the motherhood wage penalty, and secondly I analyse the effects of the availability of grandparent provided childcare upon wages and the motherhood wage penalty. Although there is a significant body of international research regarding measurement and explanation of the motherhood wage penalty, very few studies have been carried out using Australian data and no studies to my knowledge have related the motherhood wage penalty to access to childcare. Furthermore, of those studies using Australian data no consensus has been reached regarding either the existence or the magnitude of the motherhood wage penalty in Australia. Issues of endogeneity (especially the decision to have children) have also plagued past Australian work, motivating further research.

Investigation of the motherhood wage penalty in Australia is primarily motivated by the potential implications for gender equality and social justice. Since most women do eventually have children, the penalty associated with having children may have important implications for gender wage inequality more broadly. In our society the majority of childcare burden falls upon mothers, in terms of reduced wages and increased domestic workload (Baxter 1992, pp.230-32). Moreover, quality child rearing and good parenting can be viewed as having strong positive externalities for society, where the social benefits of well raised children greatly exceed private

benefits (Budig & England 2001, p.205).[1] Accordingly, understanding the nature of the motherhood wage penalty, and the role which childcare (in particular informal childcare) may go some way into helping develop policies used to elevate gender wage inequity and improve social justice for women with children.

This dissertation contributes to existing research in the following ways. Firstly, alternate econometric methods drawn from other fields are introduced, accounting for the potential reverse causal relationship between motherhood and wages, which although raised in prior Australian research by Livermore et al. (2011, p.83), remains unaddressed. Secondly, to my knowledge this dissertation will be the first to examine any potential link between access to grandparent provided childcare services and the motherhood wage penalty. While other studies such as Whelan (2012) have looked at the links between the wages and childcare responsibilities for grandparents themselves, this study will look at the links between the wages of mothers and access to care provided by grandparents.

This dissertation uses an "endogenous switching model" developed in the union/non-union wage gap literature by Lee (1978) to analyse the motherhood wage gap. This model is then combined with an Oaxaca (1973, p.696) decomposition of the wage penalty. By using this approach, concerns surrounding endogeneity raised in earlier research by Livermore et al. (2011, p.6) can be addressed. However, in order to ensure robustness of results, this dissertation will estimate several other econometric models each targeted at addressing a specific econometric concern such as selectivity or unobserved heterogeneity.

To objectively measure the accessibility of informal grandparent provided childcare, geographical distance between the residence of children and their grandparents is used. The influence of grandparent provided childcare is then analysed more broadly, also looking at the influence of grandparent provided childcare upon labour force attachment.

The structure of this dissertation is as follows. In section 1, existing literature regarding the measurement of the wage penalty and theoretical reasons for its existence will be reviewed. In section 2, attention will be focused upon the role which childcare constraints may play in the wage penalty. Section 3 will discuss the data used for the empirical investigation, section 4 will discuss econometric issues in the measurement of the motherhood wage penalty. Section 5 will present results and analysis regarding the motherhood wage penalty. Section 6 will present more results measuring the effects of grandparent provided childcare upon wages and labour force attachment. Section 7 will draw the results together and conclude.

[1]The implication of this is that society more generally is free riding on the labour of mothers.

1 Literature Review - Motherhood Wage Penalty

There is a significant body of existing literature concerning the differences in the wages of mothers and non-mothers. Although there is broad consensus regarding the motherhood wage penalty in many countries including the USA and the UK (See Table 1), few studies have been conducted using Australian data. Amongst studies using Australian data, results are inconsistent. For example, Baxter (1992, p.244) and Livermore et al. (2011, p.89) both find a 4% to 5% wage penalty where as Krepp (2007, p.23) and Whitehouse (2002, p.389) do not find a significant wage penalty.

This chapter will first review and discuss the conclusions of existing literature the regarding the existence and scale of the wage penalty, with a focus on Australian studies. The methodologies used will then be summarised and discussed. Finally the existing theories used to explain the wage gap will be examined, paying particular attention to theories related to the childcare responsibilities of mothers.

1.1 The Existence and Scale of the Motherhood Wage Penalty

There is an important distinction between the *gross* motherhood wage gap and the *net* motherhood penalty. Measuring the gross wage *gap* involves simply finding the mean wage difference between women with and without children. Whereas measuring the net wage *penalty* involves finding the effect of children upon women's wages ceteris paribus. Following prior research in this field, this dissertation focuses upon the net motherhood wage penalty, after all relevant characteristics have been controlled for. Simply measuring the gross wage gap would be inappropriate as there may be systematic differences in the characteristics of women with and without children. For example, as Becker (1985, p.S36) points out, women with children tend to have lower levels of work experience due to long absences from the work force to have children. Ignoring the systematic differences between the two groups would lead to a biased estimate of the motherhood wage penalty. Thus, when this dissertation refers to the motherhood wage penalty, I refer to the net ceteris paribus effect of children on wages.

Substantial international research on the motherhood wage penalty has been conducted using data from the UK and the USA, with estimates consistently ranging from 4-10% in the UK and 5% to 11% in the USA. However, as shown in Table 1 other studies conducted using data from Australia, Canada, Denmark and Sweden appear far less certain.

Table 1: Estimates of Motherhood Wage Penalty

Study	Wage Penalty	Dataset	Model	Country
Baxter (1992)	4%	CPCSCC 1986	Cross Section	AUS
Krepp (2007)	Insignificant	HILDA 2001-2004	Pooled CS	AUS
Livermore et al. (2011)	5%	HILDA 2001-2008	Fixed Effects	AUS
Whitehouse (2002)	Insignificant	AWIRS 1995	Cross Section	AUS
Drolet (2002)	4-5%	SLID 1998	Cross Section	CAN
Gustafsson et al. (1996)	2%	GSOEP 1994-2005	Fixed Effects	GER
Gupta & Smith (2002)	Insignificant	DLD 1980-1995	GEE	DNK
Simonsen (2006)	2-7%	DLD 1980-1995	Score Matching	DNK
Albrecht et al. (1999)	Insignificant	F&W1992-1993	Pooled CS	SWE
Joshi et al. (1999)	Insignificant	NCDS 1981-1991	Pooled CS	UK
Waldfogel (1995)	9%	NCDS 1981 & 1991	Fixed Effects	UK
Waldfogel (1998*a*)	11%	NCDS 1981 & 1991	Multiple	UK
Whitehouse (2002)	5%	WERS 1998	Cross Section	UK
Amuedo (2005)	5%	NSLY 1979	Multiple	USA
Anderson et al. (2002)	3%	NLSYW	Fixed Effects	USA
Baum (2002)	2%	NLSY 1979	First Diference	USA
Budig & England (2001)	3%	NSLY 1979	Fixed Effects	USA
Hill (1979)	Insignificant	PSID	Cross Section	USA
Korenman & Neumark (1992)	4%	NLSYW 1980 & 1982	CS-IV	USA
Waldfogel (1997)	4%	NLSYW 1968 & 1988	Fixed Effects	USA
Waldfogel (1998*a*)	8%	NLSY 1979-1996	Multiple	USA
Waldfogel (1998*b*)	10%	NLSYW 1980 & 1991	Pooled CS	USA

Most prominent Estimates Given (After Controls) - See Appendix Acronyms (Section 8.2)

Draws upon summary in Livermore et al. (2011) (Preprint version)

GEE - Generalised Estimation Equation, Pooled CS - Pooled Cross Section

CS-IV - Instrumental Variable Cross Section

1.2 Econometric Methods

Measurement of the motherhood wage penalty is not a straightforward matter; several features of the data may cause considerable biases to be introduced if they are not accounted for. Despite the wide recognition of problems, there does not appear to be any consensus regarding the relative importance of these features or the best way to model the motherhood wage penalty. To this end, the nature of each problem will be briefly outlined together with a summary of the importance which authors place upon the problem and their potential solutions.

Firstly, a problem of selection may arise due to the fact that hourly wages are only observed for those women who are working. If the sample of working women is believed to be systematically different from the underlying population of all women, then the omission of women not working

could result in biased estimates (Heckman 1976). As Budig & England (2001, p.213) note, this issue may be of particular importance to the measurement of the motherhood wage penalty because those mothers who are most affected by the wage penalty (largest decline in wages) are the most likely to not be working. In Australia, Krepp (2007, p.15) and Livermore et al. (2011, p.87) both find a significant positive selection to work, meaning those women who are currently working tend to have higher unobservables (such as ability or motivation) than the underlying population, leading to potential biases. Despite this, other authors place less emphasis on this bias, Waldfogel (1998, P.149) argues that the selection bias in the estimation of the effects of children on womens wages is of *"lesser concern"*. Korenman & Neumark (1992, P.249) find that selection is only *"marginally significant"*, moreover Whitehouse (2002) does not consider selection bias in estimation of the penalty. Given the uncertainty surrounding the influence of this bias, it is prudent to estimate a cross sectional model accounting for selectivity using a Heckman (1976) selection adjustment.

A second problem raised by Livermore et al. (2011, p.83) (although left unaddressed) is that there may be reverse causality between motherhood and wages. That is, children may both cause a reduction in wages and wages may influence the decision to have children. This issue has also been considered in international research by Neumark & Korenman (1994, p.381) and Joshi et al. (1999, p.547), however to date no research using Australian data has accounted for this problem. If this problem is indeed significant in Australia, then past conclusions may be biased. Thus, it is prudent to estimate a model whereby the potential reverse causality can be accounted for (such as the endogenous switching model estimated in Section 5.4).

A final source of bias is unobserved heterogeneity. It is widely recognised in both international research and Australian research by Livermore et al. (2011) and Krepp (2007, p.7) that women with and without children may differ systematically in terms of an unobserved variable such as innate ability or career ambitions. For example, as Krepp (2007) rightly points out *"women with lower motivation for paid work might be more likely to have children"* Krepp (2007, p.7). Although many authors account for this bias, the direction of any impact and existence of the bias is contestable. Waldfogel (1997, p.215) finds that unobserved heterogeneity has a minimal impact upon the motherhood wage penalty estimation where as other authors such as Budig & England (2001, p.281) find a significant impact. Given the uncertainty, a fixed effects model will be estimated, accounting for any potential unobserved heterogeneity.

Given the uncertainty regarding various sources of bias, it is prudent to estimate a range of models, each accounting for different potential sources of bias in order to ensure robust results. Although there are innumerable econometric methods which can be utilised to solve the problems outlined above, the primary methods used in the literature are summarised in Table 2.

Table 2: Summary of Econometric Methods

Model	Advantages	Disadvantages
Cross Section OLS	Simple.	Unable to account for reverse causality, unobserved heterogeneity or selectivity to work.
Pooled Cross Section OLS	Allows aggregation of multiple survey years, meaning larger samples.	Unable to account for reverse causality, unobserved heterogeneity or selectivity to work. May require standard error adjustments when pooling multiple observations of the same people (Discussed in Section 3.1).
Fixed Effects	Deals with time consistent unobserved heterogeneity.	Unable to use any time consistent explanatory variables such as social background or race. Requires panel data.
Heckman Cross Section	Deals with selectivity to work.	Does not account for unobserved heterogeneity across mothers / non-mothers or endogeneity.
IV Cross Section	Deals with reverse causality.	Requires instrumental variables.
IV Fixed Effects	Deals with endogeneity of the choice to have children and unobserved heterogeneity.	Requires instrumental variables which vary with time. Requires panel data.
Endogenous Switching Model	Deals with endogeneity of the choice to have children, allows for estimation of separate wage equations for mothers and non-mothers.	Does not account for selectivity to work. Only accounts for unobserved heterogeneity between mother and non-mother groups, not individuals.

1.3 Sources of the Motherhood Wage Penalty

As shown in Table 1, the motherhood wage penalty is found to exist in a substantial number of countries. This section will review theories explaining why such a penalty exists and the relative importance they are likely to play in explaining the penalty.

Depreciation in Human Capital

An important point raised by Mincer & Ofek (1982, p.4) and Anderson et al. (2002, p.357) is that hourly wages upon re-entry into the labour market are on average lower than the hourly wages at the time the individual withdrew from the labour market. Mincer & Ofek (1982, pp.9-10) find that the longer the period of withdrawal, the larger the decline in wages. Mincer & Ofek (1982, p.11) also find that wages tend to "rebound" relatively quickly upon reentry, as human capital is once again accumulated. For women with young children this can be problematic, as accumulated human capital can depreciate over the time spent detached from the labour market. Although we are primarily interested in the net ceteris paribus effect of having children on the wages of women, simply measuring the human capital in years of work experience and education level may be misleading. In order to properly measure human capital, depreciation during time out of the workforce needs to be accounted for. Failure to consider the depreciation in human capital may lead to spurious results where the motherhood wage penalty is falsely identified, through the effects of depreciation rather than motherhood itself.

Human Capital - Return Expectations

Anticipation of long periods of time outside of the workforce may also lead to a lower level of human capital accumulation than would otherwise be optimal (Becker 1991, pp.42-43). For women expecting to have children (especially multiple) at some point in the future, Mincer & Ofek (1982, p.6) along with Becker (1991, pp.42-43) argue that these women will rationally invest in lower levels of human capital. It is reasoned that, as their effective working life is reduced, return on investment in human capital is lower for women with children when compared to women who do not have children and hence they rationally acquire less human capital. Although this may be a source of wage raw differentials between mothers and non-mothers, it is unlikely to be an important consideration in estimating the motherhood wage penalty as differences in human capital (measured through work experience and education) are held constant.

Family Work Conflict

Australian society has seen the steady increase of workforce participation of mothers with young children over the last 25 years, effectively breaking the traditional stay-at-home mother archetype (Pocock 2003, pp.73-74). While there has been a steady increase in participation of women with children, there has only been a small decrease in male participation and very little redistribution of household duties (Pocock 2003, pp.73-74). As a result, Australian mothers are increasingly taking on paid work without a reduction or redistribution of household duties between partners, resulting in many women having to cope with a 'double day' of paid work and household/childcare work (Baxter 1992, pp.230-32). Becker (1991, pp.42-43) and Baxter (1992) argue that as a result of the extra work, mothers have a lower level of real productivity relative to women without children. It is argued by Coverman (1983, p.625) that mothers have less energy while at work due to additional duties at home. Thus, under a neoclassical economic model, where workers are paid their marginal product, mothers are then paid lower wages than women without children because of their lower marginal productivity.

Additionally, women with young children who are unhappy with the quality of the non-parental childcare used in order to work, may feel apprehensive towards work (Arendell 2000, p.62). Arendell (2000, p.62) finds that use of commercial childcare for the purposes of work is associated with distress amongst working mothers. As a result of this apprehension and stress, it can be reasoned that women with young children in childcare are ultimately less engaged and productive at work which may lead to lower wages.

Motherhood Friendly Jobs

Budig & England (2001, p.207) discusses the possibility of mothers self-selecting to "Motherhood Friendly Jobs". It is argued that mothers seek jobs which have features which allow them to combine paid work with their roles as mothers. Features of these motherhood friendly jobs may include flexible work hours, no need to travel or work late nights, or simply require mothers to expend less energy. Budig & England (2001, p.207) contends that mothers are trading off a reduction in wages for desirable "motherhood friendly" properties of their work. This theory is formalised using a compensating differentials argument: people must be paid more to induce them to work in jobs without "motherhood friendly" properties, resulting in a pay differential between "friendly" and "unfriendly" jobs. Although flexibility may be an important characteristic of work, it is likely to be difficult to objectively measure. However, part time or casual work may be viewed as the highest level job flexibility. By controlling for part time work

(which can be objectively measured) workplace flexibility is likely to be accounted for in the estimation of wage equations.

Taste Discrimination

Budig & England (2001, p.208) amongst others presents a view that employers simply find that employing women with children is "distasteful". The argument follows that, even if women with and without children have the same level of productivity, employers, co-workers or customers may prefer women without children. Given the rigidity in anti-discrimination laws in Australia (Australian Human Rights Commission 2007) surrounding this type of discrimination, such a theory is unlikely to apply in Australia.

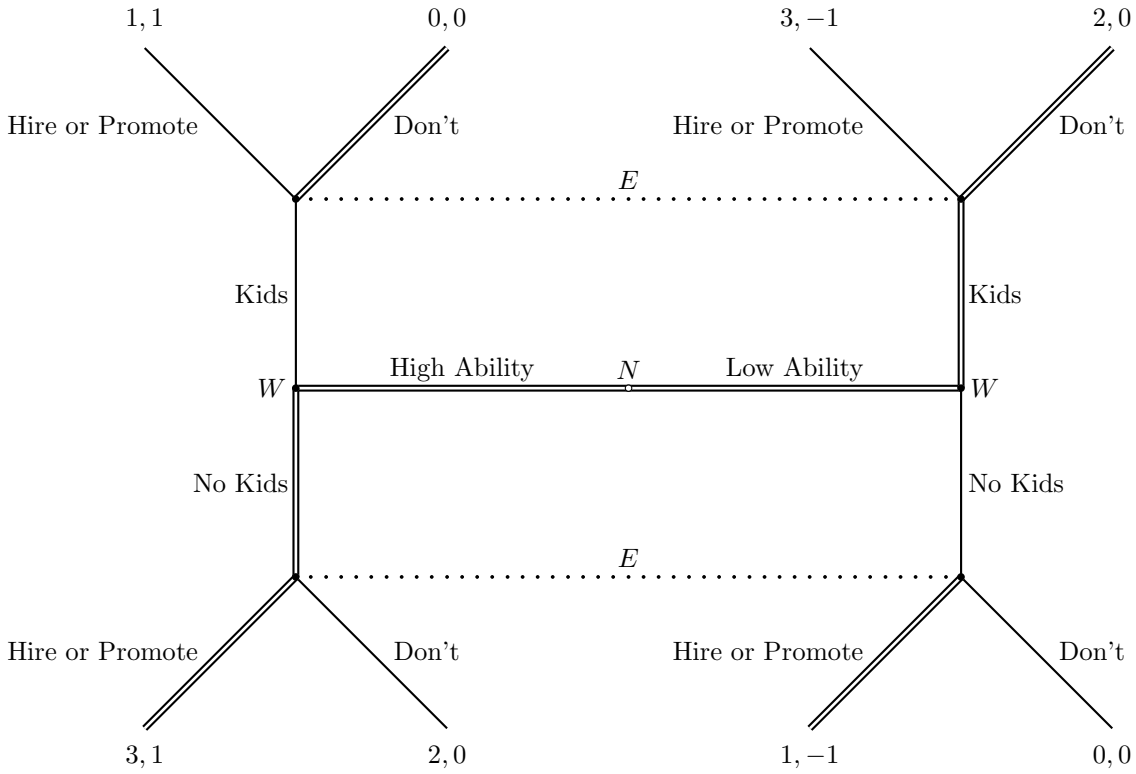
Statistical Discrimination - Signaling

Budig & England (2001, pp.208-09) use arguments in similar vein to earlier labour market models of education signalling by Spence (1973) to explain the motherhood wage penalty. Budig & England (2001) argue that because employers believe that highly productive women are less likely to have children than those with poor productivity (low human capital and ability), employers can use motherhood as a signal for employee quality (human capital endowments and other factors such as ability). Although not explicitly done in Budig & England (2001, pp.208-09), it is insightful to represent this strategic interaction graphically as extensive form game with imperfect information, as shown below in Figure 1.

In this case, employers prefer to hire those women with high levels of ability rather than those of low ability. Similarly, women prefer to be hired or promoted than to not be hired or promoted. Employers cannot directly observe the true ability of the job applicant. Employers only receive a signal of whether the particular applicant has children or not. However, the employers knows that it is more costly (lower payoffs) for women who have high ability to have children than low ability women, due to the opportunity cost of forgone earnings. Thus, the employer can deduce that if a woman has children then it is the case that she is of low ability and if she does not, then she must have high ability (shown as the equilibrium in Figure 1). Although this example is stylised in that the signal is *perfectly* revealing, it is a straight forward extension to show that motherhood could act as a imperfectly revealing signal of ability (eg. Motherhood signals a higher probability of low ability). The implication of an imperfect signal is that employers would simply believe that an applicant without children has a higher probability of being a "high ability" worker than an applicant without children. Given the informational asymme-

tries and costly nature of gaining information in assessing job applicants, this theory is not an unreasonable driver of the motherhood wage penalty.

