Specialization, Comparative Advantage, and the Sexual Division of Labor

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Abstract

Recent work situates gender norms as a key driver of the sexual division of labor. But the explanatory power of Becker's comparative advantage explanation is still not well understood. Drawing on unique data, we test the predictions of a formal Beckerian model. We complement this by proposing and analyzing new measures of specialization. We show that comparative advantage plays little or no role in the sexual division of labor within couple households. Absolute advantage also plays no role in specialization for same-sex couples, and this is not explained by having fewer children.

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1. Introduction

The sexual division of labor, by which men specialize in market work (MW) and women specialize in domestic work (DW) has been studied through various lenses. The canonical economic explanation is biologically determined comparative advantage within heterosexual couples (Becker 1991). According to this theory, women's innate ability to bear, deliver and feed children with their own milk, leads them to specialize in DW, whilst their husbands focus on MW (Becker, 1991). Becker (1991) argues that even small sex-determined biological differences can lead to large differences in comparative advantage, due to gendered differences in human capital investments from very early in the life course.

The family economics literature has long dispensed with the unitary framework of household behavior which underpins Beckerian models. Instead, distinct preferences of family members are emphasised in cooperative and non-cooperative bargaining models (Lundberg and Pollak, 1996). But bargaining models do not provide an alternative explanation for the sexual division of labor.[1]

A number of stylised facts are consistent with Becker's comparative advantage explanation for the sexual division of labor. In particular, women's participation in the labor force has increased dramatically in recent decades, at the same time as their comparative advantage in domestic work has decreased. This decline in comparative advantage has several drivers. Declining fertility and the growing availability of birth control have meant that children are decreasingly central to family life (Goldin & Katz, 2002; Stevenson & Wolfers, 2007).[2] Female education – a key determinant of productivity in market work – has increased dramatically relative to men (Blau & Kahn, 2017). Explicit policies of gender-based pay discrimination are no longer legal, further increasing returns to female market work. Next, as argued by Stevenson & Wolfers (2007), the emergence of labor-saving domestic technologies not only decreased the time needed for domestic labor, they have also made domestic work less skilled, reducing absolute advantage in domestic work (see also Greenwood & Guner, 2008).

[1] Bargaining models are focused primarily on within-household distribution of consumption, even if their predictions for time allocation may differ from the Beckerian model. For example, in the words of Lundberg and Pollak (2003), 'one of the casualties of this paradigm shift from unitary to non-unitary models is the presumption that families are efficient.' Nevertheless, this literature does not provide an alternate explanation for men and women to traditionally focus on market work and domestic work respectively.

[2] Children are at the centre of Becker's explanation for the sexual division of labor. They have also been shown to impact specialization decisions in empirical work (see, for example, Antecol & Steinberger, 2013; Giddings *et al.* 2014, Martell & Roncolato, 2016).

This is coupled with the emergence of service industries which have allowed housework to be outsourced. Finally, the shift towards cognitive over physical skills in the workplace has increased labor-market opportunities for women (Welch, 2000; Beaudry & Lewis, 2014). All of these factors have reduced female comparative advantage in domestic work over the last 60 years or so.

Yet, as female participation in MW has dramatically increased over time, a similar shift in men's relative contribution to unpaid work has not occurred, contrary to the predictions of a Beckerian model. Motherhood still comes with a sharp and immediate drop in the labor market earnings. Kleven *et al.* (2019) estimate the motherhood penalty for first-time mothers' ranges between 20 to 60 per cent in the five to ten years post-birth.

Norms are an alternate explanation for the sexual division of labor. Decisions may be shaped by powerful gendered stereotypes about roles and skills. The prescriptive nature of norms can affect behavior if gender stereotypes are internalised, shaping both preferences and subjective beliefs about skills (Bertrand, 2020). For example, gendered differences in math ability are socially constructed (Carlana, 2019). Even if individuals do not fully internalise such stereotypes, gender norms may still change behavior due to the perceived cost of deviating from gender expectations (Akerlof & Kranton, 2000). This may help explain why, for example, women who earn more than their husband's do more (not less) housework (Akerlof & Kranton, 2000) or why women undertake more unpaid work than men more broadly.

The role of gender norms in the sexual division of labor has gained traction in the past two decades (see Akerlof & Kranton, 2000; Bertrand *et al.*, 2015; Bertrand, 2020).[3] In a key contribution, Bertrand *et al.* (2015) show that a single norm (for men to earn more than their wives) has broad implications, influencing behavior in marriage markets, labor markets and in domestic work. These findings demonstrate that comparative advantage cannot completely explain the sexual division of labor.

[3] Sociologists and feminist economists have argued for the role of norms for a long time (Hartmann, 1981; West & Zimmerman, 1987; Folbre, 1994; Badgett & Folbre, 1999). The sociological tradition also provides an alternate explanation for women's higher housework contributions: 'exchange theory', which emphasises power and dependence. This explanation proposes that women do more housework than men because they have lower economic power, as measured by relative earnings (Bittman *et al.*, 2003). This model, however, does not explain why women do more housework instead of more market work as a consequence of economic power imbalance. Indeed, hours of market work are usually treated as exogenous in this literature. Therefore, it does not provide an explanation for specialization or the sexual division of labor, *per se*.

Norms clearly have a role. Despite this, we still do not have a clear understanding of how much influence comparative advantage has on the sexual division of labor.

We address this by examining patterns of within-household specialization in time allocation through a combination of approaches. Whilst comparative advantage is arguably not measurable, absolute advantage in market work (AAM) is measurable, and there is great variation in AAM between households. There is also much to learn from same-sex and childless households, for whom sex-based absolute advantage in domestic work (AAD) is less relevant.

We draw on data from Australia's Household, Income and Labour Dynamics survey (HILDA), which is ideally suited for the analysis. Crucially, HILDA's time use data are collected for all adult members of responding households, facilitating meaningful analysis of within-couple time allocations. HILDA's panel dimension also helps to greatly reduce missing wage data for people who are not employed in a particular wave. Rather than losing those people from the sample (or imputing wages), we instead draw on their wage observations from adjacent waves, or from more distant waves if necessary. This allows us to study the role of AAM for time use decisions at both the internal and external margins. HILDA also identifies same-sex couples, and its sample size is large enough for meaningful analysis. To our knowledge, no other dataset has all these features. For example, the American Time Use Survey (ATUS) only collects time use data for one member of each household, and the time diary only includes one specific day per respondent. Also, ATUS is not a panel survey, and so hourly wages are only observed for people employed at the time of the survey.