Figure 1: Extensive Form Game of Statistical Discrimination



Where players are;
N - Nature,W - Woman (P1), E - Employer (P2),
Equilibrium Strategy shown in double lines

Source: Author's own illustration

Unobserved Heterogeneity

There may be systematic unobserved differences between the underlying characteristics of mothers and non-mothers. The result of the omission of these potentially important differences across the two groups may be that the estimated wage gap is in fact non-existent. These concerns have been echoed by many authors including Waldfogel (1997, p.210) and more recently Livermore et al. (2011, p.80). For example, if mothers were to have systematically lower work-effort or ability (which is unobserved) then the estimated wage gap may be over estimated. Further as Budig & England (2001, p.210) suggest, motherhood may be associated with a "present" orientation (e.g inability delay gratification) which is both correlated with a higher prevalence

of unplanned pregnancy and lower self discipline, ultimately leading to lower wages. Several studies including Livermore et al. (2011) and Gustafsson et al. (1996) have utilised panel data and regression techniques such as Fixed Effects whereby individuals wages are tracked across time and any unobserved constant differences removed. Using these techniques, Livermore et al. (2011) and Gustafsson et al. (1996) have found a statistically significant motherhood wage penalty. Due to the importance placed upon this by other authors, serious attention must be payed to potential unobserved heterogeneity in the development of an econometric model in this dissertation.

Reverse Causality

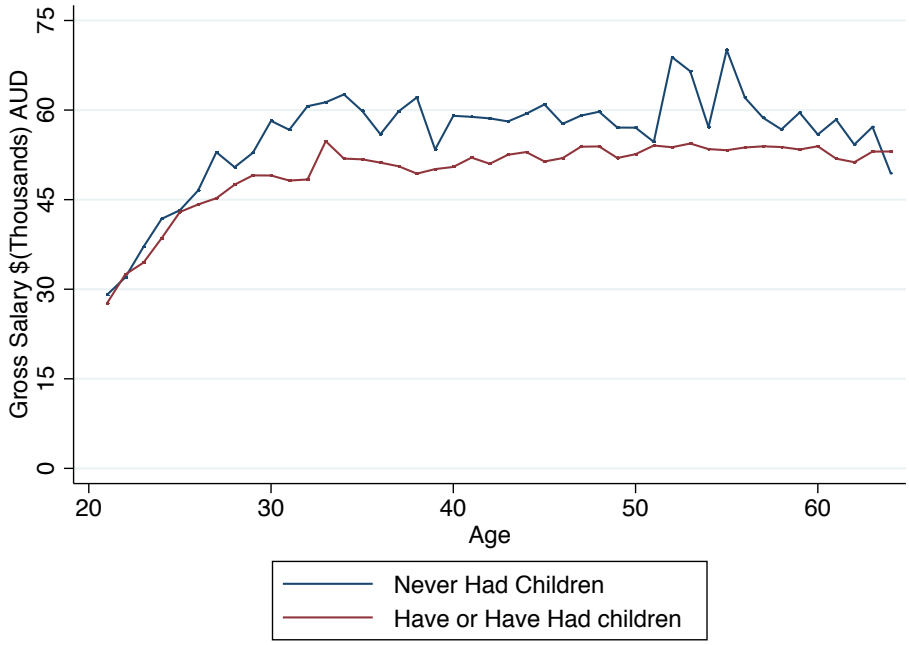
There is potential for a reverse causal relationship between motherhood and wages (Neumark & Korenman 1994, p.381). Wages are likely to effect the decision to have children while the decision to have children may also effect wages. Korenman & Neumark (1992, p.381) argues that fertility may be endogenous to wages by invoking the arguments of Becker (1991), whereby wages partly determine fertility through influencing the *"price of children"*. As a result, it is important to account for this possibility in the estimation of the motherhood wage penalty as ignoring this issue could result in misleading conclusions.

1.4 Nature of the Motherhood Wage Penalty

In Australia Livermore et al. (2011, p.89) finds evidence that the motherhood wage penalty materialises through a reduction in the rate of wage *growth* after having children, rather than an immediate penalty for motherhood. This hypothesis is also consistent with the observed path of hourly wage levels of mothers relative to non-mothers (See Figure 2), whereby wage growth of women begin to diverge around childbearing age (25-35).

The findings by Gupta & Smith (2002, p.610) also correspond to the notion that the motherhood wage gap emerges slowly across time. This gives rise to an important distinction when identifying the motherhood wage penalty. If the findings are accepted then the motherhood wage penalty must be identified by comparing the wages of women who have had children several years ago and women without children. If the motherhood wage penalty was identified by comparing the wages of relatively new mothers to women without children, then the conclusion in Gupta & Smith (2002) and Livermore et al. (2011) would predict an insignificant wage penalty as the changes to wage growth would not yet have had time to come to fruition. That is, findings by Gupta & Smith (2002) and Livermore et al. (2011) suggest that motherhood has

Figure 2: Average Wage of Mothers & Non-Mothers by Age



Source: HILDA 2001-2012 - Author's Own Calculations - Real Wages in 2006 AUD
Sample: All working women aged 21-65

an important impact upon wage rates in the long run, rather than the wage rates observed in years shortly after childbirth. Thus, for the purposes of this dissertation both mothers with young children and mothers who have had children some time ago should be included in the sample.

There are several theoretical reasons explaining why the motherhood wage penalty exists. Although evidence points to existence of a motherhood wage penalty in many countries, Australian evidence is unclear. In the next section, this dissertation first aims to determine whether the motherhood wage penalty does exist in Australia, before moving onto an analysis of whether grandparent provided childcare has any impact upon wages and the motherhood wage penalty.

2 Grandparent Provided Childcare & The Motherhood Wage Penalty

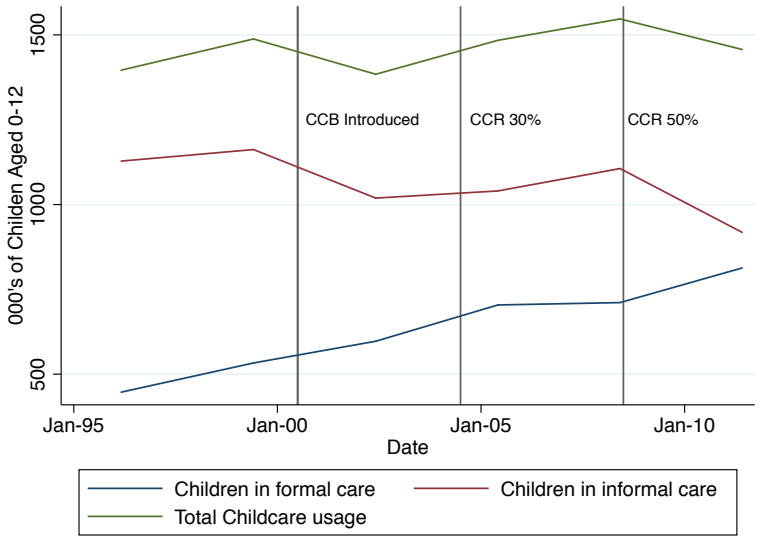
Children represent a significant responsibility in terms of care and parenting, which can be both time consuming, tiring and can constrain labour market participation for parents. These responsibilities can be particularly burdensome for mothers as the majority of this responsibility usually falls upon them (Baxter 1992, p.231). However, use of childcare services in effect allows mothers to delegate a portion of this responsibility for the purposes of work or otherwise. As a result of this, access to childcare services may influence the motherhood wage penalty. This dissertation focuses upon the role of informal childcare and in particular the influence of access to grandparent provided childcare on motherhood wage penalty.

The reason for this focus is the prevalence of grandparent provided childcare. Table 3 reveals that in 2011 just over 38% of all children aged 12 years or less received informal childcare as their usual mode of non-parental childcare (majority of which is provided by grandparents). This is contrasted with only 23.7% of children receiving some type of formal childcare as their usual mode of non-parental childcare or 13.6% receiving long day care (ABS 2011). Furthermore, ABS (2011) data shows that 98.1% of childcare services provided by grandparents is at no cost to the parents, thereby avoiding cost constrains in its use and econometric problems associated with the interaction between access to childcare and income (although it may carry small indirect costs such as transport or social costs). Further, informal care is of particular interest to policy as its use has been falling in recent years and Australia has seen a substitution away from informal childcare toward government subsidised formal childcare (as shown in Figure 3) (P.C. 2014, p.453, 100).

This section will focus upon the potential mechanisms through which the availability of grandparent provided childcare may influence the motherhood wage penalty.

Throughout this dissertation, geographical proximity between the primary residence of children and grandparents (minimum distance of either fathers or mothers parents) will be used as a proxy for access to grandparent provided childcare. Given that Whelan (2012, p.5) together with Gray (2005, p.562) and Guzman (2004, p.3) all find that grandparents living in close proximity to grandchildren are more likely to fulfil a caregiving role, distance is a reasonable proxy for availability.

Figure 3: Childcare Usage Over Time for Children Aged 0-12



Source: (P.C. 2014) (Using ABS Data collected triennially) ABS (2011)
Where CCB is "Childcare Benefit" and CCR is "Childcare Rebate" (Government Subsidies)

Table 3: Childcare Usage by Type

Proportion of children aged 0-12 (%)	
Usually attended care	52.2
Formal care	
Before and/or after school care	7.7
Long day care	13.6
Family day care	2.2
Occasional care	0.6
Total formal care	23.7
Informal care	
Grandparent	25.7
Non-resident parent	7.0
Other relative	7.2
Other person	5.9
Total informal care	38.6
Usually attended formal care only	13.6
Usually attended informal care only	28.5
Usually attended both formal and informal care	10.1
Did not usually attend care	47.8

Components do not sum as some children receive multiple types of care as their "main type"
Source: ABS (2011)

2.1 Flexibility & Quality of Grandparent Provided Childcare

Grandparent provided childcare is unique in its ability to fill gaps in the availability of other childcare providers and solve the "childcare jigsaw" (Wheelock & Jones 2002, pp.448-449). It is argued that the availability of grandparent provided childcare is particularly valuable in that it can be used as complementary or backup childcare for periods of time which formal childcare is unavailable such as evenings and weekends (Wheelock & Jones 2002, pp.448-449).

The perceived quality of grandparent provided childcare is also found to be superior to all other forms of non-parental childcare (Jenkins 2007, p.6). It is found that grandparent provided childcare is perceived as the next best thing to parental childcare and is highly valued for its intrinsic benefits in terms of close intergenerational relationships and quality (Jenkins 2007, p.6). Further, it is found that there was a *"clear perception that grandparental care is linked to the wellbeing of children"* Jenkins (2007, p.8), encouraging the development of a meaningful relationship between generations, while providing trusted high quality childcare.

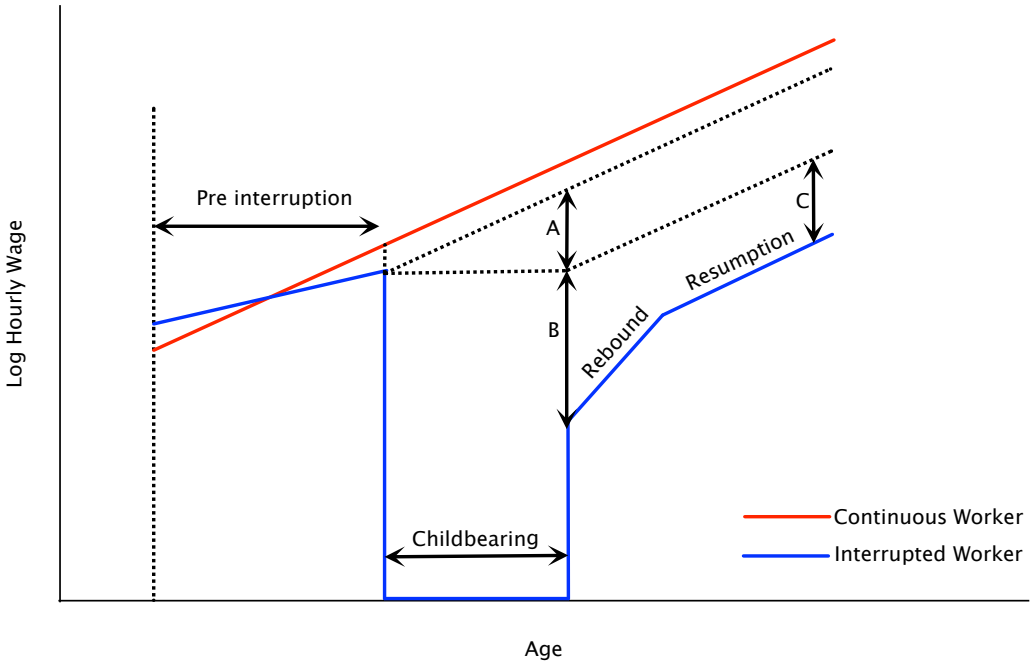
Additionally, Wheelock & Jones (2002, p.454). finds that grandparents are highly valued substitutes for parental care as parents are particularly confident in the quality of care provided. It is argued that grandparent provided care does not involve the same detrimental developmental impacts believed to be associated with formal childcare and maternal absence. Using this finding, (Jenkins 2007, p.9) argues that in circumstances where children are particularly young, grandparent provided childcare meets mothers needs better than the formal market.

Overall, most authors find that grandparent provided childcare is highly valued by parents of younger children. In particular, it appears that parents hold grandparent provided childcare in high esteem and view it as superior quality childcare which is as good as parental childcare. As a result, it is likely that grandparent provided childcare has a particularly power influence on labour market interactions, as will be discussed below.

2.2 Labour Market Attachment

Anecdotal evidence suggests that the availability of childcare is a key factor constraining maternal workforce participation (Nash 2013). Given the flexibility, quality and low costs associated with grandparent provided childcare, it's availability may have important effects upon participation in paid work and the degree of labour market attachment as measured though hours worked and the portion of mothers in full time work (Wheelock & Jones 2002, pp.458-459) (Whelan 2012, p.4). Recent evidence in Breunig et al. (2011, p.112) suggests that the supply elasticity of labour supply with respect to childcare costs, availability and quality may be considerable. Given that grandparent childcare is generally provided at zero cost and is regarded as superior quality, access to it may significantly increase labour supply, participation and labour market attachment.

Figure 4: Theoretical Time Path of Wages for Women With / Without Children



Adapted from Mincer & Ofek (1982, p.6)

Using the model of career interruptions developed by Mincer & Ofek (1982) as a framework, the potential effects of access to childcare can be analysed in detail. Figure 4 shows Mincer & Ofek (1982, p.6)'s model applied to the setting of motherhood. In the period leading up to the work interruption, women expecting to have children would rationally accumulate lower

levels of human capital, as the returns to this investment are lower due to the period of time spent outside of the workforce. Thus, the blue path in Figure 4 takes on a lower slope than the red path (women not expecting to have children), representing a lower rate of wage growth of women expecting to have children. Women having children then leave the workforce for a period of "Childbearing", where they do not engage in any work. However, upon their return, wages are expected to be substantially lower due to depreciation in human capital (shown by the line segment B) and forgone human capital accumulation (line segment A)(Mincer & Ofek 1982, p.6). Mincer & Ofek (1982, p.4) then argue that post return, human capital is accumulated at a greater rate than would otherwise be expected due to "rebound" in which the small parts of missing skills/knowledge are "repaired" with little effort, leading to a rapid rebound in human capital. In the long run using the Mincer & Ofek (1982, p.8) model, women with children would then have lower wages due to the effect of human capital depreciation (Segment C) and forgone human capital accumulation (Segment A).

The availability of childcare (such as grandparent provided care) may have serious impacts upon the period of time which mothers spend outside of the workforce and hence the depreciation in human capital. As shown in Table 4, the increased availability of grandparent provided childcare (deemed to be available if grandparents have cared for the family's children in any capacity in the last 12 months) is associated with shorter periods of time outside of the workforce. Furthermore, if access to grandparent provided care is measured through close geographic distance (20 km or less) of the residence of grandparents, women with access tend to have shorter periods of time spent outside of the workforce.

Applying the model of Mincer & Ofek (1982), mothers who spend shorter periods of time outside of the workforce are likely to have lower levels of human capital depreciation and lower levels of forgone wage growth. The implication of this is that availability of grandparent provided childcare may have serious impacts upon the wages of mothers. The effects of a lack of availability is associated with increased lengths of time outside of the labour force can be visually by an increase to the 'Childbearing' period in Figure 4. It would be expected that the line segment A+B would larger in magnitude for women who have an increased period of time outside of the labour force as a result of no grandparent provided childcare being available. That is, the length of time outside of the labour force and hence wage effects of career interruptions are likely to be less severe for women who have access to grandparent provided childcare.

Table 4: Time Spent Out of Labour Force by Availability of Grandparent Childcare

Grandparent Childcare Available	Mean Time spent not working	Sample Size
No	4.55	5502
Yes	3.37	2023
Total	4.23	7525

Source: HILDA 2001-2012. Sample: Mothers who have considered childcare & have children 14 years old or less
Avalable if children have been care for by grandparents at any point in the last 12 months

Table 5: Time Spent Out of Labour Force by Geographic Proximity of Child's Grandparents (Geographical distance used as a proxy for availability)

Distance	Mean Time spent not working	Sample Size
Greater than 20 km	6.54	4039
Within 20km	4.62	2145
Total	5.87	6184

Source: HILDA 2001-2012. Sample: Mothers who have considered childcare & have children 14 years old or less
Grandparents asumed not to have moved from last observation in the case of missing values
Sample size smaller because data only avalable after 2008 for geographic distance

2.3 Family Work Conflict

As previously discussed in the literature review, women with young children may have lower wages due to lower real productivity as a result of being stressed or worried when leaving their children in commercial childcare in order to work. Given this, it is reasonable to expect that mothers with access to grandparent provided childcare would be less worried about their children while at work, resulting in higher productivity. This is reflected in Table 6 and Table 7,[2] where data suggests that feelings of lower work performance is associated with lower levels of grandparent provided childcare. Using the arguments similar to that of Becker (1991, pp.42-43), then mothers with access to grandparent provided childcare may experience a diminished motherhood wage penalty, attributable to higher levels of productivity at work (owing to reduced apprehension regarding work and reduced family work conflict more generally).

[2]Table 6 and Table 7 use different measures of "access" to grandparent provided childcare. Access is measured in Table 6 by the past use of grandparent provided childcare in any capacity in the last 12 months, whereas Table 7 measures "access" using close geographical proximity (within 20 km) as a proxy.

Table 6: Work Performance & Grandparent Provided Childcare

Portion of women agreeing with the phrase *"Thinking about my children interferes with my performance at work'* vs. access to grandparent provided childcare.

Grandparent Childcare Available	Portion of women agreeing	Sample
Not Available	0.432	2689
Available	0.139	3548
Total	0.27	6237

Source: HILDA 2001-2012. - NB. Some individuals refused to answer this question or "did not know"
Sample: Working mothers who have considered childcare & have children 14 years old or less, and provide an answer to the question - Difficulty with childcare availability is defined as rating difficulty $\geq \frac{4}{7}$
Available = 1 if Children have been care for by grandparents at any point in the last 12 months

Table 7: Work Performance & Geographic Distance of Grandparents

Portion of women agreeing with the phrase *"Thinking about my children interferes with my performance at work'* vs. geographic distance of grandparent (proxy for availability).

Grandparent Geographic Distance	Portion of women agreeing	Sample
Greater than 20 km	0.216	2273
Within 20km	0.242	1345
Total	0.208	3618

Source: HILDA 2001-2012. - NB. Some individuals refused to answer this question or "did not know"
Sample: Working mothers who have considered childcare & have children 14 years old or less, and provide an answer to the question - Difficulty with childcare availability is defined as rating difficulty $\geq \frac{4}{7}$

2.4 Flexibility

As previously mentioned, grandparent provided can differ substantially in terms of flexibility (such as care availability at short notice) when compared to formal childcare. This is reflected in Table 8, where access to informal childcare provided by the child's grandparents is associated with increased ability to find childcare at short notice. Applying the "compensating differentials" argument of Becker (1991) as discussed in the literature review, it is possible that women with access to informal childcare may be more able to work in jobs which do not offer high levels of flexibility (ie. do not require jobs which are "motherhood friendly").

Table 8: Difficulty Finding Childcare at Short Notice & Access to Informal Care

Level of agreement with the phrase *"[I have had] Difficulty in last 12 months finding care at short notice"* vs. portion of women having difficulty with access to informal childcare e.g. Grandparents.

Level of Agreement	% of women with access to informal childcare	Sample
No Data		321
Not a problem	0.394	1637
1	0.406	468
2	0.396	540
3	0.370	395
4	0.355	273
5	0.296	460
6	0.369	233
7	0.325	335
8	0.275	447
9	0.246	309
Very much a problem	0.225	592
Total	0.337	6010

Source: HILDA 2001-2012.
Sample: Working mothers who have considered childcare & have children 14 years old or less
Access to informal childcare defined as having used informal childcare in the past 12 months in any form.

Overall, there is a solid theoretical background which predicts that grandparent provided childcare may act to reduce the motherhood wage penalty, through a reduced family work conflict and reduced time spent outside of the labour force. As such, it is worth while testing whether these theoretical arguments are realised and whether grandparent provided childcare has any impact upon the motherhood wage penalty.

3 Data

For the estimation of models and testing of results, this dissertation uses unit record data from the Household Income and Labour Dynamics in Australia survey (HILDA) over the period of 2001-2012. HILDA is a nationally representitive household based panel study which collects data regarding labour market dynamics, the financial position and well-being of households (Melbourne Institute 2014). HILDA has been widely used within both Australian labour market research broadly and Australian research focusing on the motherhood wage penalty, such as Krepp (2007) and Livermore et al. (2011). Given the extensive prior research using HILDA and construction of the survey specifically to study labour market dynamics, HILDA is ideally suited for use in this dissertation.

Wave 1 of HILDA (2001) consisted of 7,682 households comprised of 19,914 individuals. Continued detailed surveys of these individuals have been conducted yearly since 2001, with an additional 2,153 households comprising of 5,477 individuals included since 2011. Of particular interest to this dissertation is the detailed responses collected regarding children, childcare, labour supply and human capital. Key strengths of HILDA for the purposes of this dissertation are firstly the quantity and detail of data available. Secondly data is collected both within a household context and observations are collected from the same households across time.

Sample

Although HILDA has 165,299 observations in total, several exclusions of observations must be made as shown in Table 9. Firstly, the population of interest for the purposes of this dissertation are women, resulting in 78,249 observations of men being excluded. Secondly, women outside of the ages 25 to 59 are excluded as in Livermore et al. (2011, p.83) to ensure that the majority of women in the sample are educated and have the ability to join the labour force. Thirdly, self employed or unpaid workers are excluded from the sample as wage figures provided are likely to be highly uncertain or unavailable. Finally, observations in which individuals do not provide adequate information, either refusing to answer important questions or giving clearly unreasonable results are removed (Eg. Answering that they do not know how many children they have). These exclusions are summarised in Table 9 below.

Table 9: HILDA Sample Exclusions

Population	Observations	No. Individuals
Full HILDA Dataset	165,299	26,965
Women Only	87,050	13,916
Keep ages 25 to 59	52,110	8,742
Drop all students	48,008	8,423
Drop all business owners self employed / unpaid workers	43,305	8,052
Drop all observations with missing data / inconsistent data / refusal to answer	35,974	7,206
Sample Size	**35,974**	**7,206**

Composition of Sample

The sample of interest, consists of 35,974 observations and is classified in Table 10 below;

Table 10: Sample Composition

Sample	Observations
Working	24,871
Not Working	11,103
Women without children	7,932
Women with children	28,042
Women with young children (0-14)	15,808
Women with young children (0-14) who are working	9,895

3.1 Pooled OLS vs. Panel Data Methods

This dissertation makes use of both panel data models (showing the same individuals across time) such as fixed effects and pooled cross sectional models such as Pooled OLS. Although panel data methods can be used to control for issues such as unobserved heterogeneity (discussed in "Empirical Analysis" chapter), often more flexibility is available using pooled methods (for example Heckman (1976) corrected models). Although analysis will primarily done using pooled regression methods, panel data methods will also be utilised to ensure the robustness of results.

Implications Of & Corrections For Sample Pooling

Pooling multiple years of data collected in a cross sectional context such as HILDA can give rise to issues of heteroscedasticity and autocorrelation if the correlation in errors is not accounted for. Due to the fact that the same individuals are surveyed across time in HILDA (and it is likely that errors are correlated within observations of the same individual), the assumption that conditional covariates of the errors across time are zero is unlikely to hold in a Pooled OLS model. That is;

$$E(u_t u_s \mathbf{X}_t \mathbf{X}_s) \neq 0 \ \ \forall \ \ t \neq s, s = 1, \cdots, T \tag{1}$$

Where t is the year of the interview and s is another year, which is not t.
Furthermore, the errors in an OLS regression are unlikely to be homoscedastic, that is;

$$E(u_t^2 \mathbf{X}_t' \mathbf{X}_t) \neq \sigma^2 E(\mathbf{X}_t' \mathbf{X}_t) \quad \text{where} \ \ \sigma^2 = E(u_t^2) \ \forall \ t \tag{2}$$

Equation (1) and Equation (2) show that if HILDA data was to be pooled for use in OLS, then the assumptions of non-autocorrelation and homoscedasticity are likely to be violated. The implications of this are that estimates are no longer be the "Best Linear Unbiased Estimates" (BLUE) (Wooldridge 2008, ch. 8).

To account for these problems, asymptotically robust estimates of the variance of coefficients can be computed using a "Huber Sandwich Estimator", clustered on the basis of the individual's cross time identifier (HILDA Person identifier). This estimator is expressed as follows Wooldridge (2010, p.197);

$$V(\widehat{\boldsymbol{\beta}}_{OLS}) = (\mathbf{X}'\mathbf{X})^{-1} \mathbf{X}' \widehat{\boldsymbol{\Omega}} \mathbf{X} (\mathbf{X}'\mathbf{X})^{-1} \tag{3}$$

$$\widehat{\boldsymbol{\Omega}} = \begin{pmatrix} \sigma_1^2 & \sigma_{1,2}^2 & \sigma_{1,3}^2 & \cdots & 0 & 0 & 0 \\ \sigma_{1,2}^2 & \sigma_2^2 & \sigma_{2,3}^2 & \cdots & 0 & 0 & 0 \\ \sigma_{1,3}^2 & \sigma_{2,3}^2 & \sigma_3^2 & \cdots & 0 & 0 & 0 \\ \vdots & \vdots & \vdots & \ddots & \vdots & \vdots & \vdots \\ 0 & 0 & 0 & \cdots & \sigma_1^2 & \sigma_{1,2}^2 & \sigma_{1,3}^2 \\ 0 & 0 & 0 & \cdots & \sigma_{1,2}^2 & \sigma_2^2 & \sigma_{2,3}^2 \\ 0 & 0 & 0 & \cdots & \sigma_{1,3}^2 & \sigma_{2,3}^2 & \sigma_3^2 \end{pmatrix} \tag{4}$$

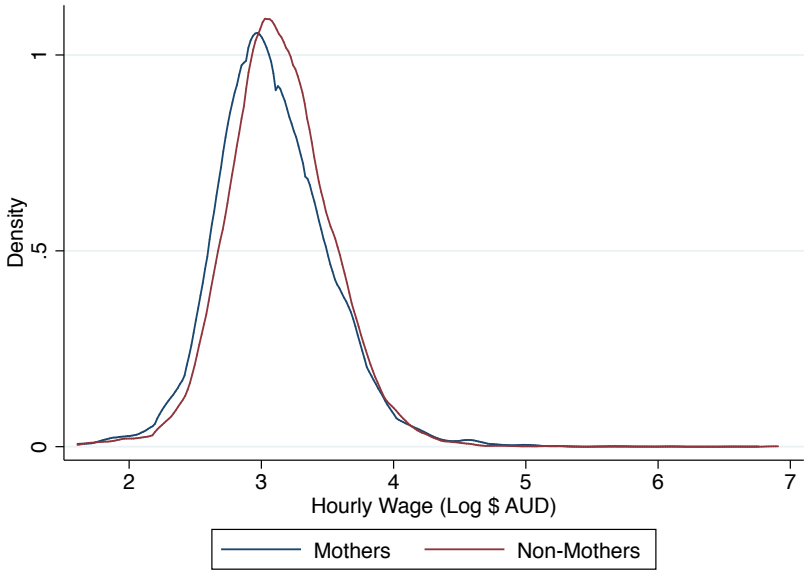
Where the top left cluster represents a single individual with 3 observations (different years) and

the bottom right cluster represents another separate individual with 3 observations (different years) of observations (Kaplan n.d.).

3.2 Are Mothers and Non-Mothers Different?

Before using regression analysis to identify whether the motherhood wage gap exists, it is prudent to look at the differences between the two groups to see if there are any distinguishing factors which should be controlled for in later regression analysis. Shown in Figure 5 is the kernel density of hourly wages, amongst working working women. From Figure 5 it is clear that mothers on average receive lower wages than women without children, with mothers over represented at lower income levels. This provides prima facie evidence in favour of the gross wage gap (not accounting for any observed differences in human capital etc.), motivating further investigation.

Figure 5: Average Wage of Mothers & Non-Mothers by Age



Source: HILDA 2001-2012 - Author's own calculations - Hourly wages measured in 2001 $AUD

Given that mothers appear to receive lower wages than women without children on average, it is important to identify the source of this wage gap. As a first starting point, it is prudent to review the differences in observed characteristics between the two groups as potential drivers of this wage gap. Table 11 summarises group averages and provides the p-values of a hypothesis test, testing against the null hypothesis that the two groups have equal means of the particular observation.

From Table 11, it can be seen that there is a significant difference between women with and without children in most respects. The implication of this is that, simply looking at differences in wages cannot identify the motherhood wage penalty, but rather regression analysis is required to find the ceteris paribus effect of motherhood upon wages.

Table 11: Summary Statistics - For Working Individuals

	All Women	No Kids	Mothers			
Variable	Mean	Mean	Mean	Diff.	T-Stat	P-Value
Log Hourly Wage	3.103	3.143	3.088	0.055***	9.589	0.000
Hrs. Worked	32.47	39.07	29.96	9.108***	57.82	0.000
Age	41.64	35.41	44.00	-8.592***	67.89	0.000
Ed. Y12	0.138	0.149	0.134	0.015***	2.964	0.003
Ed. TAFE	0.264	0.241	0.272	-0.031***	5.033	0.000
Ed. Bachelors	0.203	0.296	0.168	0.128***	20.71	0.000
Ed. Post Grad	0.147	0.189	0.132	0.057***	10.67	0.000
Occupation Tenure	9.316	7.557	9.983	-2.426***	20.17	0.000
Employer Tenure	6.740	5.666	7.147	-1.482***	15.15	0.000
Work Experience	19.47	15.78	20.87	-5.091***	38.13	0.000
Time Not Working	4.845	1.642	6.060	-4.418***	81.51	0.000
Supervisor	0.466	0.492	0.456	0.036***	5.093	0.000
Public Sector	0.310	0.311	0.309	0.002	0.329	0.742
Union Member	0.317	0.300	0.323	-0.023***	3.451	0.001
Indigenous	0.014	0.014	0.015	-0.001	0.299	0.765
Born OECD	0.907	0.931	0.898	0.033***	8.812	0.000
Married or de facto	0.716	0.571	0.771	-0.200***	29.58	0.000
Parents Status	44.15	49.20	42.23	6.971***	23.94	0.000
Partner Wage	755.2	610.7	810.0	-199.3***	16.56	0.000
Partner Hours	28.92	22.81	31.24	-8.431***	25.82	0.000
Partner Income	34863	28199	37392	-9193***	14.71	0.000
Manager	0.084	0.107	0.076	0.031***	7.323	0.000
Professional	0.317	0.400	0.285	0.115***	16.874	0.000
Trade	0.037	0.040	0.036	0.003	1.176	0.240
Service	0.132	0.083	0.150	-0.066***	15.547	0.000
Admin	0.261	0.260	0.262	-0.002	0.243	0.808
Sales	0.083	0.064	0.090	-0.025***	6.879	0.000
Machine Op.	0.012	0.009	0.013	-0.004***	3.093	0.002
Labourer	0.074	0.037	0.088	-0.052***	16.632	0.000
Part Time	0.431	0.164	0.533	-0.368***	63.27	0.000
Young Kids	0.398	0.000	0.549	-0.549***	148.1	0.000
Close Parents	0.138	0.136	0.139	-0.003	0.660	0.509
Devout Catholic	0.159	0.130	0.169	-0.039***	7.979	0.000
Number of Siblings	2.740	2.298	2.908	-0.610***	24.91	0.000
Housing Tenure	4.671	1.836	5.748	-3.912***	32.93	0.000
Moved out 25 plus	0.894	0.963	0.944	-0.069***	17.33	0.000

A full list of the variable descriptions and HILDA data codes can be found in the appendix.

3.3 Measuring Changes in Wages Using Logs

This dissertation will use a standard "log level" specification for the wage equations estimated. This involves regressing the *natural log* of the hourly wage upon *levels* of independent variables. The advantage of this specification allows for simple interpretations of the estimated coefficients as the percentage changes in hourly wages for a given unit change in an independent variable Pattanayak (2013, p.2). An example of this is given below;

$$\ln(W_i) = \beta_0 + \beta_1 x_{1,i} + \beta_2 x_{2,i} + \cdots + u_i \tag{5}$$

Where W_i is hourly wage $x_1, x_2 \cdots$ are control variables such as human capital and $\beta_1, \beta_2 \cdots$ slope coefficients.

Suppose we wanted to interpret β_1, the coefficient of $x_{1,i}$. For example, $x_{1,i}$ could represent a variable counting years of education. If we take the differential of *Equation* (5) W.R.T $x_{1,i}$, holding all other factors constant;

$$d\ln(W) = dx_1\beta_1 \tag{6}$$

$$\frac{d\,W_i}{W_i} = dx_1\beta_1 \quad [3] \tag{7}$$

Rearranging and multiplying by 100;

$$\frac{100 \times dW_i}{W_i} = 100 \times dx_1\beta_1 \tag{8}$$

$$100 \times \beta_1 = \frac{\frac{100 \times dW_i}{W_i}}{dx_1} = \frac{\%\Delta W_i}{unit\ \Delta x_i} \tag{9}$$

Thus, from $100 \times \beta_1$ could simply be interpreted as the percentage change in wages resulting from for an additional year of education. Alternatively, if a variable like $x_{2,i}$ represented a dummy variable such as 'have kids', then the interpretation of $100 \times \beta_2$ would be the percentage change in wages as a result of having kids (compared to not having kids) Pattanayak (2013, p.2). Given that "log level" specifications are common throughout labour economics literature and are easily interpreted, this dissertation will make extensive use of this specification.

[3] $100 \times \Delta \ln(x) \approx \%\Delta x$ from a first order taylor series expansion. NB This is only an accurate approximation for small changes in x

4 Identification Issues

There are several issues which may cause problems in identifying the true motherhood wage penalty. This section will discuss each of these potential issues and outline econometric strategies for dealing with them.

4.1 Self Selection Bias

Straightforward pooled OLS regression may not result in appropriate measurement of the motherhood wage penalty. A potential selection bias may occur due to the fact that the model is fitted using hourly wage data, which is only observed for those women who have selected to work. This would not be a particularly important problem if the vast majority of women worked and women selected to work at random (and hence were observed at random). However in the sample taken from HILDA, a significant portion (30.9%) of women are not working, giving rise to potential sample selection biases which needs to be taken into account if the decision to work is non-random (Heckman 1979, p.153).

A priori, a positive sample selection bias toward work would be expected, meaning individuals with higher wage attainable in markets (wage offers) are expected to be more likely to work (Mroz 1987, p.774). The sample selection can be modelled using an income/leisure tradeoff type model. In this model, the individuals labour supply problem can be represented as;

$$\max_{0 \leq h \leq 168} u_i(I, l) \tag{10}$$

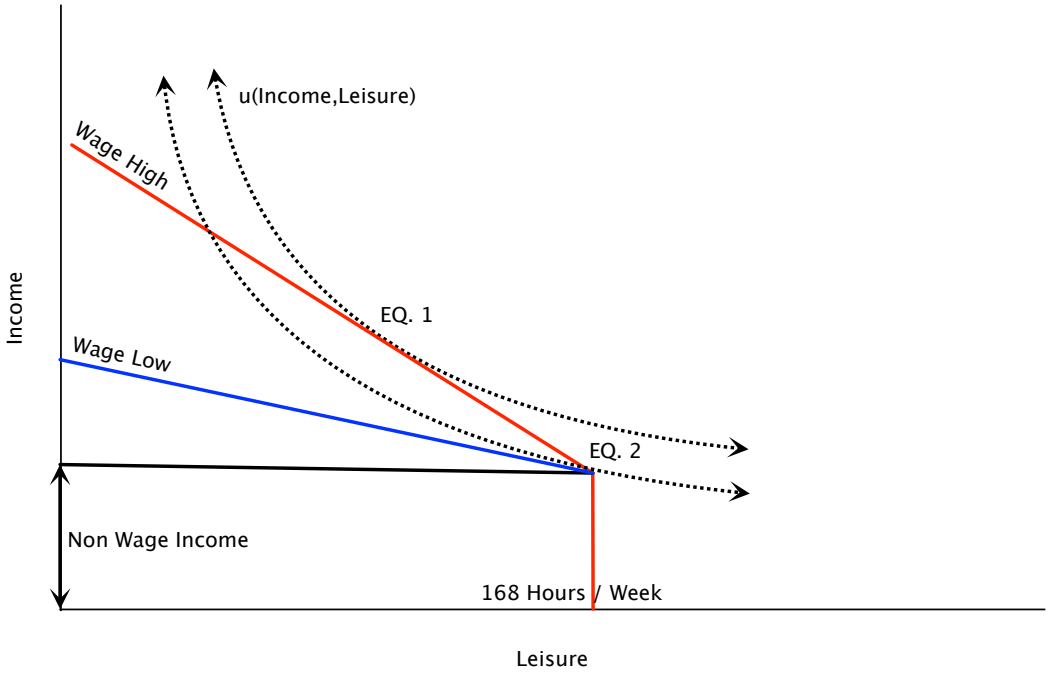
$$\max_{0 \leq h \leq 168} u_i(w_{it}h + a_i, 168 - h) \tag{11}$$

Where an individual i maximises utility $u_i(I, l)$ by choosing income I (made up of earned and non-earned income) and non-work time (leisure) l. By increasing hours of paid work, individuals increase their income by w_i (wage rate) per hour but also have disutility from the lost leisure time (can also be though of as lost time with children in the context of mothers). Using straight forward optimisation, the following condition can be derived where individuals choose h such that;

$$w_{it} = -\frac{\frac{\partial u}{\partial l}}{\frac{\partial u}{\partial I}} \tag{12}$$

Where $\frac{\partial u}{\partial l}$ is the marginal utility of leisure time and $\frac{\partial u}{\partial I}$ is the marginal utility of Income. Furthermore, we can ensure uniqueness of this solution so long as we assume continuity, convexity and strict monotonicity of preferences. This is shown in Figure 6 below, where the equilibrium utility maximising (income, leisure) bundle is tangential to the income/consumption constraint.