We begin by outlining and testing the predictions of a formal Beckerian domestic production model. We examine the model's predictions for the relationship between DW and comparative advantage. Whilst we don't observe AAD, we outline what AAD would need to be for comparative advantage to explain couples' time allocations. We believe this is the most direct test to date of the influential comparative advantage hypothesis. We find the relationship between AAM and DW allocation to be weak. At every point of the relative wage distribution, the female is expected to do the majority of the DW. If one is willing to extrapolate outside the support of the data, a woman would need to be over 100 times more productive in market work than her male partner before reaching expected parity in domestic work. Even amongst couples without children, expected parity in domestic work occurs only when the woman's wage is 12.6 times higher than her husbands'. For the Beckerian model to completely explain the sexual division of labor, such women would need to be 12.6 times as productive in domestic work than their husbands, even in the absence of children. We argue that the direction of

any bias due to endogenous relative wages is favourable to our conclusions. This assertion is supported by results from Bartik-style instrumental variable regressions and supplementary analysis.

But the Beckerian model imposes major restrictions on behavioral responses to wages. In particular, it assumes that all time is allocated either to market work or domestic work, with no role for leisure. It therefore provides a limited perspective on the relationship between comparative advantage and specialization. We avoid this limitation in the next part of our analysis, which begins with measurement. We propose three new within-couple Specialization Indices. Unlike previous attempts to measure specialization, each index includes time-use inputs from both market and household spheres for both members of each couple. We argue this is essential to identify genuine within-couple specialization.[4]

The first index (SI_1) measures the extent to which one member of the couple does most of the MW, whilst the other member does most of the DW. This index is hence sex-neutral, and blind also to AAM. It therefore allows us to explore the extent of within-household specialization, without imposing any assumptions on its determinants. The second index (SI_2) is a measure of sex-based specialization - relevant only for heterosexual couples. It takes its maximum value when the male partner does all the MW and none of the DW. The third index (SI_3) measures the extent to which couples specialize in a way that conforms with AAM. It takes its maximum value when the spouse with the higher hourly wage does all the MW, while the other member does all the DW.

We find a weak association between sex-based specialization (SI_2) and AAM, echoing the results of the Beckerian analysis. Importantly, corresponding IV estimates are reasonably precise. These are close to zero, suggesting no causal relationship of AAM (and hence comparative advantage) on specialization.

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[4] While many studies discuss specialization, few explicitly seek to measure it. Of those that do, most use labor-market proxies "as signals of household specialization" (Jepsen & Jepsen, 2015, p. 110), rather than measuring specialization in its own right.[4] Such proxies are problematic because working more labor-market hours than one's spouse does not necessarily imply doing less hours in domestic labor, or vice versa (Bittman *et al.*, 2003; Bertrand *et al.*, 2015). Conversely, others have attempted to measure household specialization using only measures of time in domestic work, ignoring market work (Stratton, 2005; Bonke *et al.* 2008). Other papers, such as Black *et al.* (2007) and Stevenson & Wolfers (2007), seek to circumnavigate these issues altogether by providing a descriptive analysis of specialization. Whilst useful in their discussion of the connection between human capital accumulation and specialization, their capacity to quantify the extent of specialization occurring across households is limited. Thus, we believe our measure of specialization facilitates a richer analysis of within-household specialization relative to previous work.

We gain further insights by exploring the role of children, again drawing on our Specialization Indices. We show that children are a central determinant of specialization. They also completely explain differences in the extent of specialization between same-sex couples and heterosexual couples. But children do not explain couple-type differences in the nature of specialization. Whilst AAM appears to have some role for heterosexual couples, it plays no role at all for same-sex couples. These differences remain after controlling for children and other factors. We argue that the apparent role of AAM for heterosexual couples is likely overestimated, since current AAM may reflect earlier time use decisions which affect human capital, and are in turn driven by gender norms.[5] In comparison, sex-based specialization, is much larger.

All the analysis leads to the conclusion that comparative advantage has little or no role in the sexual division of labor, in perhaps the strongest test to date of the Beckerian model.

The remainder of the paper is structured as follows. Section 2 describes data. Section 3 outlines and tests the predictions of a Beckerian model of specialization and comparative advantage. Section 4 outlines our new specialization indices. Section 5 briefly profiles the diverse nature of specialization and differences between couple types. Section 6 further examines the relationship between sex-based specialization and absolute advantage. Section 7 examines the role of children, and Section 8 concludes.

2. Data

The Household, Income and Labor Dynamics Australia (HILDA) Survey has a unique combination of features which make it ideal for studying specialization and the sexual division of labor. It includes time-use data on both MW and DW for both members of couples. It is also a longitudinal survey, which helps to navigate potential sample selection bias from missing wage information, as well as

[5] As we discuss in Section 3, AAM is likely endogenous, but the direction of resulting bias is favourable. AAM is a function of human capital, which in turn reflects choices about time use allocation made in earlier periods of life – through labor supply, and through education. In a similar vein, Becker's theory of sex-based specialization describes a process of gendered human capital accumulation throughout the life course. This implies that AAM may be a consequence of earlier sex-based specialization. Both factors suggest that our static analysis should overestimate the importance of AAM as an independent determinant of specialization decisions.

measurement error in hourly wages, which are constructed from self-reported earnings and hours.[6] HILDA also identifies same-sex couples, which has allowed us to also consider the role of absolute advantage when sex-based differences are not relevant. We elaborate on these features below.

2.1 Time-Use Variables

Our time-use data are drawn from HILDA's Self-Completion Questionnaire, where respondents record how much time they typically spend in a range of activities per week. Commonly referred to as stylised estimates, such data are regarded as inferior to time diary data for some purposes. But we argue that they are more suitable for our purposes than diary data.[7]

Our measure of DW combines time spent in outdoor tasks, childcare, housework, and household errands. These variables are clearly delineated in the HILDA survey,[8] such that they are able to be

[6] To our knowledge, there is no dataset available for the US which has all of these features.