Figure 6: Income Leisure Tradeoff



Where EQ1 is the high wage equilibrium and EQ2 is the low wage equilibrium

From Figure 6, it can be seen that as the wage rate falls, there is a critical wage level where the individual's utility maximising allocation is to allocate all 168 hours per week to leisure and thereby not participating in work (movement from EQ.1 to EQ.2). Using the idea of trading off leisure for work, the lowest wage which induces an individual to work can be found, as follows;

Workers participate if and only if;

$$w_{i,t} \geq -\frac{\frac{\partial u}{\partial l}}{\frac{\partial u}{\partial I}} \tag{13}$$

$$w_{i,t} \geq MRS_{I,l} \tag{14}$$

$$w_{i,t} \geq \underbrace{w_i^r}_{reservation\ wage} \tag{15}$$

When $-\frac{\frac{\partial u}{\partial l}}{\frac{\partial u}{\partial I}}$ (slope of the indifference curve) is evaluated at $l = 168$ and $I =$ non-wage income (ie. $\text{MRS}_{I,l}$ is evaluated for the first hour of work in Figure 6)

The right hand side of Equation (15) is referred to by Gronau (1974) as the *"reservation wage"*. If the individual is offered any wages below this critical level (depicted as the blue line in Figure 6) then the individual maximises their utility by not working at all. The implication is women who have lower wage offers are less likely to work and are less likely to be included in the sample, resulting in a potential positive sample selection bias.

The goal is to estimate Equation (16) in a consistent unbiased manner, however to do this the interaction between equation Equation (16) and Equation (17) below must be considered;

$$ln(w_i) = \mathbf{X}_{i,1}\boldsymbol{\beta}_1 + u_{i,1} \quad \text{Potential Hourly Wage} \tag{16}$$

$$ln(w_i^r) = \mathbf{X}_{i,2}\boldsymbol{\beta}_2 + \gamma a_i + u_{i,2} \quad \text{Reservation Wage} \tag{17}$$

Where $(u_{i,1}, u_{i,2})$ is independent of $(\mathbf{X}_1, \mathbf{X}_2, a_i)$, $\mathbf{X}_1$ contains productivity characteristics such as human capital and other characteristics such as demographics which determine wages. $\mathbf{X}_2$ contains variables which determine the utility of leisure time and income. a_i is other non-wage income. For example, income of the individual's partner.

The problem of selection is that $ln(w_i)$ is only observed when $ln(w_i) > ln(w_i^r)$ (individual is working). That is;

$$\ln(w_i) - \ln(w_i^r) = \mathbf{X}_{i,1}\boldsymbol{\beta}_1 - \mathbf{X}_{i,2}\boldsymbol{\beta}_2 - \gamma a_i + u_{i,1} - u_{i,2} > 0 \tag{18}$$

$$= \mathbf{X}_i\boldsymbol{\delta}_2 + u_{i,1} - u_{i,2} > 0 \tag{19}$$

In order to correct selection bias, econometric methods similar to that discussed in Wooldridge (2010, p.802) can be applied. Without correcting for the selection, a simple OLS estimate is actually estimating $ln\left[w_i | ln(w_i) > ln(w_i^r)\right]$ which is not equal to $ln\left[w_i\right]$ in the presence of correlation between $u_{i,1}$ and $u_{i,2}$. That is, estimates will be biased if there is any correlation between the errors in the potential hourly wage equation and the errors of the reservation wage equation. However, it is reasonable to expect some correlation will be present. A potential cause of correlation in errors is due to unobserved factors such as "family focus" vs. "work focus". Women with greater family focus would be expected to earn lower wages (because they

place an emphasis on flexible working hours and no after hours commitments), while simultaneously having higher reservation wages, because they value leisure or family time more greatly, meaning correlation in errors (ρ) is negative. A further example is the case of a particularly lazy woman (meaning $u_{i,1} < 0$ due to laziness being unobserved). This woman would be likely to have an abnormally high reservation wage and hence $u_{i,2} > 0$ owing to the fact that she does not like work. Overall, we expect correlation of errors to be negative ie. $\rho < 0$

This bias can be corrected using the method outlined in Heckman (1974). Heckman (1974)'s procedure involves first estimating a probit model (probability model) for the participation of mothers in the workforce, then using these estimated probabilities to generate a selection term (Inverse Mills Ratio - IMR) and adding this to the regression equation, to account for the bias. Where the coefficient $\beta_{IMR} = \rho\sigma$ where ρ is the correlation of errors discussed earlier and σ is the variance of the error term u_i .

4.2 Endogeneity of Children & Reverse Causality

The second econometric issue to consider is the potential endogeneity of fertility and reverse causality. A mother's choice to have a child may be influenced by her wages achievable in the marketplace. However, her wages may also be influenced by whether or not she has children. Ie. there is potential for a reverse causal relationship between motherhood and wages. If this is not accounted for in the estimation of econometric models, this endogeneity (reverse causality) may lead to serious biases in the estimation of the wage equation and more specifically bias estimates of the impact of motherhood upon wages. A prior study looking at the motherhood wage penalty by Livermore et al. (2011, p.83) did highlight the potential of this issue to cause problems, however the authors did not account for endogeneity in the estimation of the wage penalty. This section will first discuss the nature and likely importance of the problem and second discuss potential methods of overcoming this issue.

There is a well established theoretical literature on the potential endogeneity of fertility choices and the extent to which an increases in the wage rate increases the opportunity cost of having children. Accordingly, the inclusion of children in a wage equation can lead to endogeneity issues. (Becker 1991, ch. 5) develops a model for the decision making process in which families plan the number of children to have. (Becker 1991, p.135) starts with the observation that amongst advanced nations, income and fertility appear to be negatively related. That is, lower income households tend to have more children than middle income families, ceteris paribus.

(Becker 1991, p.140) reasons that the negative relationship between income and fertility is due to the relatively high opportunity cost of having children for high income earners, as income must be forgone to care for children.

Following (Becker 1991, p.140), it is not unreasonable to expect that women with higher potential income are likely to have lower fertility rates. The cost of having children would be the sum of forgone wages, the present value of lost earnings resulting from human capital depreciation (assuming that human capital depreciates when outside of the labour market) and other expenses associated with additional costs of living. Thus, for higher income earners, birth rates would then be expected to be lower as the mother's forgone wages are major part of the total cost of producing and raising children[4].

(Becker 1991, pp.145-51) goes beyond just a simple model and proposes a "quality" and "quantity" trade off amongst the children within a household. In this model, Becker (1991) proposes that a household's utility is composed of an aggregate consumption commodity, the number of children and the "quality" of children. Through this argument, (Becker 1991, p.147) reasons that there is a strong interaction between quality and quantity despite having low substitutability. By way of predictions, Becker (1991) proposes that small increases in the prices of children relative to other goods can have create large declines in fertility rates and large increases child "quality". That is, when the wages or potential wages of women increase, the effective price of children increases leading to lower fertility levels.

In the standard Mincer (1958) log wage equation, log-hourly wages are a function of observed variables, $\mathbf{X}$ and a dummy variable indicating whether the individual is a mother or not, that is;

$$\ln(w) = \mathbf{X}\boldsymbol{\beta} + \beta_{kids}\, kids + u \tag{20}$$

In the case of endogeneity, such as that discussed above, $Cov(x_k, u) \neq 0$ (where $kids_i$ is a dummy variable representing young children). This is a violation of the "strict exogeneity" assumption of ordinary least squares estimation, meaning that estimation may be biased (Wooldridge 2008, p.521).

[4]Forgone wages by mothers is estimated to be 2/3 of the total cost of rearing children in the USA (Espenshade 1977)

In order to correct the problems associated with endogeneity, instrumental variable (IV) techniques can be utilised. However, to apply IV techniques, instrumental variables for the "*have kids*" dummy variable must be found, which is a non-trivial matter. In order to obtain valid instruments for fertility (probability of *have kids* = 1), instruments must both be exogenous to the wage equation (have no direct impact upon log hourly wages) and must be relevant in predicting whether a woman has children. Once instruments have been found, estimation techniques such as Angrist et al. (1996)'s procedure (2 stage least squares) can then be applied.

For the purposes of estimation of the motherhood wage penalty, the following instrumental variables were constructed as instruments for fertility rates;

Table 12: Instrumental Variables for Fertility Rates

Instrumental Variables used for Fertility Rates

Variable	Definition	HILDA Data Code
Devout Catholic	Dummy Variable: 1 if the individual identifies themselves as a Catholic Christian **and** gives a subjective rating of their personal view on the importance of religion of greater than 5/10. Where 0 represents the statement "religion is not important to my life at all" and 10 represents the statement "religion is the most important thing in my life"	religb relimp
Number of Siblings	Count Variable: The number of siblings the individual had growing up. (Previously used in Blacklow & Church (2006))	fmnsib
Moved Out at 21 or Less	Dummy Variable: 1 if the individual moved out of home at an age of 21 or less, 0 otherwise. (Previously used in Amuedo (2005))	fmageln

"Number of Siblings" and "Moved Out at 21 or Less" have all been used as fertility instruments in the previous research as as noted in Table 12. However, this dissertation is the first of the author's knowledge to introduce "Devout Catholicism" as an instrument for fertility choices.

Given the Catholic church's persistent stance against the use of contraception, it is reasonable to expect that devout followers of the religion would tend to have children at higher rates when compared to the wider population. The implication of this is that *devout catholic* is expected to be relevant in explaining the likelihood of a woman becoming a mother. However, there is no reason to expect that being a devout catholic has any impact on wages, meaning that *devout catholic* is expected to be a valid instrument.

It is also reasonable to expect that if an individual moves out from the parental home at 21 years or younger, they are likely to be more independent, social and mature individuals. As a result, it is expected to increase fertility rates. However, there is expected to be no partial effects upon wages, implying that "*Moved Out at 21 or Less*" is also a valid instrument (Amuedo 2005).

Blacklow & Church (2006, p.20) finds that women from large families tend to have large families themselves, meaning the number of siblings a woman has is likely to influence her fertility choices. There is a possibility that "number of siblings" could potentially influence wages through the amount of attention which was paid to a child in their early developmental years or their "quality". Despite this, augmenting a Heckman corrected wage model (same specification as Table 15 on page 43) with a term for "number of siblings", yielded a highly *insignificant* coefficient (p-value = 0.957). Given that testing has revealed "number of siblings" to be exogenous and it has been found by Blacklow & Church (2006, p.20) to influence fertility, we are happy to proceed on the basis that "number of siblings" is a valid instrument.

For the estimation of endogeneity robust models, an endogenous switching model can be estimated whereby an the probability of motherhood is predicted using instrumental variables, then individuals allocated to 'motherhood' and 'non-motherhood' group have separate wage equations estimated. However, a drawback of IV techniques is that standard methods cannot directly control for both endogeneity and self selectivity (as discussed earlier) simultaneously.

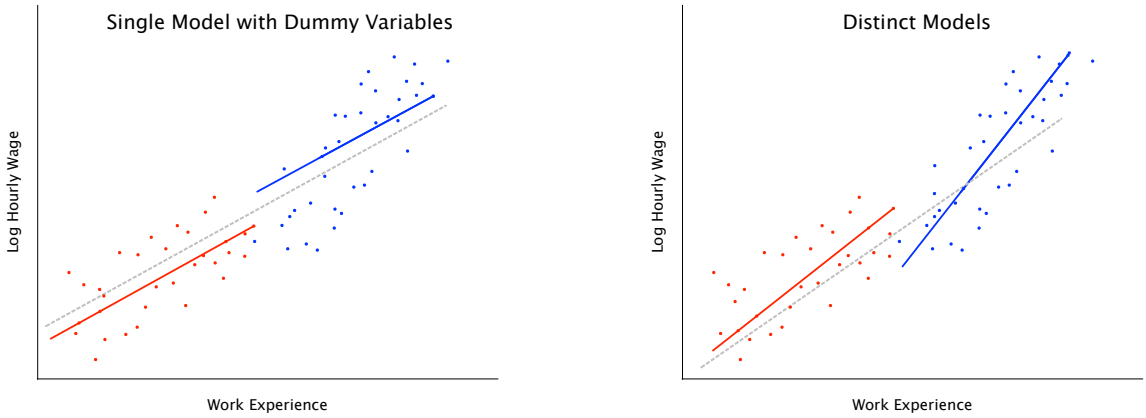
4.3 Pooling of Mothers and Non-Mothers

A Mincer (1958) log wage model augmented with dummy variables "have kids" and "young kids" may not be the most appropriate model specification to analyse the motherhood wage penalty. Using a single regression equation allows for different intercepts for hourly wage on the basis of grouping, however this model forces coefficients to be constant across groups. However, this may be problematic. The effects of motherhood and young children may not be characterised by a simple changed in the intercept, motherhood could be characterised through altered returns on endowments (and hence slope coefficients). Figure 7 shows an example of the potential relationship between wages and work experience for two groups of women[5]. The left panel of this example shows inappropriate use of a single model with dummy variables which has masked the true differences in wages. The right panel of Figure 7 then shows two distinct

[5]Data for illustration purposes - Real data not used

models, revealing the true relationship between work experience and log hourly wage.

Figure 7: Example - Effects of Sample Pooling



In order to determine whether fitting a single model is appropriate, the Chow (1960) test can be conducted to determine whether there is a significant difference between the slope parameters estimated in separate models for each group. If there is no significant difference, then the two groups can safely be included in the same model. However, if there is significant differences, then using two distinct models is a more appropriate method of modelling wages.

4.4 Unobserved Heterogeneity

A final concern is the possibility of unobserved heterogeneity. Unobserved heterogeneity is closely related to the issue of endogeneity as discussed earlier, but it occurs when there are unobserved variables (for example ability) which are correlated with both the outcome variable (wages) and explanatory variables such as education. For example, women with high levels of education may also have higher natural ability (unobserved). Alternatively, women with children may tend to have lower unobserved ability. If a simple cross sectional model was estimated, then the coefficient for education and children would likely have a positive and negative bias respectfully, because they are both reflecting ability rather than education or children. In order to avoid unobserved heterogeneity, a fixed effects model can be estimated whereby time invariant unobservables such as ability are removed.

Unfortunately, fixed effects cannot control for either endogenous selection, or selection to work. However the model does have the advantage of differencing out any unobserved constant effects such as ability or intelligence, removing any biases resulting from the correlation of regressors with time invariant unobservables.

Overall, this section has identified four key issues which need to be addressed in the estimation of the motherhood wage penalty and methods to account for these biases. First, sample selection biases need to be corrected with the use of a Heckman selectivity adjusted model. Second, endogeneity of the choice of an individual to have children needs to be considered throughout the use of instrumental variable techniques or an endogenous switching model. Third, potential unobserved heterogeneity needs to be accounted for through the use of a panel data model such as fixed effects. Finally, it may not be appropriate to pool data in one model, but rather two separate models may need to be estimated, allowing for different coefficients. Accordingly, the next section will apply these methods and analyse results.

5 Analysis - Motherhood Wage Penalty

5.1 Pooled Model

A straight forward method of identifying the motherhood wage gap is to estimate a standard Mincer (1958) wage equation, then simply augment this model with a dummy variable which identifies whether the individual has children. An additional dummy variable indicating whether the individual has young children (aged 0 to 14) can also be added to test whether the motherhood wage penalty is different for women with younger children.

Model 1, as shown in Table 15 (pooled model) uses this approach to predict log-hourly wages, controlling for education, hours worked, demographic groups, work experience, job tenure and time spent out of the workforce amongst other factors.[6] If there is a motherhood wage penalty, then the variable "*have kids*" should have a negative coefficient. Further, the coefficient "*young kids*" should have a negative coefficient if the motherhood wage penalty is particularly pronounced for women with young children.

Using this somewhat naive model, motherhood wage penalty is measured and appears to associated with an approximate 2.70% decline in wages. However, the wages of mothers with young children are insignificantly different from mothers in general (the coefficient on "*young kids*" is not significant at any conventional level), implying young the presence on young children have no influence on the motherhood wage penalty. Arguments made in Becker (1991, pp.42-43) (as discussed in the literature review) predict a more pronounced "family/work conflict" for women with younger children. Furthermore, the hypothesised trade off between wages and workplace flexibility discussed earlier also predicts that the motherhood wage penalty would be more pronounced for women with younger children. Despite this, the model only finds a motherhood wage penalty caused by children in general. Although the insignificant coefficient on "*young kids*" is unexpected from a theoretical standpoint, it can be reconciled with earlier findings by Livermore et al. (2011, p.89) that the motherhood wage penalty emerges slowly over time.

[6] Age has deliberately been excluded as it is highly collinear with work experience (its inclusion results in a variance inflation factor of 22) thereby resulting in inaccurate estimates of the returns to work experience. Further, excluding the variable gives approximately the same R^2.

Given the simplicity of this model, it appears to performs surprisingly well, finding a positive and statistically significant motherhood wage penalty of 2.7% and explaining 45% of variation in the wages of individuals. Overall, estimates appear quite reasonable, with control variables showing both the expected signs and high levels of significance. However, using the simple approach of pooled OLS is unsatisfying as it does not account for any of the potential biases discussed in Section 4. Accordingly, more complex models will be estimated to account for these potential biases.

5.2 Differences in Returns & Non-Poolability

As discussed in Section 4.3, there may be differences in the coefficients of the wage equations of mothers and non-mothers, leading to biased estimates if both mothers and non-mothers are pooled in the same model. To test this concern, a Chow (1960) test has be conducted to determine whether there is a jointly significant difference between the coefficients of the two groups (shown in Table 31 of the appendix). If there is no significant difference in the returns on underlying characteristics between the two groups, then the implication is that mothers and non-mothers are likely to be treated in the same way by labour markets. However, if there is significant differences this may indicate different treatment by employers.

Testing is conducted against the null hypothesis that slope coefficients are equal across the two groups (mothers and non-mothers). That is;

$$\begin{aligned} H_0 : \beta_{year}^{mother} &= \beta_{year}^{non-mother} \\ \beta_{hours}^{mother} &= \beta_{hours}^{non-mother} \\ &\vdots \\ \forall \text{ slope coefficients} & \end{aligned} \tag{21}$$

As shown in Table 31 in the we find that there is sufficient evidence to reject the null hypothesis (p-value = 0.00, F-Stat = 2.99). That is, returns to underlying characteristics are significantly different (jointly) between mothers and non-mothers. The implication of this is that pooling both mothers and non-mothers in the same model is likely to lead to biases in the estimated effects of motherhood. Thus, modelling should only proceed where two distinct wage equations are fitted.

The implication of the varied slope coefficients is that it is inappropriate to fit a single model for mothers and non-mothers and with the motherhood wage penalty identified through an altered intercept term. Further, because there is a significant difference in the coefficients of the wage equation jointly, it appears that both mothers and non-mothers receive different treatment in the labour market. It appears that the motherhood wage penalty may not emerge simply as a one off penalty applied to mothers, but rather the penalty may emerge through a combination of lower endowments such as lower levels of work experience and lower returns from these endowments (reduced coefficients). In order to further explore this idea, separate models need to be estimated for both mothers and non-mothers and the source of wage differences explored.

5.3 Oaxaca Decomposition

Given that Section 5.2 found that pooling both mothers and non-mothers in a single model may lead to biased results, a mechanism by which wages of mothers and non-mothers can be compared needs to be introduced.

A widely used method for studying differences in wages between two separate groups has been developed in both Oaxaca (1973, p.696) and Blinder (1973, p.438). This "Oaxaca" method decomposes wage differences between groups into two parts, an "explained" portion and an "unexplained" portion. The explained portion is the component of the difference in wages between groups which can be attributed to differences in characteristics such as education levels and work experience (Jann 2008, pp.455-56). The unexplained component of the wage gap is then the difference attributable to differing magnitudes of slope coefficients (marginal returns to the characteristics). Furthermore, as discussed in Section 4.1, there may be a sample section bias present in the equations estimated. For this reason, a two step Heckman (1979) correction has been made in both models and a "selectivity" term added to the Oaxaca decomposition.