[7] Several studies have found that stylized estimates of housework time exceed diary estimates on average (Marini & Shelton, 1993; Baxter & Bittman, 1995; Bianchi, Milkie, & Sayer, 2000; Juster, Ono & Stafford, 2003). However, this is not the case for HILDA when compared to the 2006 Australian Time Use Survey (TUS). Both sources are nationally representative of Australians aged 15 years and over. Among all respondents in the 2006 wave of HILDA, mean domestic work time is 220.4 minutes per day, almost the same as for domestic work in the TUS (224 minutes) (Australian Bureau of Statistics, 2008: Table 1). More important is whether reporting error varies systematically (especially by sex). Repeating the comparison above by sex reveals that males over-report domestic work slightly (by 3.5%), while females underreport slightly (by 4.8%). Expressed differently, the female: male DW ratio is 1.7 in HILDA, 1.8 in TUS if only primary activities are included, or 1.9 if secondary activities are also included (Australian Bureau of Statistics, 2008: Table 4). This suggests that women's share of DW may be under-estimated in HILDA. The direction of bias from such reporting error is favorable to our conclusions. Further, diary information is usually collected over the course of one or two days. Time use on those days may be accurately recorded, but they may nevertheless provide a noisy signal of individuals' 'typical' time use allocations - in which we are interested.

8 Housework includes preparing meals, washing dishes, cleaning the house, washing clothes, ironing, and sewing. Household errands includes shopping, banking, paying bills and keeping financial records. Outdoor tasks include home maintenance (such as repairs, improvements), car maintenance and gardening. Childcare includes playing with your children, helping them with personal care, teaching, coaching or actively supervising them, getting them to childcare, school, and other activities.

summed to form a single measure for time spent in domestic work.[9] These inputs are also generally consistent with previous definitions of domestic work in the literature. However, unlike previous research, our measure is indifferent to specialization by task type and considers only time spent in domestic work at the aggregate level.[10] In a similar manner, our measure of MW is the sum of time spent in paid work and commuting.

Online Appendix 5 shows that key results are not sensitive to the exclusion of outlying (arguably implausible) reported time use values.

2.2 Hourly Wage Variables

Relative hourly wages between couple members are our measure of AAM. A person's hourly wage in each wave is derived as the ratio of weekly earnings to self-reported weekly hours worked. It is hence subject to measurement issues, with associated threats to validity. The panel nature of HILDA helps to reduce these threats greatly.

The first threat is potential sample-selection bias – couples who completely specialize have one person that does not participate in any market work, and so their hourly wage is not observed contemporaneously. However, the panel structure of HILDA goes a long way towards addressing this issue. Rather than relying on contemporaneous hourly wages, we instead use a within-person moving-median across waves. Specifically, for each person whose time use variables are observed at time *t*, we assign a wage equal to the median of this persons' non-missing observed wage across a five-year window: from *t-2* to *t+2*. This substantially reduces the sample loss due to missing wage data – an additional 7,311 couple-wave observations are included under this approach (as opposed to relying only on contemporaneous wage data), reflecting an additional 16% of the full SI_1 sample.[11] In Online

9 We assume no multi-tasking. The direction of bias from this assumption is likely favorable to our conclusions. See the discussion in footnote 8 on secondary activities in TUS.

10 See for example Stratton (2005) and Bonke *et al.* (2008), who construct a single composite measure of domestic specialization by task type.

11 Couple-year observations are dropped if either couple member's hourly wage is still missing after applying the moving-median approach described in the text. Amongst those dropped in our preferred approach, the majority had at least one partner who was self-employed (77%), while 43% included at least one partner who was not

Appendix 4, we explore sensitivity of key results to different approaches to deal with missing wage observations, including using observed wages observed at more distant waves.

Using a moving-median wage also arguably addresses the second threat to validity associated with measurement error, which is the possibility of noisy observations from misreported earnings or hours – which would lead to attenuation bias. If the wage is relatively stable over time but is reported with error, the 5-year moving-median wage may be a better measure.

We also take further steps to deal with measurement error in wages. We drop extreme outliers – hourly wages below AUD $1.90 and over AUD $211[12]. We also test the sensitivity of the results to excluding observations where the hourly wage difference is relatively small: less than 5%, 10% and 50%.

These and all other variables are described in more detail in Online Appendix 1.

2.3 Sample Construction and Descriptive Statistics

Using HILDA Release 17, we selected couple-year observations from waves 2 to 17,[13] where both members were aged 18-64. Couple-year observations were also excluded if either member did not return a self-completion questionnaire. Couple-year observations where either partner had missing data for all of the time-use variables were excluded.[14] Couple-wave observations were also dropped if either partner had missing wage data even after applying the 5-year moving-median wage window, including couples where at least one-partner was self-employed or not working.[15]

currently working. Online Appendix 4 shows sensitivity of key results to different approaches to deal with missing wage observations.

[12] These are the top and bottom 0.1% of the hourly wage observations after applying the moving-median. In total, 100 couple-wave observations were excluded as a result.

[13] We drop Wave 1 because the stylised time-use variables in the first wave differ from subsequent waves. In the first wave, time-use is measured in hours (as opposed to hours and minutes in later waves) and there is no variable for paid employment.

[14] In cases where only some time-use variables were missing, these were set to zero. This occurred frequently, for example, when individuals without children were asked how much time they spent caring for their children.

[15] We show our results are robust to potential sample-selection bias due to missing wage observations in Online Appendix 4.

After dropping a small number of couple-year observations whose sampling weights are set to zero,[16] our full estimation sample consist of 45,337 couple-year observations from 7,649 unique couples.[17] A smaller sample of 24,715 observations is used for analysis that draws on wage variables. This is from dropping waves 2, 16 and 17, necessary for constructing the moving-median wage (as described above), and from remaining missing wage information.

Table 1 displays the means for the variables used in the analysis for the full sample.[18] The majority of couples are married and different-sex, with the average couple age at just under 43 years old. Additionally, almost half the couples in our sample have a dependent child under the age of 15 living in the household, and less than a quarter have a child between the ages of 0 to 4. On average, couples in our sample spend approximately 61 hours each week on domestic work, and 72 hours in paid employment collectively.