In order to apply the Oaxaca method, two separate regression models (one for mothers and another for non-mothers) as estimated in Table 15 on page 43. The differences between mean outcomes of the groups can then be decomposed into their component parts. Firstly, $\overline{w}_m = \overline{\mathbf{X}}_m \widehat{\boldsymbol{\beta}}_m$ is estimated for mothers m where $\overline{w}_m$ is the mean log hourly wages for mothers and $\mathbf{X}$ is a $n \times k$ vector of means of the observed regressors. This is then repeated for a sample of women with children (n), $\overline{w}_n = \overline{\mathbf{X}}_n \widehat{\boldsymbol{\beta}}_n$. These estimates can then be decomposed into an "explained" portion and an "unexplained" portion. Where $\overline{w}$ denotes the mean of w and $\overline{\mathbf{X}}$ denotes vector

of means of each of the k explanatory variables.

$$\overline{ln(w)_n} - \overline{ln(w)_m} = \overline{\mathbf{X}}_n \widehat{\boldsymbol{\beta}}_n - \overline{\mathbf{X}}_m \widehat{\boldsymbol{\beta}}_m \tag{22}$$

$$\overline{ln(w)_n} - \overline{ln(w)_m} = \underbrace{\left(\overline{\mathbf{X}}_n - \overline{\mathbf{X}}_m\right) \widehat{\boldsymbol{\beta}}_n}_{Explained} + \underbrace{\overline{\mathbf{X}}_m \left(\widehat{\boldsymbol{\beta}}_n - \widehat{\boldsymbol{\beta}}_m\right)}_{Unexplained} \tag{23}$$

In the above equation, the non-mother wage equation is used as the baseline to compare the mother wage equation to. The reason non-motherhood is used is that if there was no adverse effects of motherhood then the motherhood wage equation would be the same as the non-mother wage equation (where no differing treatment by employers is present).

Using this approach, selection effects can also be accounted for, with an additional selection effects term, as shown below (Neuman & Oaxaca 2004, p.5);

$$\overline{ln(w)_n} - \overline{ln(w)_m} + \underbrace{\rho_n \overline{\lambda(\mathbf{Z}_n \boldsymbol{\gamma})} - \rho_m \overline{\lambda(\mathbf{Z}_m \boldsymbol{\gamma})}}_{Selectivity} = \underbrace{\left(\overline{\mathbf{X}}_n - \overline{\mathbf{X}}_m\right) \widehat{\boldsymbol{\beta}}_n}_{Explained} + \underbrace{\overline{\mathbf{X}}_m \left(\widehat{\boldsymbol{\beta}}_n - \widehat{\boldsymbol{\beta}}_m\right)}_{Unexplained} \tag{24}$$

Table 13: Oaxaca Decomposition

Log Hourly Wage	Estimate	Robust SE	P Value
Non-Mothers	3.143***	(0.00876)	0.000
Mothers	3.088***	(0.00627)	0.000
Difference	0.0553***	(0.0106)	0.000
Adjusted Difference	0.0837***	(0.01877)	0.000
Decomposition			
Explained	0.013	(0.0173)	0.461
Unexplained	0.071***	(0.0233)	0.002
Total	0.084		
Obs. 24,871	*** p<0.01, ** p<0.05, * p<0.1		

Robust standard errors in parentheses

In Table 13, it is shown that women with children on average 5.5% lower wages than women without children. However once the effects of selection into paid work has been taken into account, this gap increases to 8.4%. As shown in Table 15, the selection adjustment shows that there is a positive selection into work for both mothers and non-mothers ie. those with higher attainable wages are more likely to work. Interestingly though, the selectivity adjustment is far more pronounced for non-mothers and selectivity is both small and insignificant for mothers,

meaning that unobservables in the reservation wages (such as work ethic) are negatively correlated with achievable market wages only for non-mothers. Whereas there appears to be no such correlation in the case of mothers. Although considering the effect of both selection terms, for mothers and non-mothers does have a highly significant impact upon the difference in wages (as shown in Table 13). Furthermore, the results of this selectivity adjustment are consistent with (Krepp 2007, p.15).

Of the 8.4% gap between mothers and women without children, an insignificant portion of this gap can attributed to different levels of endowments of factors such as work experience and job tenure. That is, the differences in the characteristics between mothers and non-mothers does not cause a significant difference between the two groups. However, the remaining 7.1% point difference can be attributed to different *returns* upon levels of endowments of factors such as work experience and tenure. ie. A motherhood wage penalty of 7.1% has been identified. The implication of lower returns for mothers is that mothers are less highly valued by the labour market. For example, when an individual is promoted to a position where they supervise other staff (variable: *supervisor*), this is associated with a 6.9% wage rise for women without children, but the same movement for an otherwise identical woman with children is only associated with a 4.3% wage rise.

Using these estimates, we can gleam some insight into why the motherhood wage penalty exists. Shown in Table 14 below are the variables which have significantly different returns, for mothers and non-mothers.

Table 14: Highly Significant Differences (Coefficients)

Variable	Coefficient		Unexplained Log Wage Difference	
	Non-Mothers	Mothers	$\overline{\mathbf{X}}_m \left(\widehat{\boldsymbol{\beta}}_n - \widehat{\boldsymbol{\beta}}_m\right)$	P-value
Work Exp	0.017	0.008	0.134**	0.028
Work Exp Sq.	-3.14e-4	-1.71e-4	-0.074	0.110
Supervisor	0.069	0.043	0.012**	0.036
Service Sector	0.140	0.043	0.008**	0.014
Partners Wage	6.98e-5	2.70e-5	0.026***	0.001
Services Sector	0.141	0.044	0.015**	0.020

Vairables shown if significant at 5% level

A full breakdown of all unexpained as well as explained differences appears in Table 32 of the Appendix

Table 14 shows that the returns for work experience are lower for mothers when compared to non-mothers, despite time out of the workforce, tenure and subsequent depreciation of human capital being controlled for. If there was no motherhood wage penalty, coefficients on work experience would be expected to be equal. This observation may symptomatic of the family work conflict of mothers, motherhood signalling lower ability or discrimination in the workplace as discussed in the literature review, however the exact reason for why the returns on work experience are lower for mothers.

Table 14 also shows that mothers receive substantially smaller increases in wages as a result of being promoted to a position where they supervise other employees. Supervisor roles are associated with a 6.9% increase in wages for women without children, but only a 4.3% wage increase for mothers. Once again, this is consistent with the hypothesised family work conflict of mothers, motherhood signalling lower ability or discrimination in the workplace (as discussed in the literature review). However it difficult to attribute lower returns to a specific mechanism of influence.

Mothers working in the service sector are subjected to 0.8% lower wages when compared to non-mothers, which is significant at the 5% level. There is no clear explanation for this, as differences in human capital and hence productivity are controlled for. A possibility is that differences may be attributable to simple discrimination against women with children.

Partner wages have been included as a proxy for unmeasured ability.[7] The "Assortative mating" hypothesis of Mare (1991), argues that women tend to partner with others who have similar characteristics such as work motivation and intellectual ability. Thus, women with higher levels of work motivation and ability tend form couples with individuals who also have higher ability and motivation. The implication is that there should be a positive correlation in the wages of women and their partners. In Table 14 there is a highly statistically significant positive relationship between the wages of women and their partners. Although this relationship is both significant and positive for both mothers and non-mothers, it is lower for mothers. That is, for a given increase in the wages of their partner, the wages of mothers tend to not rise by the same amount as the wages of non-mothers. This difference in coefficients between the two groups accounts for 3.4% of the unexplained wage penalty. Although it does not provide conclusive evidence, this may be symptomatic of the case where mothers are less valued for their underlying ability than non-mothers (in the case where we take partners wage as a proxy for ability/motivation). Alternatively, this could also be symptomatic of the hypothesis that mothers tend to take lower skilled "motherhood friendly" jobs where there skills and natural abilities are less highly valued.

The estimated unexplained wage penalty of 7.1% is relatively consistent with international research and more recent Australian research (as shown in Table 15 in the literature review). Although a draw back of this approach is that it does not account for the potentially endogenous nature of the decision to have children as raised in Section 4.2. As such the next section will estimate an alternative model which accounts for the potential endogenous nature of motherhood.

[7]Partner's wages are given the value of 0 if no partner present

Table 15: Pooled model & Individual Models Used for Oaxaca Decomposition

Variables	Pooled	se	Mothers	se	Non-Mothers	se	Selection Probit	se
	Log Hourly Wage		Log Hourly Wage		Log Hourly Wage		Working	
Year	0.040***	(7.37e-4)	0.0410***	(9.08e-4)	0.0390***	(1.38e-3)		
Hrs Worked	-7.97e-3***	(5.39e-4)	-8.33e-3***	(6.26e-4)	-6.66e-3***	(9.74e-4)		
Hrs Worked Sq	7.86e-6***	(2.42e-6)	1.10e-5***	(3.99e-6)	4.77e-6***	(1.21e-6)		
Ed Year 12	0.033***	(0.0124)	0.0380***	(0.0143)	0.0120	(0.0243)	0.118**	(0.0489)
Ed TAFE	0.049***	(0.0101)	0.0486***	(0.0112)	0.0302	(0.0238)	0.239***	(0.0432)
Ed Bachelors	0.155***	(0.0140)	0.155***	(0.0173)	0.139***	(0.0263)	0.444***	(0.0515)
Ed Post Grad	0.210***	(0.0163)	0.201***	(0.0195)	0.201***	(0.0295)	0.496***	(0.0609)
Employer Tenure	4.42e-3***	(5.71e-4)	4.67e-3***	(6.31e-4)	0.00291**	(0.00120)		
Work Exp	1.26e-2***	(1.55e-3)	8.60e-3***	(2.04e-3)	0.0171***	(0.00328)	0.0834***	(8.59e-3)
Work Exp Sq	-2.38e-4***	(3.73e-5)	-1.71e-4***	(4.61e-5)	-3.17e-4***	(7.89e-5)	-1.31e-3***	(1.59e-4)
Time Not Working	-2.77e-4***	(8.52e-4)	-3.91e-3***	(1.10e-3)	-1.83e-3	(3.08e-3)	-0.0477***	(6.34e-3)
Supervisor	5.10e-2***	(5.88e-3)	0.0430***	(6.98e-3)	0.0692***	(0.0104)		
Public Sector	4.96e-2***	(808e-3)	0.0497***	(9.30e-3)	0.0506***	(0.0141)		
Union	2.41e-2***	(7.26e-3)	0.0331***	(8.14e-3)	3.05e-3	(0.0139)		
Indig	6.81e-2***	(0.0241)	0.0727**	(0.0300)	0.0504	(0.0368)	-0.0671	(0.109)
Born in OECD	-7.69e-3	(0.0126)	-0.0103	(0.0139)	-9.03e-3	(0.0273)	0.206***	(0.0489)
Married or Defacto	-1.18e-2	(9.09e-3)	-0.0105	(0.0112)	-0.0294**	(0.0149)	-0.147***	(0.0378)
Parents Status	9.56e-4***	(2.06e-4)	1.13e-3***	(2.48e-4)	5.52e-4	(3.36e-4)	1.11e-3	(8.24e-4)
Partner Wage	3.81e-5***	(5.81e-6)	2.70e-5***	(6.45e-6)	6.98e-5***	(1.05e-5)	1.82e-4***	(5.64e-5)
Part Time	-0.120***	(0.0103)	-0.122***	(0.0117)	-0.108***	(0.0214)		
Manager	0.337***	(0.0189)	0.339***	(0.0222)	0.345***	(0.0393)		
Professional	0.320***	(0.0152)	0.332***	(0.0173)	0.321***	(0.0356)		
Trade	6.42e-2***	(0.0188)	0.0464**	(0.0211)	0.130***	(0.0417)		
Service	5.65e-2***	(0.0139)	0.0433***	(0.0144)	0.140***	(0.0393)		
Admin	0.175***	(0.0126)	0.184***	(0.0137)	0.173***	(0.0335)		
Sales	0.046***	(0.0140)	0.0366**	(0.0151)	0.0999***	(0.0368)		
Machine Op	6.67e-2**	(0.0337)	0.0683**	(0.0335)	0.0830	(0.0966)		
Have Kids	-2.70e-2**	(0.0129)					-0.0144	(0.0644)
Young Kids	3.33e-3	(9.49e-3)	-0.0115	(0.0120)			-0.706***	(0.0463)
Age							0.151***	(0.0158)
Age Sq							-2.07e-3***	(1.81e-4)
Partner Income							-3.59e-6***	(1.05e-6)
LT Health Condition							0.626***	(0.0331)
Ever Worked							1.045***	(0.166)
Carer							-0.396***	(0.0795)
IMR (Lambda)			0.0149	(0.0240)	-0.116*	(0.0640)		
Constant	-77.85***	(1.478)	-79.30***	(1.818)	-75.44***	(2.760)	-4.021***	(0.340)
Observations	24,871		18,029		6,842		35,974	
R-squared	0.450		0.469		0.422			

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.4 Endogenous Switching Model

Up to this point, only the selectivity issue as raised in Section 4.1 has been dealt with, while the endogenous nature of the decision to have children (explained in Section 4.2) has been left unaddressed. In this section, an endogenous switching model will be explained, estimated and the results discussed. Importantly, this model allows the estimation of the effects of motherhood upon wages where there is an endogenous selection to motherhood (because the choice to become a mother is partly made on the basis of wages).

Endogenous switching models are used in other parts of the labour economics field for their ability deal with endogenous selectivity issues, similar to that of the choice to become a mother. Unfortunately however, this type of model is unable to deal with selectivity issues associated with the decision to work (as discussed in Section 4.1) while simultaneously correcting for endogeneity issues. Although this is a drawback of the model, selectivity biases corrected for in Section 5.3 did not change results materially (a significant motherhood wage gap is estimated even if selectivity is ignored). Furthermore, selectivity was only found to have a marginally significant effect for non-mothers. As such, it is not unreasonable to put these issues aside in the estimation of this model as long as it's drawbacks are acknowledged when drawing conclusions.

An endogenous switching model similar to that used in Lee (1978) to model the impact of joining a workers union on wages, has been constructed to determine the impact of children on wages. By using this model, the endogenous choice of whether or not to have children can be controlled for and estimates robust to endogenous selectivity obtained for a woman's wages. The structure of this model is as set out and discussed below.

Let;

$$ln(w_n) = \mathbf{X}\beta_n \quad \text{(wages if a woman was not to be a mother) "Non-Mother Wage Regime"} \tag{25}$$

$$ln(w_m) = \mathbf{X}\beta_m \quad \text{(wages if a woman was to be a mother) "Mother Wage Regime"} \tag{26}$$

Each woman in the sample faces a choice between two separate wage regimes. A mother wage regime, if they choose to have children and a non-mother wage regime if they choose not to have children. Amongst these two regimes, returns to the characteristics of women may be different. For example, the mother wage regime may have lower returns to work experience

than the non-mother wage regime (meaning education is less highly valued under the mother wage regime). Each woman must choose between having children and exposure to the mothers wage regime or not having children where they are exposed to the non-mother wage regime.

There are likely to be costs in having children and joining the mother wage regime. It is to be expected that a woman would have lower wages under the motherhood wage regime, when compared to the non-mother wage regime (as a result of a significant wage penalty that has been previously estimated). However, there are likely to be non-pecuniary benefits in becoming a mother such as life satisfaction and other positive emotional benefits of having children. Both benefits and costs in terms of reduced wages will differ between women. We will assume that fixed costs such as food and shelter are constant over for those who have children.

The decision to have children is then based upon both wage differentials and non-pecuniary benefits. Although these costs and benefits will differ between individuals. The decision to have children can then be represented mathematically.

Individual has children if and only if;

$$\underbrace{ln(w_{n,i}) - ln(w_{n,i})}_{costs} < \underbrace{\beta_0 + \mathbf{Z}_i\boldsymbol{\gamma} + \epsilon_{s,i}}_{benefits} \tag{27}$$

Where the individual does not have children otherwise and $\mathbf{Z}$ is a vector of instrumental variables (which effect the probability of having children) for individual i and β_0 represents the fixed costs of having children (negative).

This decision can then be represented as a probit model. All together, three equations are estimated simultaneously via maximum likelihood (refer to Lokshin & Sajaia (2004) for the detailed procedure)

$$M_i = \begin{cases} 1 & \text{if } \mathbf{Z}\boldsymbol{\delta}_i + u_i > 0 \\ 0 & \text{if } \mathbf{Z}\boldsymbol{\delta}_i + u_i < 0 \end{cases} \tag{28}$$

$$ln(w_{m,i}) = \mathbf{X}_{m,i}\boldsymbol{\beta}_m + \epsilon_{m,i} \quad \text{if } M_i = 1 \text{ (mother regime)} \tag{29}$$

$$ln(w_{n,i}) = \mathbf{X}_{n,i}\boldsymbol{\beta}_n + \epsilon_{n,i} \quad \text{if } M_i = 0 \text{ (non-mother regime)} \tag{30}$$

In estimating this model, an approach similar to the classic Heckman (1974) model is used. But this approach takes the position that there are *two* truncated distributions, where the distribution $ln(w_{m,i})$ is observed when $M_i = 1$ and the distribution $ln(w^*_{n,i})$ is observed when $M_i = 0$. Using this method, an inverse mills ratio (selection term from a probit model) is generated using the selection equation and two selection coefficients are used to adjust the estimation of each wage equation. In doing this, self selectivity into each group can be accounted for.

This estimation is performed using a full-information maximum likelihood method, as discussed in Lokshin & Sajaia (2004). However, $ln(w_{m,i})$ and $ln(w_{n,i})$ are only observed given that the individual is a mother or non-mother respectively, as a result both wage equations must be augmented with a Heckman selection term, to obtain unconditional estimates. Table 16 shows these estimates.

Table 16: Conditional Expectations - Endogenous Switching Model

Observed State	State Used for Estimate	Conditional Expectation (Lokshin & Sajaia 2004)
Mother	Mother	$E\left(ln(w_m \vert M=1,\mathbf{X}_m)\right) = \mathbf{X}_m\boldsymbol{\beta}_m + \sigma_m \overbrace{\left[f(\mathbf{Z}\boldsymbol{\delta}_i)/F(\mathbf{Z}\boldsymbol{\delta}_i)\right]}^{\text{IMR}}$
Mother	Non-Mother	$E\left(ln(w_m \vert M=0,\mathbf{X}_m)\right) = \mathbf{X}_m\boldsymbol{\beta}_m - \sigma_m \left[f(\mathbf{Z}\boldsymbol{\delta}_i)/\left[1-F(\mathbf{Z}\boldsymbol{\delta}_i)\right]\right]$
Non-Mother	Mother	$E\left(ln(w_n \vert M=1,\mathbf{X}_n)\right) = \mathbf{X}_n\boldsymbol{\beta}_n + \sigma_n \left[f(\mathbf{Z}\boldsymbol{\delta}_i)/F(\mathbf{Z}\boldsymbol{\delta}_i)\right]$
Non-Mother	Non-Mother	$E\left(ln(w_n \vert M=0,\mathbf{X}_n)\right) = \mathbf{X}_n\boldsymbol{\beta}_n - \sigma_n \left[f(\mathbf{Z}\boldsymbol{\delta}_i)/\left[1-F(\mathbf{Z}\boldsymbol{\delta}_i)\right]\right]$

Where $f(.)$ and $F(.)$ represent normal density and cumulative normal functions
w_n and w_m represent hourly wages under the non-mother and mother regime respectively

As with the prior Heckman corrected models estimated, the sign and magnitude of the selection terms σ can also be useful in determining which types of individual are observed in each "regime" and the direction of selectivity. From this, we can determine the degree of selectivity into motherhood and non-motherhood. This can then enable us to determine whether higher earning women or lower earning women tend to become mothers.