[16] 223 couple-wave observations were dropped whose sampling weights were set to zero.

[17] This includes 249 observations from 61 gay couples, and 391 observations from 79 lesbian couples, who are excluded from some components of the analysis, as will be described.

[18] Online Appendix Table A2 shows further descriptive statistics.

Table 1: Descriptive statistics

Variable	*Mean*	*SD*
Married Heterosexual	0.812	(0.391)
Unmarried Heterosexual	0.176	(0.381)
Gay	0.006	(0.075)
Lesbian	0.006	(0.077)
Couple Age	42.570	(10.452)
Couple Duration	16.190	(11.202)
Children Aged 0-4	0.239	(0.426)
Children Aged 5-9	0.215	(0.411)
Children Aged 10-14	0.210	(0.407)
Children < 15	0.485	(0.500)
Likely to Have [More] Children (average of each couple members' response on 0-10 scale)	3.653	(4.043)
Desires [More] Children (average of each couple members' response on 0-10 scale)	4.204	(4.045)
Log Relative Wage	0.389	(0.347)
Time-Use		
Market Work	72.185	(25.787)
Paid Employment	64.868	(23.463)
Commuting	7.317	(5.810)
Domestic Work	60.690	(38.034)
Housework	23.396	(13.789)
Household Errands	9.001	(6.898)
Childcare	20.386	(27.734)
Outdoor Tasks	7.907	(7.946)

3. A Beckerian Model of Comparative Advantage

In this section, we specify a modified Beckerian model of time allocation and outline its predictions. We then examine whether it can explain the patterns of gendered specialization that we see in the data. There are considerable theoretical and empirical challenges involved in testing the model, which we seek to clearly discuss. We find little evidence that comparative advantage plays an important role in the sexual division of labor.

3.1 Predictions of a Beckerian Model

Couple i seeks to maximise domestic production for a single commodity Z_i as a function of purchased inputs (x) and domestic work time by each member of the couple (t_{mi} and t_{fi}):

$$Z_i = x_i^a t_{mi}^b t_{fi}^c \quad (1)$$

This is a Cobb-Douglas production function as per Becker (1973).[19] The parameters b and c represent relative productivity in domestic work for the male and female, respectively. These too are individual-specific, although we supress this from the notation for now.

Each couple maximises Z by choosing the amount of time each member allocates to market work and to domestic work (which we refer to collectively as work time). Leisure time is determined outside of and has no explicit role in the model.[20] Allocations of leisure time may or may not be efficient or equitable, but this as irrelevant to assessing the role of comparative advantage as determinant of gendered specialization. Total time in work is specific to every individual, so that for the male in couple i, work time (T_{mi}) is the sum of domestic work time (t_{mi}) and market work time (l_{mi}), and similarly for the female. These are the time constraints:

$$t_{mi} + l_{mi} = T_{mi} \quad (2)$$
$$t_{fi} + l_{fi} = T_{fi} \quad (3)$$

The production function imposes complementarity between domestic work of the male and the female (t_{mi} and t_{fi}). But there is no complementary in male and female market work (l_{mi} and l_{fi}), since x_i is equal to the couple's earnings:

$$x_i = w_{mi} l_{mi} + w_{fi} l_{fi} \quad (4)$$

[19] In Online Appendix 3 we consider a more general class of CES production functions, which we draw upon when we interpret the empirical results later in this section.

[20] This is different to a standard Beckerian model, in which all time is allocated either to market work or domestic work. However, the conclusions of this section are the same if all time is assumed allocated either to market work or domestic work. We return to the role of leisure time in our discussion of equation (9) below.

In this model, an efficient time allocation maximizes Z_i subject to the time constraints in (2) and (3) and the budget constraint in (4). Substituting (2), (3) and (4) into (1), household i's problem is to maximise:

$$Z_i = [w_{mi}(T_{mi} - t_{mi}) + w_{fi}(T_{fi} - t_{fi})]^a \; {t_{mi}}^b \; {t_{fi}}^c \tag{5}$$

Taking logs:

$$\ln Z_i = a \ln[w_{mi}(T_{mi} - t_{mi}) + w_{fi}(T_{fi} - t_{fi})] + b \ln \; t_{mi} + c \ln \; t_{fi} \tag{6}$$

The first order conditions are:

$$\frac{\partial \ln Z_i}{\partial t_{mi}} = \frac{-aw_{mi}}{w_{mi}(T_{mi} - t_{mi}) + w_{fi}(T_{fi} - t_{fi})} + \frac{b}{t_{mi}} = 0 \tag{7}$$

$$\frac{\partial \ln Z_i}{\partial t_{fi}} = \frac{-aw_{fi}}{w_{mi}(T_{mi} - t_{mi}) + w_{fi}(T_{fi} - t_{fi})} + \frac{c}{t_{fi}} = 0 \tag{8}$$

Equations (7) and (8) imply:

$$\frac{t_{fi}}{t_{mi}} = \frac{c}{b} \Big/ \frac{w_{fi}}{w_{mi}} \tag{9}$$

which is independent of the total time each person spends working (T_{fi} and T_{mi}), confirming that the amount of leisure time each member has does not impact the model's predicted relative domestic work time allocation. Note also that the right hand side of Equation (9) is female absolute advantage in domestic work ($\frac{c}{b}$), divided by female absolute advantage in market work ($\frac{w_{fi}}{w_{mi}}$), which equals female comparative advantage in domestic work. That is,

$$\frac{t_{fi}}{t_{mi}} = \frac{AAD_{fi}}{AAM_{fi}} = CA_{fi} \tag{10}$$

Finally, we take the logged version of equation (9), and allow b and c to be couple-specific, recognising that AAD is likely to vary greatly between couples:

$$\ln \frac{t_{fi}}{t_{mi}} = \ln \frac{c_i}{b_i} - \ln \frac{w_{fi}}{w_{mi}} \tag{11}$$