Table 17: Endogenous Switching Model - Selection Terms

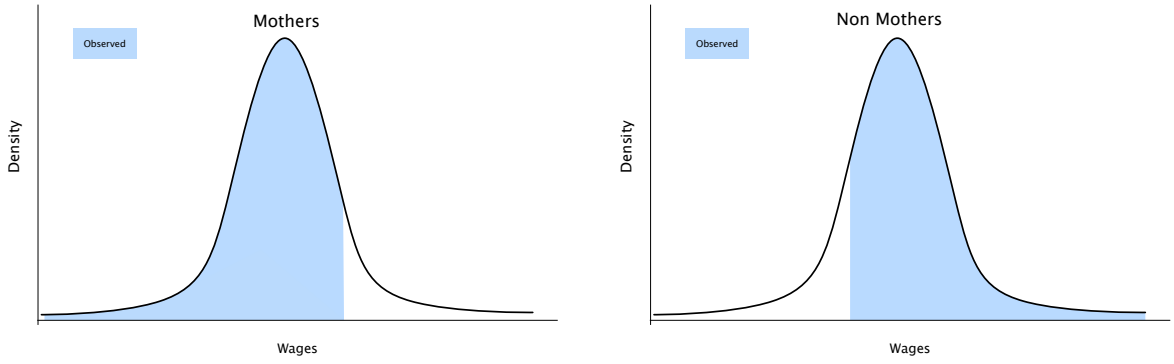
Regime	Covariance Parameter (σ)
Motherhood	0.314***
Non-Motherhood	0.307***

From Table 17, it can be shown that there is both a negative selection into motherhood (sign reverses as shown in Table 16) and a positive selection to "non-motherhood". That is, those women who choose not to have children would have higher than average wages if all women were subjected to either the non-mother wage regime or the mother wage regime. Furthermore, those women who decide to have children would have lower than average wages if all women were subjected to either the non-mother wage regime or the mother wage regime. In other words, those who choose to have children have lower endowments of desirable employment characteristics (can be thought of as ability) than those women who choose not to have children. Additionally, on average if those women without children were allocated to the motherhood wage regime, they would have higher wages than those who in fact have children (Powers 2007, p.8-9) (Adjustments due to selectivity are shown in Table 20).

The implication of this is better performing workers (earning higher wages) tend not to become mothers, and worse performing workers become mothers. Intuitively, this result makes sense in that higher wages imply increased costs of having children, as discussed in Section 4.2.

Visually, this truncation can be shown in the stylised example of Figure 8

Figure 8: Truncation of Mother and Non-Mother Wage Regimes



Using the selectivity adjustments shown in Table 16, an Oaxaca (1973) decomposition can then be done on the wage estimated wage gap after adjusting for endogenous selectivity. This gives the advantage that the decomposition has is able to give the estimated wage gap as if there was random assignment of women to motherhood. Because we only observe wages for mothers/non-mothers conditional upon them making the choice to become mothers/non-mothers, an unadjusted decomposition is inappropriate. However, this estimation allows us to remove this conditioning and obtain unbiased unconditional estimates. Table 20 shows the effects of this adjustment as a result of endogenous selection upon the estimated wages of each group and Table 20 decomposes the differences between mothers and non-mothers in a similar manner to Section 5.3.

Unconditional Expectations;

$$E\left(ln(w)_{m,i}\right) = \mathbf{X}_{m,i}\boldsymbol{\beta}_m \tag{31}$$

$$E\left(ln(w)_{n,i}\right) = \mathbf{X}_{n,i}\boldsymbol{\beta}_n \tag{32}$$

Oaxaca Decomposition for Endogenous Selection Model;

$$\overbrace{\left(\overline{ln(w)_n} + \sigma_n\left[\rho_n f(\boldsymbol{\gamma}\overline{\mathbf{Z}_i})/\left[1 - F(\boldsymbol{\gamma}\overline{\mathbf{Z}_i})\right]\right]\right)}^{Unconditional\ Mean\ Non-Mothers\ Wage} - \overbrace{\left(\overline{ln(w)_m} - \sigma_m\left[\rho_m f(\boldsymbol{\gamma}\overline{\mathbf{Z}_i})/F(\boldsymbol{\gamma}\overline{\mathbf{Z}_i})\right]\right)}^{Unconditional\ Mean\ Mothers\ Wage} \tag{33}$$

$$= \overbrace{\left(\overline{\mathbf{X}}_n - \overline{\mathbf{X}}_m\right)\widehat{\boldsymbol{\beta}}_m}^{Explained} + \overbrace{\overline{\mathbf{X}}_n\left(\widehat{\boldsymbol{\beta}}_n - \widehat{\boldsymbol{\beta}}_m\right)}^{Unexplained}$$

Table 18: Selectivity Adjustments for Endogeneous Switching Model

Non-Mothers		Mothers	
Log Hourly Wage	Estimate	Log Hourly Wage	Estimate
Observed Mean Given Non-Mother	3.143	Observed Mean Given Mother	3.088
Mills Ratio	1.172	Mills Ratio	0.445
ρ_n	0.213	ρ_m	-0.087
σ_n	0.307	σ_m	0.314
Selectivity Adjustment	0.084	Selectivity Adjustment	-0.012
Unconditional Mean	3.220	Unconditional Mean	3.100

Table 19: Endogenous Switching Model

	Mothers		Non-Mothers		Switching Equation	
Variable	Coefficient	Robust SE	Coefficient	RobustSE	Coefficient	Robust SE
Log Hourly Wage					Have Kids	
Year	0.0384***	(0.00139)	0.0411***	(8.90e-4)		
Hrs Worked	-0.00667***	(0.000973)	-0.00831***	(6.22e-4)		
Hrs Worked Sq	4.78e-06***	(1.22e-06)	1.10e-05***	(4.00e-6)		
Ed Year 12	0.0156	(0.0242)	0.0375***	(0.0142)		
Ed TAFE	0.0387*	(0.0232)	0.0473***	(0.0111)		
Ed Bachelors	0.154***	(0.0248)	0.153***	(0.0169)		
Ed Post Grad	0.216***	(0.0279)	0.198***	(0.0192)		
Employer Tenure	0.00288**	(0.00119)	0.00473***	(6.33e-4)		
Work Exp	0.0205***	(0.00259)	0.00802***	(1.94e-3)		
Work Exp Sq.	-0.000378***	(6.73e-05)	-0.000154***	(4.43e-5)		
Time Not Working	-0.00353	(0.00329)	-0.00315***	(8.05e-4)		
Supervisor	0.0696***	(0.0104)	0.0430***	(6.98e-3)		
Public Sector	0.0526***	(0.0141)	0.0494***	(9.30e-3)		
Union	0.00293	(0.0139)	0.0332***	(8.12e-3)		
Indig	0.0495	(0.0369)	0.0719**	(0.0301)		
Born OECD	-0.00621	(0.0267)	-0.0103	(0.0136)		
Married or Defacto	-0.0324**	(0.0149)	-0.00988	(0.0111)		
Parents Status	0.000556*	(0.000333)	0.00113***	(2.49e-4)		
Partner Wage	6.91e-05***	(1.04e-05)	2.68e-05***	(6.38e-6)		
Part time	-0.113***	(0.0212)	-0.123***	(0.0117)		
Manager	0.342***	(0.0390)	0.339***	(0.0221)		
Professional	0.319***	(0.0353)	0.332***	(0.0173)		
Trade	0.128***	(0.0419)	0.0470**	(0.0210)		
Service	0.140***	(0.0394)	0.0432***	(0.0144)		
Admin	0.170***	(0.0331)	0.184***	(0.0136)		
Sales	0.0972***	(0.0366)	0.0369**	(0.0151)		
Machine Op	0.0804	(0.0960)	0.0679**	(0.0334)		
Number Siblings					0.107***	(0.0135)
Devout Catholic					0.114*	(0.0617)
Moved 21 Plus					0.660***	(0.0589)
Constant	-74.115***	(2.786)	-79.570***	(1.783)	-0.316***	(0.0623)
Covariance Parameters						
Sigma (σ)	0.306	(7.392e-3)	0.314	(4.55e-3)		

Robust standard errors in parentheses - Observations : 24,871

*** p<0.01, ** p<0.05, * p<0.1

Wald test of indep. eqns. : $\chi^2(2)$ =5.65 Prob $\chi^2 = 0.0594$

Oaxaca Decomposition

Table 20: Oaxaca Decomposition of Endogenous Switching Model

Log Hourly Wage	Estimate	Robust SE	P Value
Non-Mothers (Conditional)	3.143***	0.009	0.000
Non-Mothers (Unconditional)	3.220***	0.001	0.000
Mothers (Conditional)	3.088***	0.006	0.000
Mothers (Unconditional)	3.100***	0.001	0.000
Adjusted Difference	0.120		
Decomposition			
Explained	0.018	0.049	0.320
Unexplained	0.101**	0.052	0.012
Total	0.120		

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
(NB. Figures do not exactly sum due to rounding)
Conditional refers to the fact that those individuals are observed conditional on them selecting to that group

The results of the Oaxaca decomposition are similar to those in Section 5.3. There is both a positive and significant unexplained wage gap between mothers and non-mothers. This model estimates that there is a 12% wage gap between mothers and non-mothers and of this gap, only 1.8% points can be accounted for by differing endowments (explained gap). The remaining 10.1% points are a product of lower returns upon endowments (unexplained gap). Furthermore, this unexplained gap is highly statistically significant with a p-value of 0.012 [8]. That is, the motherhood wage penalty is estimated to be 12% and statistically significant.

Additionally, a Wald test determining whether the estimated motherhood and non-motherhood wage "regimes" are independent reveal that the two wage equations are significantly independent from one another (p-value = 0.07). This result suggests that there are two distinct labour markets, one for women with children and one for women who have never had children. It is not inconceivable that there is a segmented dual labour market between mothers and non-mothers, in the same way that Reich et al. (1973, p.364) argues that there the labour market is segmented on the basis of sex.

[8]These results can also be repeated using a sample of only women with children aged 0-14 years old and women who have never had children, where the wage difference is found to be 10.7% and wage penalty is 10.2% (almost all unexplained). Results are shown in the appendix - Table 33. This result will be used in Section 6.

Further testing can be conducted on individual coefficients in both the motherhood and non-motherhood wage equations, in order to determine the sources of the "unexplained" wage penalty. Table 21 shows the coefficients on key controls and the p-value calculated under the null that the two coefficients are equal across both wage equations.

Table 21: Hypothesis Testing of Differences in Coefficients Between Regimes

Group	Variable	Coefficient		Diff.	P-Value
		Mother	Non-mother		
Education	Year 12	0.037	0.016	0.021	0.442
	TAFE	0.047	0.039	0.008	0.753
	Bachelors	0.153	0.154	-0.001	0.971
	Post Grad.	0.198	0.216	-0.018	0.590
	Joint Differences				0.818
Work Exp	Work Exp.	7.99e-3	2.05e-2	5.94e-3***	0.000
	Work Exp.Sq.	-1.53e-4	-3.79e-4	2.26e-4***	0.004
	Time out of work	-3.15e-3	-3.42e-3	2.70e-4	0.935
	Joint Differences				0.000
Industry	Manager	0.339	0.341	-0.002	0.964
	Professional.	0.332	0.318	0.014*	0.0857
	Trade	0.047	0.127	-0.08**	0.0211
	Service	0.043	0.139	-0.096**	0.0211
	Admin	0.184	0.170	0.014	0.693
	Sales	0.037	0.097	-0.060	0.135
	Machine Op.	0.068	0.081	-0.013	0.898
	Joint Differences				0.001

Hypothesis testing of all variables can be found in the appendix.

All tests shown are wald tests aginst the null of no difference in coefficients

The results from this testing show that returns to education are neither significant individually for a particular level nor are returns to education significant for the entire group. That is, education brings about the same benefits for both mothers and non-mothers in terms of hourly wage. However, returns on work experience are significantly smaller for mothers when compared to non-mothers (p-value=0.000). Furthermore, the difference is quite substantial in terms of magnitude. For a woman who has 19.5 years work experience (mean in this sample), she can expect to receive an additional 0.312% in wages if she has children, whereas if she had never had children she could expect an additional 0.572%, although this may not appear to be large in magnitude these small differences can become substantial over ones working life, as wage growth will be deminished. Additionally, the penalty attached to time out of the labour force is

not significantly different between the two "regimes" meaning that the work experience of both mothers and non-mothers is valued differently by the market, but time out of the workforce attracts the same penalty.

With regard to industry sectors, there are significantly lower returns for mothers working in the "Trade" and "Services" sectors. This is an interesting result, while the model does not suggest any reasons for this to be the case it is not inconceivable that the characteristics of these industries are particularly discriminatory against women with children. This may be of interest for future research.

Although Section 5.3 and the endogenous switching model are accounting for different potential sources of bias, both have broadly consistent results. Both models have found that the motherhood wage penalty both exists and appears to emerge through diminished returns upon endowments, resulting in diminished wages for mothers.

5.5 Fixed Effects Model

A final alternative method for modelling the motherhood wage penalty is a standard fixed effects regression. The key advantage of this model is that it is able to account for any time consistent unobserved heterogeneity (as discussed in Section 4.4). Although it can control for unobserved heterogeneity, a drawback of this model is that it is unable to control for either endogenous selection or selection to work.

The equation below shows the structure of the model estimated in Table 22.

$$ln(w_{i,t}) - ln(w_i) = \left(\mathbf{X}_{it} - \overline{\mathbf{X}_i}\right)\boldsymbol{\beta} + (\alpha_i - \overline{\alpha_i}) + (u_{it} - \overline{u_i}) \tag{34}$$

Where $\mathbf{X}$ is a vector of time variant observables including human capital, job characteristics etc. The time invariant unobserved individual effect, α_i represents factors such as natural ability, intelligence or time invariant attitude toward work and u_{it} is the random error component that varies with time. The primary reason for using this approach is that time invariant error component α_i is removed. Under this fixed effects model, estimates will not be influenced by any correlation between unobservables such as natural ability or intelligence with the observables such as the presence of children or job type.

In Table 22 the results of the fixed effects regression show a motherhood wage penalty of 8.48%, however the model also reflects that the motherhood wage is particularly detrimental for those women with young children aged 0 to 14, with a wage penalty of 9.82%. An obvious reason for this pattern is that children aged 0 to 14 require more intensive care and may interfere with work. However the penalty attached to motherhood persists, even when children are aged over 14. Further, this model confirms previous results which have found that there is a significant motherhood wage penalty, of around 10%.

Table 22: Fixed Effects Model

Variable	Coefficient	se
log wage hr		
year	0.0281***	(0.00715)
hrs worked	-0.0129***	(0.000293)
hrs worked sq	8.36e-06***	(2.59e-07)
ed y12	0.0654**	(0.0263)
ed TAFE	0.0390**	(0.0174)
ed Bachelors	0.127***	(0.0319)
ed Post Grad	0.193***	(0.0327)
employer tenure	0.00141***	(0.000474)
work exp	0.0407***	(0.00766)
work exp sq	-0.000406***	(3.80e-05)
time not working	-0.0108	(0.00822)
supervisor	0.0248***	(0.00442)
public sector	0.0376***	(0.00605)
union	0.0267***	(0.00591)
married or defacto	0.0130*	(0.00771)
part time	-0.101***	(0.00684)
Manager	0.149***	(0.0138)
Professional	0.148***	(0.0132)
Trade	0.0468***	(0.0163)
Service	0.0429***	(0.0128)
Admin	0.100***	(0.0127)
Sales	0.0538***	(0.0133)
Machine Op	0.111***	(0.0228)
have kids	-0.0848***	(0.0140)
young kids	-0.0134*	(0.00757)
Constant	-53.52***	(14.16)
Observations	24,871	
R-squared	0.398	
Number of pid	5,543	

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

5.6 Results - Motherhood Wage Penalty

This section has found that there is a statistically significant positive motherhood wage penalty in Australia. That is, women with children tend to be paid lower wages than those women without children, even after controlling for differences between the two groups. This conclusion remains robust after accounting for sample selection bias, endogeneity and unobserved heterogeneity.

Table 23: Summary of Results - Motherhood Wage Penalty

Model	Estimate	P-Value
Pooled	2.7%	0.036
Heckman Corrected -		
Oaxaca Decomposition	7.1%	0.002
Endogenous Switching	10.1%	0.012
Fixed Effects	8.48%	0.000

Although a range of estimates have been given in this section, all estimates show a consistent pattern of the wage penalty causing 7-10% lower wages for women with children (pooled model inappropriate for the reasons outlined in Section 5.2). This 7-10% wage penalty is as a result of significantly lower returns upon the underlying characteristics of the two groups such as human capital or work type.

The estimates in this section are consistent with the most recent Australian research by Livermore (2010), giving more weight to the case that there is a statistically signifiant motherhood wage penalty in Australia, disputing earlier findings by Krepp (2007, p.23) and Whitehouse (2002, p.389) which both found the wage penalty to be insignificant. Further, the estimates of the motherhood wage penalty in this section are also consistent with research in other nations including the USA and UK (as shown in Table 1).

6 Analysis - Impact of Childcare

As discussed in Section 2, there is a solid theoretical basis for the influence of access to grandparent provided childcare on the wages of women. It was argued that access to grandparent provided childcare would increase labour force attachment, reduce the workplace flexibility requirements of mothers and reduce the "family work conflict" through the provision of childcare mothers are more comfortable using.

In order to analyse whether access to grandparent provided childcare does indeed effect wages generally and the motherhood wage penalty, a sample of women with children aged 14 years old has been considered. The reason for this sample restriction is that this research is primarily interested in whether access to grandparent provided childcare has any influence upon the motherhood wage penalty. Clearly, women without children aged less than 14 would have no need for childcare (as children aged over 14 do not require significant before or after school care). Using this sample, the same Oaxaca methods employed in earlier sections can be used, this section will analyse the differences in wages between mothers who have access to grandparent provided childcare and those who do not. Differences in the wages between the two groups will then be decomposed into the difference in wages attributable to differing returns upon the underlying characteristics of the two groups and differences in wages attributable to differences in the underlying characteristics themselves. These results will then be put in the context of the theoretical basis of differences in wages and the influence of grandparent provided childcare upon the motherhood wage penalty.

6.1 Empirical Concerns & Approach

In order to accurately measure the effects of access to grandparent provided childcare, an accurate, objective measure of access is required. Simply asking people whether they use grandparent provided childcare may not be an appropriate measure of availability, usage is likely correlated with longer work hours full-time work and inability to find other forms of childcare, meaning that usage is likely to be endogenous. To avoid this issue, the geographical distance between the place of residence of mothers and their children's grandparents is used as a proxy for availability. Although some grandparents may be unwilling to be the primary non-parental provider childcare, it is reasonable to expect that the majority of grandparents would be willing to act as a safety net for situations where other childcare providers such as day care centres are not available at short notice or the entire period necessary (Wheelock & Jones 2002, pp.448-49).

If a child has grandparents living within 20 km[9] (either the mother or the mothers partner's parents), then it is deemed that their mother has "access" to grandparent provided childcare. Even if grandparents are not used as the primary mode of childcare, having grandparents living within 20km may fill gaps in the availability of the primary childcare mode used. Although 20km will be used as the primary cut-off for access, the influence of other distances will be explored, using several closer cutoffs as available in HILDA as shown in Section 6.5.[10] However, HILDA only records the distance between the primary place of residence after 2008. As a result, the sample is restricted to observations in 2008 and after.

A further concern is the choice of residential location can be chosen by parents. Parents could conceivably move in order to take advantage of grandparent provided childcare. Those parents who are willing to move are also likely to be more motivated for work, causing results to be biased. For this reason, robustness testing has been conducted whereby people who have moved within the last 5 years are dropped from the sample. Grandparents may also move to be closer to their grandchildren, however this is not of particular concern as this likely a choice of the grandparents and would have no effect upon the wage gap or participation choice other than through the provision of grandparent provided childcare (given social background is controlled for in the "family status" regressor). Robustness testing will be conducted, however it is unlikely that the proximity of grandparents is endogenous as proximity of grandparents is unrelated (at the 5% level) to area income after parental background (social status index) is taken into account.

A further issue in estimating the impact of childcare constraints upon wages is the selection to work. It is reasonable to expect that those without access to grandparent childcare are also the least likely individuals to work. For this reason, Heckman corrected wage equations will be utilised where the selection equation includes both childcare availability constraints and factors likely to influence the reservation wage of an individual (as done in Section 5.3).

[9] 20 km has been chosen as it was deemed a "reasonable" commute distance. However results remain similar (albiet reduced) for a 50 km proximity

[10] If no grandparents are present then, distance is deemed to be "far"

In order to test whether access to grandparental childcare has any influence on the motherhood wage penalty, a sample of women with children less than 14 years old has been considered. A Heckman corrected model will estimated for women who have access to grandparental childcare (proxied by the child's grandparents living within 20 km) and those women who do not have access to childcare (proxied by the child's grandparents living greater than 20 km away). This will be repeated when those people who have moved house in the last 5 years are dropped from the sample to ensure robustness.

The Oaxaca method as previously discussed can then be used to estimate the wage gap between those mothers who have and do not have access to grandparental provided childcare. Using this method, differences in observed endowments can be controlled for while allowing the returns upon endowments to differ across the group of women who have access to grandparental provided childcare and the group that does not.

An important consideration in conducting a Oaxaca decomposition is the choice of a "base case" to compare the wages of two groups. In the previous sections, the motherhood wage penalty was decomposed assuming that non-mothers were not exposed to any motherhood wage penalty and hence the coefficients estimated for the non-mother were a appropriate baseline. In this case, there is no clear baseline case. For this reason, a pooled model of both groups will be used as a baseline. That is, the Oaxaca decomposition will be constructed as follows;

$$\overline{ln(w)_G} - \overline{ln(w)_N} + \underbrace{\lambda_G(\overline{IMR_G}) - \lambda_N(\overline{IMR_N})}_{Heckman\ Selection\ Adjustment} \tag{35}$$

$$= \underbrace{\left(\overline{\mathbf{X}}_G - \overline{\mathbf{X}}_N\right)\widehat{\boldsymbol{\beta}}_{Pooled}}_{Explained} + \underbrace{\overline{\mathbf{X}}_G\left(\widehat{\boldsymbol{\beta}}_G - \widehat{\boldsymbol{\beta}}_{Pooled}\right) + \overline{\mathbf{X}}_N\left(\widehat{\boldsymbol{\beta}}_N - \widehat{\boldsymbol{\beta}}_{Pooled}\right)}_{Unexplained} \tag{36}$$

Where G represents grandparent care available (as proxied through close geographical distance), N represents no grandparent care available (as proxied through far geographical distance) and β_{Pooled} represents the coefficients obtained from a pooled regression of all observations. IMR represents the selection term (inverse mills ratio) used as a part of the Heckman correction.

6.2 Analysis

Using the approach as outlined in Section 6.1, models were estimated and decomposed as shown in Table 24 below and Table 27 on page 61. Variables included in this model are standard control variables as used in earlier sections, however in this case the equations also include dummy variables for the age group of the mother's children. The reason for including child age dummy variables is that children aged 0 to 4 (pre school aged) are likely to have fundamentally different care requirements to those children aged 5 to 14 (children over the age of 14 are not considered as they do not require significant care).[11] It is reasonable to expect that the availability of grandparent provided care for children aged 0-4 will have greater effects upon participation in the workforce and wages as children aged 0-4 require constant care, where as children aged 5-14 only require care before and after school meaning that grandparent provided childcare is likely to provide greater benefits for those mothers with children aged 0-4.

Table 24 and Table 25 show the same model and decomposition respectively. However in Table 25, the sample is limited to those people who have been living in the same house for 5 years or more. The reason for this limited sample was motivated by potential endogeneity concerns, whereby parents may move in order to be closer to their child's grandparents in order to access grandparent provided childcare. To address these concern, we remove all observations where parents of children have moved house in the past 5 years. Given that results obtained with and without the sample restriction are not substantially different, endogeneity does not appear to be an issue, thus the full sample will be used for analysis.

Table 24 reveals that there is a statistically significant 3.9% raw difference between the wages of mothers who have access to grandparent provided childcare and those who do not. Further, Table 24 shows that selection to paid work is also statistically significant, resulting in a 4.69% difference after adjustment. However, of this 4.69% almost all of the differences can be attributed to the different characteristics of the two groups, with differences in characteristics such as work experience and education accounting for a 4.72% wage difference. The returns to these characteristics (the motherhood wage penalty) is insignificant at all conventional levels. That is, market returns upon characteristics do not appear to differ in any significant way, meaning that employers are likely to treat both groups of women in the same way. The implication of this is the motherhood wage penalty is unaffected by access to grandparent provided childcare. The difference in the wages of mothers who have and do not have access to grandpar-

[11] Children aged 5-14 years old is used as the dummy variable 'base'

ent provided childcare is attributable to different levels of work experience education etc (the control variables).

Table 24: Oaxaca Decomposition - Impact of Grandparent Childcare
(Measured by Geographic Proximity)

Log Hourly Wage	Estimate	Robust SE	P Value
Geographically Close	3.320***	(0.0166)	0.000
Geographically Far	3.281***	(0.0124)	0.000
Difference	0.0390*	(0.0207)	0.060
Adjusted Difference	0.0469		
Decomposition			
Explained	0.0472***	(0.0173)	0.006
Unexplained	-0.0002	(0.0510)	0.996
Total	0.0469		
Obs. 4,072	*** p<0.01, ** p<0.05, * p<0.1		

Robust standard errors in parentheses
Sample: Women who have children 0-14 years old

Table 25: Oaxaca Decomposition - Impact of Grandparent Childcare
(Housing Tenure $\geq$ 5 Years) - Used for Robustness Testing

Log Hourly Wage	Estimate	Robust SE	P Value
Geographically Close	3.339***	(0.0218)	0.000
Geographically Far	3.314***	(0.0179)	0.000
Difference	0.0243	(0.0282)	0.389
Adjusted Difference	0.0305		
Decomposition			
Explained	0.0463**	(0.0235)	0.049
Unexplained	-0.0157	(0.0515)	0.760
Total	0.0305		
Obs. 1,968	*** p<0.01, ** p<0.05, * p<0.1		

Robust standard errors in parentheses
Sample: Women who have children 0-14 years old

Although closer inspection of the statistically significant differences in the underlying characteristics (endowments) does reveal why mothers who have access to grandparent provided childcare tend to have increased wages. Table 26 shows the statistically significant differences endowments which contribute towards the wage gap between women who have access to grandparent provided childcare and those who do not.

Table 26: Significantly Different Endowments & Explained Difference

Variable	Close Grandparents Mean Endowment	No Close Grandparents Mean Endowment	Explained Gap (%)	p-value
Age	37.5	40.0		
kids 04	0.418	0.329	0.65**	(0.003)
hrs worked	26.75	28.80	1.57***	(0.006)
hrs worked^2	1742	1165	0.71***	(0.006)
work exp	16.07	17.46	4.05***	(0.014)
work exp^2	301.3	358.0	-2.85***	(0.010)
employer tenure	7.261	5.970	0.77***	(0.003)
time not working	3.500	4.736	0.90***	(0.003)
part time	0.654	0.577	-0.96***	(0.004)

Table only shows variables significant at 5% level

NB. Work Exp. & Hrs. Worked Explained gap Is made up of two effects, so both parts have been shown

P-value from the significance of the "explained effect" - Full Decomposition shown in Appendix

Table 26 shows all differences in characteristics between the two groups causing significant differences in wages at the 5% level. From this it is clear that mothers who have access to grandparent provided childcare (as proxied through close geographic distance) have higher levels of labour force attachment. Although mothers who can access grandparent provided care are 2.5 years younger in this sample, they have both higher levels of workplace tenure (1.3 Years higher), they have spend fewer years out of the workforce (1.16 years fewer) and only have 1.2 years less work experience, despite being 2.5 years younger than women without access to grandparent childcare. These effects are all significant and contribute significantly to explaining the difference in wages.

A possible explanation of this difference is that grandparent provided childcare can make the transition of women back to work after having children easier, by providing childcare as either the primary non-parental care or acting to "fill the gaps" of other childcare providers. These results also fit reasonably well with the theory which predicted that mothers with access to grandparent provided care would have greater levels of labour market attachment. Although Table 26 shows that working mothers have a higher propensity of part time work (which we would associate with less workforce attachment), results shown in Table 27 (in the next section) confirm that mothers with access to grandparent provided childcare are more likely to be working in general. A possible explanation of this is access to grandparent care improves the accessibility of work and hence at the margin, women would enter work in a part time manner, resulting in an increased prevalence of part time work as women "ease back" into work.

Table 27: Models For Mothers With & Without Grandparent Provided Childcare

VARIABLES	Pooled	se	Close	se	Far	se	Selection	se
	Log wage hr		log wage hr		log wage hr		Working	
Year	0.0335***	(0.00363)	0.0349***	(0.00565)	0.0307***	(0.00422)		
Kids 04	0.0679***	(0.0184)	0.0492*	(0.0291)	0.0672***	(0.0210)		
Hrs Worked	-0.00766***	(0.00114)	-0.00684***	(0.00169)	-0.00630***	(0.00145)		
Hrs Worked Sq	1.24e-05***	(4.35e-06)	9.45e-06***	(2.47e-06)	5.21e-05**	(2.50e-05)		
Work Exp	0.0291***	(0.00625)	0.0278***	(0.0105)	0.0260***	(0.00752)	0.0767***	(0.0113)
Work Exp Sq	-0.000502***	(0.000139)	-0.000511**	(0.000244)	-0.000441***	(0.000160)		
Ed Year 12	0.0558**	(0.0241)	0.0398	(0.0408)	0.0585**	(0.0269)	0.0788	(0.0928)
Ed TAFE	0.0901***	(0.0230)	0.0878**	(0.0360)	0.0806***	(0.0274)	0.228***	(0.0858)
Ed Bachelors	0.223***	(0.0315)	0.248***	(0.0492)	0.183***	(0.0375)	0.459***	(0.0956)
Ed Post Grad	0.256***	(0.0349)	0.300***	(0.0566)	0.212***	(0.0441)	0.479***	(0.116)
Employer Tenure	0.00599***	(0.00119)	0.00404**	(0.00186)	0.00668***	(0.00148)		
Time Not Working	-0.00710***	(0.00234)	-0.00595	(0.00393)	-0.00667**	(0.00262)	-0.0352***	(0.0113)
Supervisor	0.0347***	(0.0133)	0.0230	(0.0212)	0.0357**	(0.0154)		
Public Sector	0.0343**	(0.0156)	0.0462*	(0.0261)	0.0313	(0.0190)		
Married or Defacto	0.00146	(0.0186)	-0.0237	(0.0391)	0.00250	(0.0204)	-0.379***	(0.108)
Parents Status	0.00114***	(0.000404)	0.000620	(0.000729)	0.00118***	(0.000428)	-0.000311	(0.00149)
Part time	-0.124***	(0.0226)	-0.0821**	(0.0369)	-0.120***	(0.0267)		
Manager	0.343***	(0.0390)	0.306***	(0.0558)	0.332***	(0.0538)		
Professional	0.310***	(0.0347)	0.331***	(0.0601)	0.273***	(0.0402)		
Trade	0.0484	(0.0432)	0.0423	(0.0665)	0.0533	(0.0504)		
Service	0.0312	(0.0310)	0.105*	(0.0557)	0.00953	(0.0346)		
Admin	0.157***	(0.0290)	0.177***	(0.0492)	0.146***	(0.0338)		
Sales	-0.00120	(0.0332)	0.0487	(0.0556)	-0.0204	(0.0386)		
Machine Op	0.119*	(0.0629)	0.339*	(0.183)	0.0356	(0.0515)		
Close Parents							0.148**	(0.0601)
Age							0.0365	(0.0409)
Age Sq							-0.000566	(0.000529)
Indig							0.176	(0.184)
Born in OECD							0.178**	(0.0871)
Partner Wage							0.000104	(7.91e-05)
Partner Hours							0.00611***	(0.00218)
Partner Income							-5.15e-06***	(1.54e-06)
LT Health Condition							0.362***	(0.0696)
Ever Worked							0.878**	(0.388)
Carer							-0.362***	(0.132)
Want More Kids							-0.188***	(0.0556)
Lambda	0.192***	(0.0618)	0.170*	(0.0932)	0.170**	(0.0740)		
Constant	-64.59***	(7.282)	-67.49***	(11.34)	-59.01***	(8.459)	-2.223***	(0.840)
Observations	4,072		1,497		2,575		6,184	
R-squared	0.426		0.447		0.511			

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

6.3 Influence on Decision to work

The high cost of caring for young children may act as a constraint on the labour force attachment of women with young children. However, grandparent provided childcare may act to reduce this and enable mothers to gain an increased level of attachment to the workforce. The influence of grandparent provided childcare is reflected in Table 28, where probability of working full time is greater for those women who have either their or their partners parents living within 20 km radius. From Table 28, it appears that availability of grandparent provided childcare has a statistically significant impact upon the decision to work, increasing the probability of working in any capacity from 64.7% to 69.6%. Although there does not appear to be any statistically significant impact upon the probability of part-time work, there is a statistically significant impact upon full time work, increasing the probability from 34.3% to 39.5% (for the mean individual).

Of those women who have access to grandparent provided childcare and are working, a greater portion of women work full time (56.7% of women working full time)[12], compared to those who do not have access to grandparent provided childcare (53.0% of women working full time)[13]. The implication of these results are that access to grandparent provided childcare influences both the decision to work and plays a role in determining the whether those people work part time or full time.

Table 28: Influence of Mothers / Fathers Parents Providing Childcare Upon Decision to Work

Group	Grandparents Close	Grandparents Far	P-value (null of equal probability)
Not Working	30.4%	35.3%	0.005
Working in any capacity	69.6%	64.7%	0.005
Working Part Time	30.1%	30.4%	0.141
Working Full Time	39.5%	34.3%	0.006

Predicted Probabilities (at means) from Ordered Probit (Shown in Appendix - Table 35)

[12]With Access - portion of full time work = 39.5%/69.6%=56.7%
[13]Without Access - portion of full time work = 34.3%/64.7%=53.0%

6.4 Influence of Mother's or Father's Parents

Up to this point, analysis has been conducted on the basis that access to grandparent care, provided by either the mother or fathers parents is perfectly substitutable. That is, care provided by grandparents on the mothers side of the family is identical to care provided by the father's parents. In the literature review, it was found key benefit of grandparent provided care is that mothers feel particularly comfortable leaving their children in the care of their own family, resulting in mothers being less "stressed" and "worried" about leaving their children in care of others while at work. However, it is likely to be the case that mothers would be more comfortable leaving their children with their own parents as opposed to their partners parents. As a result, there may be a significant difference between the influence of grandparent provided childcare on the mother's or father's side.

Table 29 shows the predicted probability of working (for the average women), by access to grandparent provided childcare on the mother's and father's side. The results show that there is a statistically significant 6.42% point increase in the probability of working when grandparent provided childcare on the mother's side is available (compared to none). However, there is no statistically significant influence of access to grandparent provided childcare on the father's side. This confirms the hypothesis that grandparent provided childcare on the mothers side is a particularly powerful influence upon the probability of working. This also reaffirms, the idea that the particular influence that grandparent childcare has is a result of mothers being comfortable with the childcare provided.

Table 29: Influence of Grandparent Provided Childcare Upon Decision to Work

Group	Probability of Work	Difference vs. No Grandparents	P-value
No Grandparents	69.6%		
Mothers Parents Only	76.1%	6.42%***	0.003
Fathers Parents Only	69.9%	0.25%	0.922
Mother & Fathers Parents	76.3%	6.64%**	0.032

Difference in percentage points
Predicted Probabilities (at means) from Probit (Shown in Appendix - Table 35)

6.5 Influence on Closeness of Grandparents

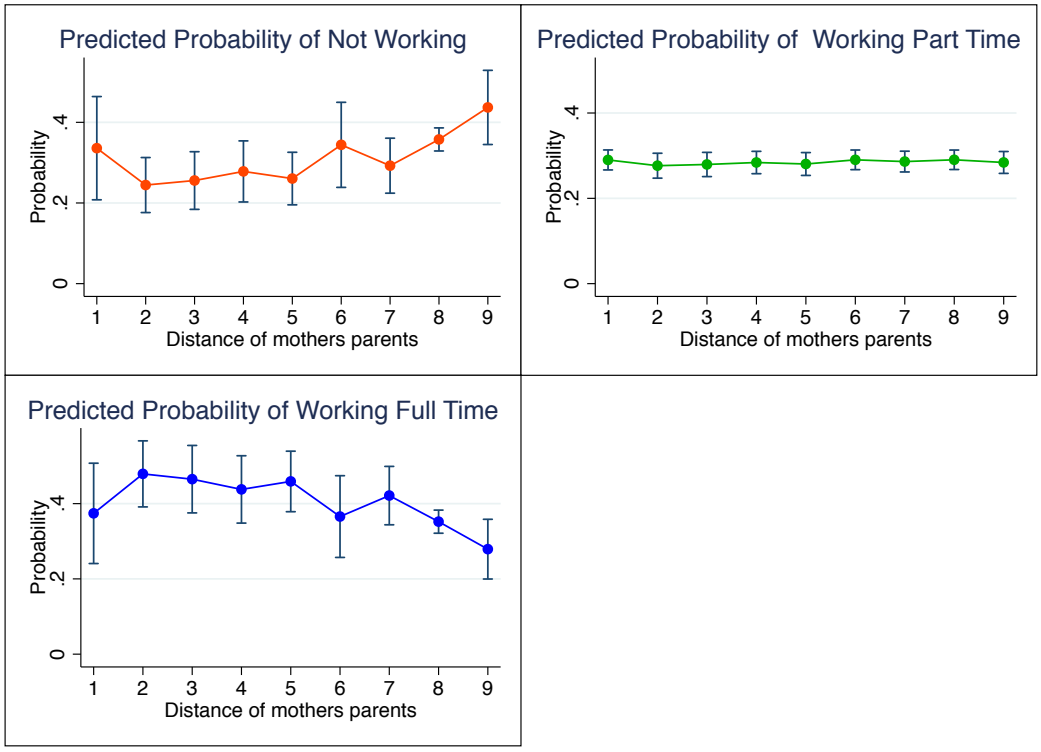
Although earlier analysis has proceeded on the basis of a binary "access" to grandparent provided childcare using a 20km proximity of grandparents as a proxy for access, "access" is more of a relative concept. It is reasonable to assume that closer geographical proximity of child's grandparents, is associated with better access. If a a child's grandparents were to live very close then access would likely be better than if a child's grandparents were to live a long distance away. To explore this potential influence, predicted probabilities of working at all, working part time and working full time have been estimated using the model shown in Table 35 in the appendix. These estimates are shown for the average woman, varying by the distance at which her parents live away. Where distance is ranked 1 to 9;

Ranking	1	2	3	4	5	6	7	8	9
Distance (Km)	<1	1-4	5-9	10-19	20-49	50-99	100-499	≥500	Overseas.

NB. If grandparents no longer alive, they ranked distance = 9

Results are shown graphically below in Figure 9, with error bars denoting the 95% confidence interval.

Figure 9: Predicted Probability of Work Types by Distance of Mothers Parents



Source: Author's own calculations

From Figure 9, there is a reasonably clear trend showing that the probability of not working increases with the distance at which mother's parents are living away. That is, women with parents living closer by are more likely to work. However, the majority of this influence appears to be as a result of the increased probability of full time work. There appears to be very little influence upon the probability of part time work. Although as mentioned before, at close distances of children and grandparents, full time work represents a larger portion of those women working.

Although there is substantial uncertainty surrounding the estimates depicted in Figure 9, there is reasonably convincing evidence that having better access to grandparent provided childcare (as measured through geographical distance) is associated with increased labour force attachment.