3.2 Testing the Beckerian Model

Testing whether the theoretical prediction above is consistent with our data is challenging. Nevertheless, we can make a number of conclusions about the ability of the Beckerian model to explain the patterns in the data. We begin by outlining how we navigate these challenges:

a) We do not observe AAD - the first term on the RHS of (11). We also do not know whether AAD is correlated with AAM, or the size of this correlation. To scrutinise equation (11), we are limited to studying the bivariate relationship between $\ln \frac{t_{fi}}{t_{mi}}$ and $\ln \frac{w_{fi}}{w_{mi}}$. We can however, infer what AAD would need to be for equation (11) to hold at various values of the observed variables.

b) AAM (the second term on the RHS of 11) is likely endogenous. In particular, wages are a function of decisions in the past to invest in human capital (especially time spent in market work), and there is likely to be strong serial correlation in such time use decisions. This is especially likely to affect women's wages and time use, since men typically work full-time for most of their working-age. This implies that any observed relationship between relative domestic work time and AAM is biased away from zero. As we will show, however, this direction of bias is favourable, since the observed relationship is already very small. We also implement a Bartik-style instrumental variable estimator which directly addresses endogeneity. The IV results support the main conclusions, but they are imprecise. We then gain further insights into this endogeneity by separately considering male and female time use as a function of AAM.

c) The Beckerian model above assumes a Cobb-Douglas production function, which imposes a substitution elasticity of 1 between male and female domestic work. This has no empirical justification. Online Appendix 3 shows that relaxing this assumption with a class of CES production functions yields solutions which are similar to (11), but with s (the elasticity of substitution) appearing as a coefficient to both terms on the RHS (see equation A7). Since we do not know the true elasticity of substitution, this complicates the interpretation of both the slope and the intercept in the relationship between $\ln \frac{t_{fi}}{t_{mi}}$ and $\ln \frac{w_{fi}}{w_{mi}}$, which we examine below. We are able to navigate this complication by considering what the relative wage would have to be for predicted parity in housework. At this point, the elasticity of substitution is not relevant. For the Beckerian model to hold, AAD must exactly equal AAM at this point, regardless of the elasticity of substitution.

d) Finally, measurement error in the relative wage would bias the slope the relationship between $\ln \frac{t_{fi}}{t_{mi}}$ and $\ln \frac{w_{fi}}{w_{mi}}$ towards zero. As discussed in Section 2, there is good reason to believe that

measurement error in wages is relatively minor, especially since we exploit panel data and take a local average of several observed wages for each person-year time-use observation.

It is useful to consider what results could be interpreted as supporting some role of comparative advantage in the sexual division of labor. A negative association between relative housework time and AAM constitutes support for comparative advantage having some role.[21] More persuasively, establishing a negative causal effect of AAM (and hence comparative advantage) on relative housework time would provide stronger support, especially given the serious potential endogeneity issues we have outlined. We investigate this association, and then take some steps towards estimating the causal effect, using instrumental variable regression.

Figure 1 shows the actual non-parametric relationship between $\ln\frac{t_{fi}}{t_{mi}}$ and $\ln\frac{w_{fi}}{w_{mi}}$.[22] Each point represents the mean of the former for each percentile of the latter, with a superimposed linear fit. This fit is suggestive of a negative linear relationship, which is qualitatively consistent with the Beckerian model, and this is confirmed in regression analysis (Table 2).[23]

Perhaps the main feature of Figure 1 is that women do much more housework than males at every percentile of the relative wage distribution. For example, at wage parity, the fitted value is 0.446, implying that women do 56% more housework than their husbands. Even at the 99th percentile of the relative wage distribution, where women's wages are 2.4 times higher than their partners', women still do 44% more housework. It seems no matter how large her wage advantage, a woman always has an even larger expected absolute advantage in domestic work, if the Beckerian model holds.

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[21] If there is no association at all between relative housework time and AAM, this could still be consistent with the comparative advantage explanation. However, this would only be the case if AAD and AAM are extremely highly associated – i.e. if comparative advantage was constant across the support of AAM. This seems unlikely. This would also be inconsistent with Becker's (1973) theory of efficient assortative mating.

[22] We show corresponding results for a variety of sub-populations in Appendix Figure A6. The pattern varies little with age, education, or time. The presence of children appears to be the major source of heterogeneity.

[23] For this analysis, we exclude observations in the top and bottom 0.5% of the relative wage distribution. The top 0.5% of the distribution in particular is characterised by outlying high values of female/male relative housework. We believe this is because extreme values in the relative wage distribution result from measurement error rather than the actual relative wage. If however, we include those observations, the main results are even stronger. These results are available on request.

A literal interpretation of the Beckerian model outlined above would conclude that at wage parity, women are on average 56% more productive in the home, whilst at the extreme end of relative wage advantage, women are 3.5 times as productive in domestic work as their husbands (drawing on equation 11). This implies a very strong correlation between AAM and AAD. But this pattern of results could also be consistent with a different (smaller) elasticity of substitution between male and female housework. The estimated slope of the relationship in Figure 1 is -0.095. We could instead assume the elasticity of substitution is 0.095 (as per equation (A7) in Online Appendix 3) and that AAD and AAM are uncorrelated. This would imply that women are 109 times more productive than their husbands in domestic work (regardless of their relative wage). This uncertainty over the elasticity of substitution and the correlation between AAD and AAM makes it clear that another approach is needed to interpret these results.

Figure 1: Relative domestic work time by relative wage

Notes: Each point represents one percentile of the female: male relative wage distribution amongst heterosexual couples.

Table 2: Regressions of log relative domestic work time on log relative wage

	(1) OLS no controls	(2) OLS with controls	(3) Bartik-IV no controls	(4) Bartik-IV with controls
		A: All couples		
log (female wage / male wage)	-0.095***	-0.101***	-0.012	-0.029
	(0.030)	(0.029)	(0.094)	(0.095)
Constant	0.446***	0.434***		
	(0.015)	(0.021)		
N	24,003	23,622	44,239	43,539
		B: Couples without children		
log (female wage / male wage)	-0.115***	-0.099**	0.093	0.103
	(0.040)	(0.041)	(0.094)	(0.093)
Constant	0.291***	0.277***		
	(0.020)	(0.030)		
N	12,917	12,718	22,909	22,566

Notes: This table presents results from regression models which correspond to Figure 1, and equations (11) and (A7). Control variables are all standardized so as to preserve the interpretation of the constant. Controls include quadratics in female age and male age, duration of relationship, and number of children aged 0-5, 5-9 and 10-14 years, respectively. Standard errors in parentheses clustered on coupleID. Standard errors in columns (3) and (4) estimated using a clustered bootstrap with 100 repetitions.

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

A more fruitful approach is to ask how large a woman's wage advantage would have to be for parity in domestic work time to be expected. This exercise requires extrapolation well outside the support of the data. However it avoids some complications, since it does not require assumptions as to the elasticity of substitution, or the correlation between AAD and AAM. Predicted parity in domestic work occurs when a woman's wage is 109 times higher (and hence that her domestic productivity is also 109 times higher).[24] This is clearly extremely high. If we restrict the sample to couples without children (drawing on Table 2 Panel B), this falls to 12.6. Whilst considerably smaller, this is still an extreme value, well outside of the support of the data.

These results are a consequence of the weak relationship between the relative wage and relative housework time. As mentioned above, however, the relative wage is likely endogenous to this relationship. But the direction of resulting bias is favourable to the emerging conclusion. For example, it is entirely possible that endogeneity explains all of this relationship (i.e. that relative wages are a

[24] It is not a coincidence that this number (109) is the same as under the CES interpretation above. But the interpretation here is different.

consequence of earlier time use decisions, rather than a determinant of current time use decisions). If so, this would suggest that comparative advantage may have no role at all in explaining gendered time use patterns.

In an attempt to directly account for endogeneity of relative wages, we also implement a Bartik-style instrumental variable estimator (Bartik, 1991; Aizer, 2010, Betrand *et al.*, 2015). The first stage regression for female wage is shown in equation (12), with a corresponding equation for males.

$$\ln(w_{fit}) = Z_{stae} + \beta_s + \gamma_t + \delta_a + \theta_e + \vartheta_{Pa} + \pi_{Pe} + \varepsilon_{it} \quad (12)$$

In this model, the log hourly wage of each couple member in each year is instrumented by state-year-age–education-specific shocks (Z) to sex-specific hourly wages.[25] The identifying assumption is that Z is orthogonal to unobserved determinants of time use decisions, conditional on state (s), year (t), age (a), education (e), partner's age (Pa) and partner's education (Pe). [26] The same controls are included in the second stage regressions. In some versions, we also include additional controls (the same set as in Table 2 Column (2)).

The results are shown in Columns (3) and (4) of Table 2. In Panel A, the estimates are close to zero and statistically insignificant. In Panel B, the point estimates are actually positive, but are also statistically insignificant. In both Panels, the results suggest that exogenous shocks to relative wages have little effect on the division of domestic labor within couples, especially in the direction predicted by the Beckerian model.

We gain further insights by separately considering men's and women's housework time. Since most men work full-time, the endogeneity of relative wages is more likely to generate a (spurious) relationship for females than for males. We separate the LHS of Equation (11) into two components, which respectively address men's and women's responses to relative wages:

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[25] Since the IV estimates are identified by temporal shocks, we use the actual wage observed in each wave, instead of the moving-median approach that we use elsewhere.

[26] Education categories are (i) degree or higher qualification, (ii) post-school qualifications but less than degree, (iii) no post-school qualifications. Age categories are: less than 30, 30-39, 40-49, 50+. Small states are grouped with adjacent large states (Tasmania with Victoria, ACT with New South Wales, Northern Territory with Queensland).

$$\ln t_{mi} = -\ln \frac{c_i}{b_i} + \ln \frac{w_{fi}}{w_{mi}} \quad (13)$$

$$\ln t_{fi} = \ln \frac{c_i}{b_i} - \ln \frac{w_{fi}}{w_{mi}} \quad (14)$$

Figure 2 shows the binned-mean plots corresponding to (13) and (14), for males, and females respectively. Visually, there is no apparent relationship between male housework time and the relative wage. In contrast, there is a clear negative relationship for females.

Results from corresponding regression models shown in Table 3 confirm this. As mentioned, this discrepancy may reflect endogeneity related to earlier female time use decisions. Whether or not this is the case, these results strongly suggest that AAM has no role at least in men's domestic time use allocation, which immediately contradicts the predictions of models which assume that households allocate their productive time efficiently.

Overall, we reach the same conclusion as our earlier analysis – that AAM has little or no role in specialization decisions, contrary to the predictions of a Beckerian model.