6.6 Results - Motherhood Wage Penalty & Grandparent Provided Childcare

This section has found that access to grandparent provided care (as measured through geographical proximity of grandparents) does not have a direct influence upon the motherhood wage penalty of mothers with children aged 0 to 14 years, meaning that there is no difference in market returns to the underlying characteristics of the two groups, such as returns to education or work experience. However, there is a statistically significant wage difference between mothers with and without access to grandparent provided childcare. This wage difference can be attributed to the different characteristics of the groups, in particular increased levels of labour market attachment amongst mothers with access to grandparent provided childcare. It was found that these women tend to have increased levels of work experience, increased tenure and reduced time spent outside of the workforce. Accordingly, we find that the wages of women who do have access to grandparent provided childcare are 5.26% higher than those who do not have access to grandparent provided childcare, of which the vast majority of the difference can be attributed to differing underlying characteristics and in particular labour force attachment. Although there is a raw wage difference, there does not appear to be any difference in wages after controlling for all the relevant observables.

This section also finds that those women with children aged 0 to 14 years, who have access to grandparent provided care are significantly more likely to work, with access increasing the probability of working for the mean women from 64.7% to 69.6 %. This section has also found that access to childcare provided by the mothers parents has a particularly powerful positive influence upon the probability of working, where as the influence of access to care provided by

the father's parents was found to be insignificant. Further, closer geographic proximity of the mothers parents was found to be associated increased probability of working.

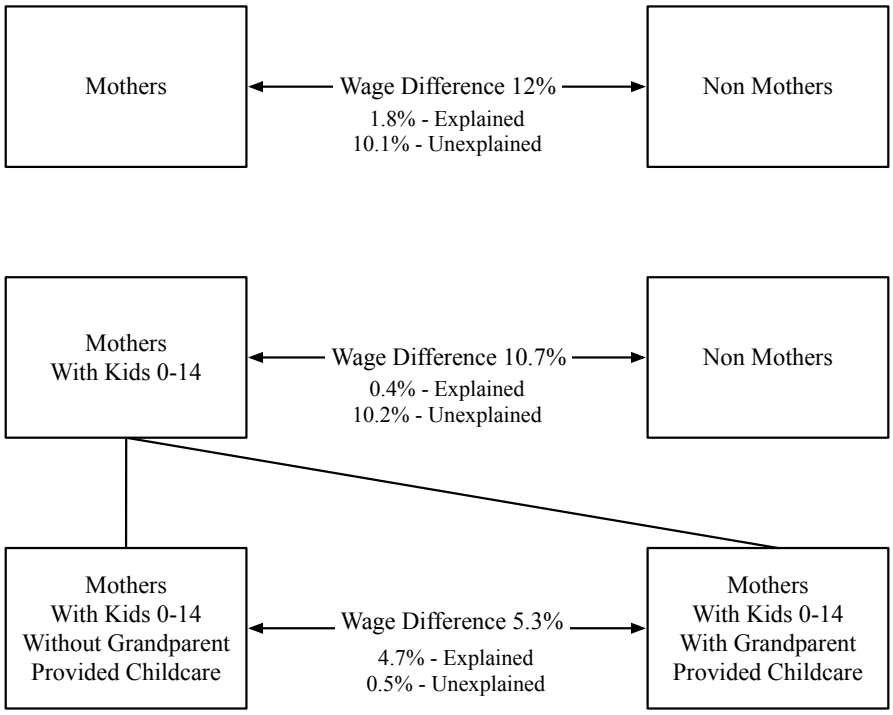
Overall, access to grandparent provided childcare appears to be associated with increased wages due to increased labour force attachment. Although, there appears to be no direct influence upon the motherhood wage penalty, as returns to the underlying characteristics are not significantly different between the two groups.

7 Summary and Conclusion

This dissertation has provided robust quantitative evidence for the existence of a motherhood wage penalty in Australia. In particular, using data from the nationally representative HILDA dataset, our empirical estimates show that there is a positive and statistically significant 12% difference in the wages of mothers and non-mothers in Australia. Of this 12% difference, the majority (10% points) is "unexplained". That is, for an otherwise identical women with and without children (same human capital, hours etc.), a woman with children tends to receive 10% lower wages. In other words, the robust analysis conducted in this thesis finds evidence of a 10% motherhood wage *penalty*. These results are largely consistent with previous international research and more recent Australian research by Livermore et al. (2011). Furthermore, it has been found that these results remain consistent and statistically significant after controlling for potential endogeneity of the choice to have children, the self-selection to work and unobserved heterogeneity.

Using Australian data, it was found that access to grandparent provided childcare does not directly influence the motherhood wage penalty. Although access to grandparent provided childcare is associated with higher wages in general (5.3% greater), this difference can be almost entirely attributed to differences in the underlying characteristics of mothers with and without access to grandparent provided childcare ("explained" wage differences). In other words, two otherwise identical *mothers* with/without access to grandparent provided childcare are expected to have the same wages. Higher wages amongst those with access to grandparent provided childcare are attributable only to different characteristics such as higher levels of work experience and tenure, differences are not attributable to the motherhood wage penalty. In other words there does not appear to be any statistically differences, caused different by treatment of the two groups by labour markets (motherhood wage penalty). These results are depicted visually in Figure 10 on the next page.

Figure 10: Breakdown of Wage Gaps and Motherhood Wage Penalty



"Explained" denotes differences in wages attributable to different underlying characteristics
"Unexplained" denotes differnces in wages attributable to different treatment in labour markets

Although grandparent provided childcare was found to have no influence on the motherhood wage penalty, this dissertation has found that access to grandparent provided childcare is associated with increased probability of working by approximately 6.5%. Further, access to grandparent provided care positively influences a range of labour market attachment measures such as work experience and tenure. Interestingly, grandparent childcare provided by the mothers parents was found to have a particularly powerful effect upon labour market attachment, indicating that familiarity and trust associated with the childcare provider may be a key consideration in the labour market choices of women with younger children.

Overall, this dissertation has found that there is a positive statistically significant motherhood wage penalty in Australia. However, this wage penalty is not directly influenced by access to grandparent provided childcare.

8 Appendix

8.1 Variable Description

Demographic Variables

Variable	Definition	HILDA Data Code
Age	Categorical Variable: 1) 25-29 Years Old 2) 30-34 Years Old 3) 35-39 Years Old 4) 40-44 Years Old 5) 45-49 Years Old 6) 50-54 Years Old Using age in years as of 30th June in survey year Coded as a series of dummy variables with the reference group of 25-29 year olds, also used as a continuous variable in some cases	hgage
Year	Categorical Variable: The which the observation was made (ranges from 2001 - 2012) Coded as a series of dummy variables with the reference year is 2001, also used as a continuous variable in some cases	year
Education Level	Categorical Variable: 1) Less than Year 12 2) Year 12 3) TAFE 4) Bachelors (Including Honours) 5) Postgraduate Coded as a series of dummy variables with the reference group of individuals with less than "year 12" education	edhigh1
Married or defacto	Dummy Variable: 1 if currently in a married or defacto relationship, 0 if separated, divorced, widowed or not in a defacto relationship / married.	mrcurr
Indigenous	Dummy Variable: 1 if the individual identifies as a person from an Aboriginal or Torres Strait Islander background, 0 otherwise	anatsi

OECD	Dummy Variable: 1 if born in an OECD member nation (as of 2014), 0 otherwise. People born in defunct states are dropped from sample (eg. Slovenia).	ancob
Long Term Health	Dummy Variable: 1 if the individual has a long term health condition, 0 if otherwise.	helth
Parents Social Status	Continuous Variable: Proxy for family's social background. The occupational socioeconomic status of the individuals parents, based upon the sector which they primarily work/worked. Index ranges from 0 to 100, where 100 is has the highest social status. Eg. 3.4=Sewing Machinist, 100=Surgeon (AUSEI06 scale) (McMillan et al. 2009). When both mother and father's status levels are available, a simple average is taken, when only one is available that status level is used.	fmmo6s fmfo6s
Carer	Dummy Variable : 1 if the individual receives government Carer allowance, eligibility requirement is that they "Provide daily care and attention to a person with a disability or medical condition or someone who is frail aged", 0 Otherwise . Used as a proxy for a person acting as a carer. (Valid proxy as the provision of care is the only requirement for the allowance - not means tested)	bnccra

Work Variables

Variable	Definition	HILDA Data Code
Working	Dummy Variable: 1 if working full time or part time, 0 if unemployed or not in labour force.	esdtl
Log hourly wage	Continuous Variable: The natural logarithm of currently weekly gross wages in the individuals main job divided by hours usually worked in the individuals main job. Missing if not working.	wscme jbmhruc
Hours Worked	Continuous Variable: The number of hours an individual usually works in their main job. Missing if not working.	jbmhruc

Part Time	Dummy Variable: 1 if working part time , 0 if working full time. Missing if not working.	esdtl
Supervisor	Dummy Variable : 1 if normally supervise work of other employees, 0 otherwise. Missing if not working.	jbmsvsr
Union	Dummy Variable : 1 if Union membership or employee association, 0 otherwise. Missing if not working.	jbmtuea
Public Sector	Dummy Variable: 1 if the individual works for a "Government business enterprise or statutory authority" or individual works for an "Other governmental organisation". Missing if not working	Jbmmpl
Occupation Tenure	Continuous Variable: The number of years the individual has been working in the same occupation.	jbocct
Employer Tenure	Continuous Variable: The number of years the individual has been working for the same employer. Missing if not working	jbempt
Ever Worked	Dummy Variable: 1 if the has worked 0, 0 if the individual has never had a job (ie. zero experience and not currently working).	esempst ehtjb
Time Not Working	Continuous Variable: The number of years the individual has either been out of the work force or unemployed (ie. not working because they are either not looking for a job or unable to find a job) - Measured for all individuals	ehto ehtuj
Work Experience	Continuous Variable: The length of time in paid work, measured in years.	ehtjb
Considered Child Care	Dummy Variable: 1 if used or considered using childcare in the previous 12 months, 0 Otherwise.	ccuseth
Previously Considered Childcare	Dummy Variable: 1 if used or considered using childcare since having children, 0 Otherwise.	ccuseth
Close Parents	Dummy Variable: 1 if the individuals parents (children's grandparents) live within 20 km, 0 Otherwise.	ccuseth

Partner's Variables

Partners Hours	Continuous Variable: Partner's hours usually worked in the individuals main job. 0 if no partner and 0 if partner is not working	wscme jbmhruc matched by hhpxid
Partners Wage	Continuous Variable: The natural logarithm of currently weekly gross wages in the individual's partner in their main job divided by hours usually worked in that job. 0 if the partner is not working.	matched by hhpxid

Child Related Variables

Variable	Definition	HILDA Data Code
Have Kids	Dummy Variable: 1 if the individual has had 1 or more children (at any point), 0 if the individual has never had any children.	tchad
Young Kids	Dummy Variable: 1 if the individual has any of their biological children aged 0 to 14 living in their household, 0 if otherwise.	tcr04 tcr514
Kids 0-4	Continuous Variable: The number of biological children aged 0 to 4, which are living in the same household.	tcr04
Kids 5-14	Continuous Variable: The number of biological children aged 5 to 14, which are living in the same household	tcr514
Kids 15-24	Continuous Variable: The number of biological children aged 15 to 24, which are living in the same household	tcr1524
Kids 25+	Continuous Variable: The number of biological children 25 and older which are living in the same household	tcr25

8.2 Data Set Acronyms

Acronym	Name
HILDA	Household Income and Labour Dynamics in Australia Survey (Annual 2001-12)
AWIRS	Australian Workplace Industrial Relations Survey (1995)
CPCSCC	Comparative Project on Class Structure and Class Consciousness
WERS	Workplace Employee Relations Survey (1998)
NLSYW	The National Longitudinal Study of Young Women
NLSY	The National Longitudinal Study of Youth (Biannual Starting in 1979)
NCDS	National Child Development Study
SLID	Canadian Survey of Labour & Income Dynamics (1998)
GSOEP	German Socio Economic Panel
DLD	Danish Longitudinal Database
F&W	Swedish Family and work Survey (1992-1993)

8.3 Additional Estimate Output

Table 31: Hypothesis Tests: Coefficient Groups

Group	Coefficient	Mother Est.	Non-Mother Est.	p-value
Education	Year 12	0.0359	0.0130	0.41
	TAFE	0.0438	0.0246	0.46
	Bachelors	0.1450	0.1285	0.59
	Post Grad	0.1895	0.1889	0.99
Joint Significance				0.88
Job Type	Machine Op.	0.0729	0.0855	0.90
	Sales	0.0396	0.1056	0.10*
	Admin	0.1867	0.1751	0.75
	Services	0.0450	0.1418	0.02**
	Trade	0.0501	0.1297	0.09*
	Professional	0.3350	0.3216	0.74
	Manager	0.3418	0.3216	0.91
	Supervisor	0.0429	0.0700	0.03**
	Public Sector	0.0489	0.0517	0.87
	Union	0.0331	0.0022	0.05**
	Part Time	-0.1221	-0.1034	0.44
Joint Significance				0.00***
Other Human Capital	Work Exp	0.0071	0.0141	0.07*
	Work Exp^2	-0.0001	-0.0003	0.18
	Tenure	0.0047	0.0030	0.20
	Time Not Working	-0.0025	-0.0005	0.53
Joint Significance				0.19
Demographics	Indigenous	0.0745	0.0488	0.57
	Born in OECD	-0.0104	-0.0030	0.80
	Married or De Facto	0.0397	0.0531	0.61
	Social Background	0.0011	0.0004	0.12
	Partners Wages	3.8e-5	8.9e-5	0.00***
	Partners Hours	-0.0014	-0.0024	0.12
Joint Significance				0.00***
Overall Significance				0.00***

Table 32: Explained & Unexplained Differences in Oaxaca Decomposition

Variable	Explained		Unexplained	
Year	0.000177	(0.00261)	-4.938	(3.481)
Hrs Worked	-0.0605***	(0.00914)	0.0503	(0.0346)
Hrs Worked Sq	0.000174	(0.000756)	-0.00537	(0.00363)
Ed y12	0.000170	(0.000385)	-0.00353	(0.00374)
Ed TAFE	-0.000892	(0.000849)	-0.00522	(0.00712)
Ed Bachelors	0.0176***	(0.00389)	-0.00288	(0.00521)
Ed Post Grad	0.0114***	(0.00308)	-4.74e-05	(0.00455)
Employer tenure	-0.00431**	(0.00191)	-0.0127	(0.00964)
Work Exp	-0.0854***	(0.0174)	0.175**	(0.0795)
Work Exp Sq	0.0535***	(0.0141)	-0.0743	(0.0465)
Time not working	0.00729	(0.0137)	0.0124	(0.0198)
Supervisor	0.00250**	(0.000973)	0.0120**	(0.00571)
Public sector	0.000110	(0.000724)	0.000362	(0.00513)
Union	-6.30e-05	(0.000317)	-0.00976*	(0.00517)
Indig	-2.53e-05	(0.000226)	-0.000332	(0.000686)
Born OECD	-0.000322	(0.000920)	0.000952	(0.0265)
Married or Defacto	0.00443	(0.00292)	-0.0110	(0.0140)
Parents Status	0.00389	(0.00238)	-0.0240	(0.0171)
Partner Wage	-0.0125***	(0.00250)	0.0312***	(0.00919)
Part Time	0.0396***	(0.00800)	0.00785	(0.0129)
Manager	0.0107***	(0.00285)	0.000508	(0.00336)
Professional	0.0370***	(0.00628)	-0.00305	(0.0113)
Trade	0.000421	(0.000686)	0.00306*	(0.00171)
Service	-0.00939***	(0.00289)	0.0146**	(0.00628)
Admin	-0.000263	(0.00235)	-0.00273	(0.00946)
Sales	-0.00255**	(0.00116)	0.00578	(0.00357)
Machine Op	-0.000376	(0.000493)	0.000220	(0.00136)
young Kids			0.00546	(0.00650)
Constant	4.845	(3.478)		
Total	0.0124	(0.0174)	0.0719***	(0.0232)
Observations	24,871			

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 33: Oaxaca of Endogenous Switching Model
Sample: Women with no Children/ Children 0-14 only

Log Hourly Wage	Estimate	Robust SE	P Value
Non-Mothers (Conditional)	3.143***	(0.00776)	0.000
Non-Mothers (Unconditional)	3.221***	(0.00672)	0.000
Mothers (Conditional)	3.109***	(0.00627)	0.000
Mothers (Unconditional)	3.114***	(0.00396)	0.000
Adjusted Difference	0.107		
Decomposition			
Explained	0.005	(0.0524)	0.915
Unexplained	0.102**	(0.0496)	0.041
Total	0.107		
Obs. 1,968	*** p<0.01, ** p<0.05, * p<0.1		

Table 34: Ordered Probit Model - Working

Where ordinal slection is: "Not Working", "Part time", "Full Time"		
Variable	Coefficient	Robust SE
kids 04	-0.414***	(0.0595)
kids 514	0.105	(0.0650)
c par	0.137***	(0.0494)
age	0.0231	(0.0326)
age sq	-0.000467	(0.000404)
ed y12	0.0791	(0.0795)
ed TAFE	0.167**	(0.0716)
ed Bachelors	0.272***	(0.0788)
ed Post Grad	0.210**	(0.0867)
work exp	0.0387***	(0.00950)
time not working	-0.0372***	(0.00973)
indig	0.0267	(0.173)
born high inc OECD	0.249***	(0.0688)
married or defacto	-0.195**	(0.0886)
parents status	0.000229	(0.00119)
partner wage	0.000223***	(6.70e-05)
partner hours	0.00660***	(0.00178)
partner income	-5.47e-06***	(1.34e-06)
LT health condition	0.222***	(0.0605)
ever worked	1.205***	(0.392)
carer	-0.274**	(0.117)
Cut-off 1	1.795**	(0.712)
Cut-off 2	2.575***	(0.713)
Observations	6,184	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 35: Probit Model - Working

Variable	Working	se
Working		
Kids 04	-0.985***	(0.0721)
Kids 514	0.222***	(0.0701)
Mum close parents	0.194***	(0.0689)
Dad close parents	0.00720	(0.0732)
Age	-0.0139	(0.0418)
Age sq	-0.000287	(0.000543)
Ed y12	0.150	(0.0932)
Ed TAFE	0.250***	(0.0865)
Ed Bachelors	0.572***	(0.0965)
Ed Post Grad	0.682***	(0.117)
Work exp	0.0705***	(0.0115)
tTme not working	-0.0552***	(0.0118)
Indig	0.193	(0.197)
Born high inc OECD	0.170*	(0.0902)
Married or defacto	-0.197*	(0.115)
Parents status	0.000694	(0.00146)
Partner wage	0.000131	(8.21e-05)
Partner hours	0.00542**	(0.00223)
Partner income	-5.76e-06***	(1.61e-06)
LT health condition	0.414***	(0.0732)
Ever worked	0.958**	(0.452)
Carer	-0.514***	(0.140)
Constant	-0.558	(0.856)
Observations	6,184	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 36: Explained Differences - Close Vs. Far Grandparents

Variable	Explained Difference	Robust SE
year	4.66e-05	(0.00134)
kids 04	0.00653**	(0.00275)
kids 514	-0.000457	(0.00105)
hrs worked	0.0157***	(0.00564)
hrs worked sq	0.00714	(0.00561)
work exp	-0.0405***	(0.0144)
work exp sq	0.0285***	(0.0105)
ed y12	0.000799	(0.00125)
ed TAFE	-0.00220	(0.00244))
ed Bachelors	0.00797	(0.00593)
ed Post Grad	0.000230	(0.00576)
employer tenure	0.00770***	(0.00264)
time not working	0.00902***	(0.00339)
supervisor	0.000490	(0.000879)
public sector	0.000957	(0.000995)
married or defacto	0.000144	(0.00261)
parents status	-0.000421	(0.00136)
part time	-0.00957***	(0.00361)
Manager	0.00639	(0.00522)
Professional	0.00781	(0.00845)
Trade	-0.000197	(0.000535)
Service	-0.00133	(0.00142)
Admin	0.00341	(0.00377)
Sales	-1.01e-05	(0.000228)
Machine Op	-0.000790	(0.000715)
Total	0.0473***	(0.0173)
Observations	9,895	

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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