Figure 2: Domestic work time and relative wage by sex

A: Males

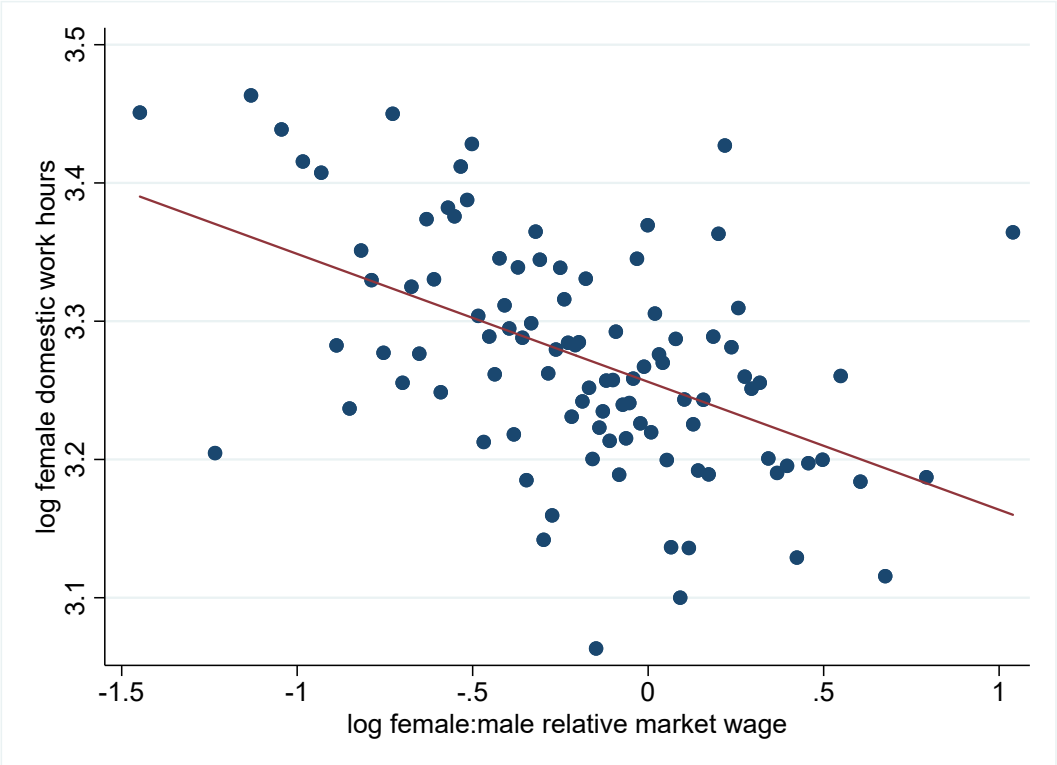

Table 3: Regressions of log domestic work time on log relative wage

	(1) No controls	(2) With controls
	A: Log male domestic work	
log (female wage / male wage)	0.003	0.009
	(0.024)	(0.023)
Constant	2.811***	1.012***
	(0.013)	(0.154)
N	24,098	23,713
	A: Log female domestic work	
log (female wage / male wage)	-0.094***	-0.093***
	(0.027)	(0.021)
Constant	3.255***	1.106***
	(0.014)	(0.137)
N	24,118	23,731

Notes: This table presents results from regression models which correspond to Figure 2, and equations (12) and (13). Control variables include quadratics in female age and male age, duration of relationship, and number of children aged 0-5, 5-9 and 10-14, respectively. Robust standard errors in parentheses are clustered on coupleID.
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4. Measuring Specialization Within Couples

In this section, we propose three new couple-level measures of specialization in time use.[27] Whilst these new measures may have many uses, we have developed them primarily because they help us to extend our assessment of the comparative advantage explanation for the sexual division of labor, in sections 6 and 7.

In Section 3, we examined comparative advantage through a Beckerian lens. Whilst grounded in the most relevant theory, such an approach has major limitations. It rules out important behavioral responses to AAM. Consider the effect of an increase in the female's wage. The model assumes that a resulting increase in female MW implies a decrease in DW. It rules out the possibility that the female

[27] In Appendix 7, we outline an alternate set of specialization indices which are weighted according to the time spent by the couple in each realm (market work and domestic work), as suggested by a referee. We also show that all the main results are very similar when the alternate measures are used.

will instead reduce her leisure time. For the same reason, the implicit measure of specialization (relative domestic work time) completely ignores time spent in market work.

Without explicitly outlining an alternate theoretical framework, we propose new measures of specialization which avoid this limitation, as they draw on time in MW and DW by both couple members. Surprisingly, these seem to be the first such measures of within-couple specialization in the literature. Previous work has attempted to measure specialization by observing only MW or only DW (for example, Nottmeyer, 2011; Jepsen & Jepsen, 2015; Stratton, 2005; Bonke *et al.*, 2008).

4.1 A Within-Couple Specialization Index

The first specialization index (SI_1) is blind to sex, comparative advantage, and its components. It simply measures the extent to which each couple is specializing in their division of labor between market work and domestic work.

$$SI_1 \quad = \quad \left| \frac{MW_1}{MW_1 + MW_2} - \frac{DW_1}{DW_1 + DW_2} \right| \tag{15}$$

The first term on the RHS of (15) is the share of couple's market work performed by person 1. The second term is the share of the couple's domestic work performed by the same person. SI_1 takes its maximum value (1) when one spouse does all of the household's market work, while their partner does all of the domestic work.[28] It takes its lowest value (0) if their share of household market work is equal to their share of domestic work. This occurs if, for example, MW and DW are both shared equally by the members of the couple, but also if one member contributes none of their time in work of either type. In both of those cases, the household is not specializing.[29]

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[28] It is straightforward to show that the choice of which couple member to label as person 1 is arbitrary and the index takes the same value regardless:

$$\left| \frac{MW_1}{MW_1 + MW_2} - \frac{DW_1}{DW_1 + DW_2} \right| = \left| \left(1 - \frac{MW_1}{MW_1 + MW_2}\right) - \left(1 - \frac{DW_1}{DW_1 + DW_2}\right) \right| = \left| \frac{MW_2}{MW_1 + MW_2} - \frac{DW_2}{DW_1 + DW_2} \right|$$

[29] Leisure time (L) does not feature directly in the index. The index is not intended to measure fairness of time allocation. However as mentioned above, as L approaches one for one member of the couple (whilst remaining unchanged for the other member), the index will approach zero, since the other member of the couple would be doing the majority of both types of labor.

4.2 Measuring specialization which conforms with sex and AAM

Whilst SI_1 measures the extent of specialization, it does not measure whether specialization conforms with sex-norms or with absolute advantage in either sector. We propose two more specialization indices for this purpose. Both are based on SI_1, with minor tweaks.

The second index (SI_2) is our preferred measure of sex-based specialisation, which we use in Section 6, when we return to the assessment of comparative advantage. It measures whether couples divide their labor in a direction which conforms with sex norms (which may or may not in turn reflect AAD). Specifically, it measures the extent to which a female partner specializes in DW and the male partner in MW, as per equation (16).[30]

$$SI_2 \quad = \quad \frac{DW_F}{DW_F + DW_M} - \frac{MW_F}{MW_F + MW_M} \tag{16}$$

The third index (SI_3) measures whether couples specialize in a way which conforms with AAM. This is the extent to which the couple member with the higher hourly wage does most of the MW, whilst their partner does most of the DW, as per equation (17).[31]

$$SI_3 \quad = \quad \frac{MW_H}{MW_H + MW_L} - \frac{DW_H}{DW_H + DW_L} \tag{17}$$

SI_2 is hence equal to the female's share of DW minus her share of MW. SI_3 is defined as the share of MW done by the person with the higher hourly wage, minus their share of DW.

[30] This index is relevant for heterosexual couples only.

[31] Measurement error in hours of paid work may mechanically lead to downward bias in SI_3. To illustrate, consider an individual who underreports hours worked. This person has an upward biased wage, and consequently is more likely to be coded as having a higher wage than their partner. But this person's share of paid work is also biased downwards and, consequently, so is SI_3. Fortunately, in every wave, HILDA collects time in paid work twice – once in the interviewer-administered Person Questionnaire, and again in the time-diary section of the subsequent Self-Completion Questionnaire. We use the first of these to construct the hourly wage, and the second of these to construct each specialization index. Whilst this does not eliminate the issue completely (since reporting error may be correlated between the two reports), it likely reduces its importance.

Unlike SI_1, these two indices range from -1 to 1. The greater range reflects the fact that unlike SI_1, these indices are intended to capture specialization as it conforms (or differs) to AA in either sector. A score of 1 implies the couple is fully specialized in a way that conforms with sex norms (in the case of for SI_2) or with AAM (in the case of SI_3). In the case of SI_2, this implies that the female is doing all the DW and none of the MW. For SI_3, it implies that the couple member with the higher hourly wage does all the MW and none of the DW. A score of -1 also implies complete specialization, but in the opposite direction predicted by sex or AAM. For SI_2, this is when the female partner does all of the MW and none of the DW. For SI_3, it implies the partner with the lower hourly wage completes all of the MW and none of the DW. For both indices, a score of zero implies there is no specialization occurring in the household.

The second and third specialization indices therefore incorporate elements of SI_1, this being the extent to which couples specialize, but they also impose a direction in which specialization conforms with a particular prediction. For these reasons, SI_1 is not directly comparable to the other two indices. However, SI_2 and SI_3 may be compared to each other to determine whether sex or AAM plays a greater role in within-family time-allocation.

Table 4 shows that the mean of SI_2 (0.278) is much higher than the mean of SI_3 (0.103). This implies that specialization conforms much more to sex-roles than it does with absolute advantage in the market – a theme that we explore in subsequent analysis.[32] It also shows the proportions of couples who have positive values of SI_2 and SI_3, respectively – that is, couples who specialize consistently with sex and with AAM.[33] The results show that approximately 78% of couples specialize consistently with sex, while just 61% specialize consistently with AAM.[34]

[32] A similar conclusion is made if the sample is restricted to couples with valid values for both SI_2 and SI_3. For this restricted sample, the mean of SI_2 is 0.218 and the mean of SI_3 is 0.105.

[33] It is noted that couples with a positive value for SI_2 and/or SI_3 may not necessarily be specializing as much as a Beckerian model of comparative advantage may predict. However, this is not possible to determine, as AAD is immeasurable.

[34] A similar conclusion is made if the sample is restricted to couples with valid values for both SI_2 and SI_3. For this restricted sample, 76% have a positive value of SI_2 and 61% have a positive value of SI_3.

Table 4: Descriptive statistics for Specialization Indices

Variable	*Mean*	*SD*
SI_1	0.383	(0.270)
SI_2	0.278	(0.379)
$SI_2 > 0$	0.776	(0.417)
SI_3	0.103	(0.387)
$SI_3 > 0$	0.608	(0.488)

Table 5 displays the bivariate Pearson correlations between the three specialization indices. SI_1 and SI_2 are strongly positively correlated, with a coefficient of 0.65. The correlations between SI_3 and each of the other two indices are relatively weak, at around 0.3. This suggests that household specialization overall conforms strongly with sex-roles, much less so with AAM.

Table 5: Bivariate Pearson Correlations between the specialization indices

	SI_1	SI_2	SI_3
SI_1	1.000		
SI_2	0.650	1.000	
SI_3	0.292	0.306	1.000

5. Describing Specialization

Before using the SIs to revisit the role of comparative advantage, we first show patterns of specialization and its diversity.

5.1 The Distribution of Specialization

Panel A of Figure 3 shows the distribution of sex-based specialization. This heat-plot shows the bivariate density for the share of DW and MW undertaken by the female member of the heterosexual couples in our sample. It shows two dominant patterns of behavior. Much of the data lies towards the middle of the plot, where the female partner undertakes between 30% and 55% of the total market work, and between 40% and 80% of the total domestic work. The highest density within this region is

very close to a 50:50 split in both MW and DW, but this is only slightly higher than the surrounding region. By far the highest density occurs at the south-east corner, where the female partner undertakes 80% of the DW and none of the MW. This shows that a large portion of heterosexual couples in the sample which exhibit a sexualised division of labor. There are very few observations in which the female does all of the MW (at the top of the Figure). In those cases, however, females also do close to half of the DW[35].

Panel B of Figure 3 is a density plot of the proportion of DW and MW undertaken by the partner with the higher hourly wage. It shows whether couples are specializing in a way that conforms with AAM. In some ways, this density plot is similar to the previous, with a high density in the centre of the plot and another in the direction predicted by absolute advantage. However, it is much more symmetric around the diagonal – with the density only slightly higher towards the north-west of the region compared to the south-east. Those couples conforming most strongly with AAM are in the north-west corner, where the member with the higher hourly wage undertakes most of the market work and only a small proportion of housework. But there is also considerable mass in the south-east corner, where the partner with the higher hourly wage undertakes very little of the market work and most of the housework, contrary to AAM.

Panel C of Figure 3 is based on Panel B, but with the sample restricted to same-sex couples. Compared to Panel B, the density is even more concentrated in the centre of the plot, reflecting a very high level of equality in MW in particular. There is also no evidence of asymmetry in the density around the diagonal, and hence no sign that same sex couples conform with AAM.

These density plots highlight a great diversity in how couples allocate their time. For some, allocations conform with sex-roles, as well as with AAM. But many other couples make choices which are opposed to AAM in particular. Finally, many other households allocate their time relatively equally in both spheres, and hence do not specialize at all.

[35] Bittman *et al.* (2003) and Bertrand *et al.* (2015) find that married heterosexual women tend to contribute more to the household when their income exceeds that of their husband's, in order to compensate for deviating from prescribed social norms.

Figure 3: Within-Household Distribution of Work

5.2 Specialization by Couple-Type

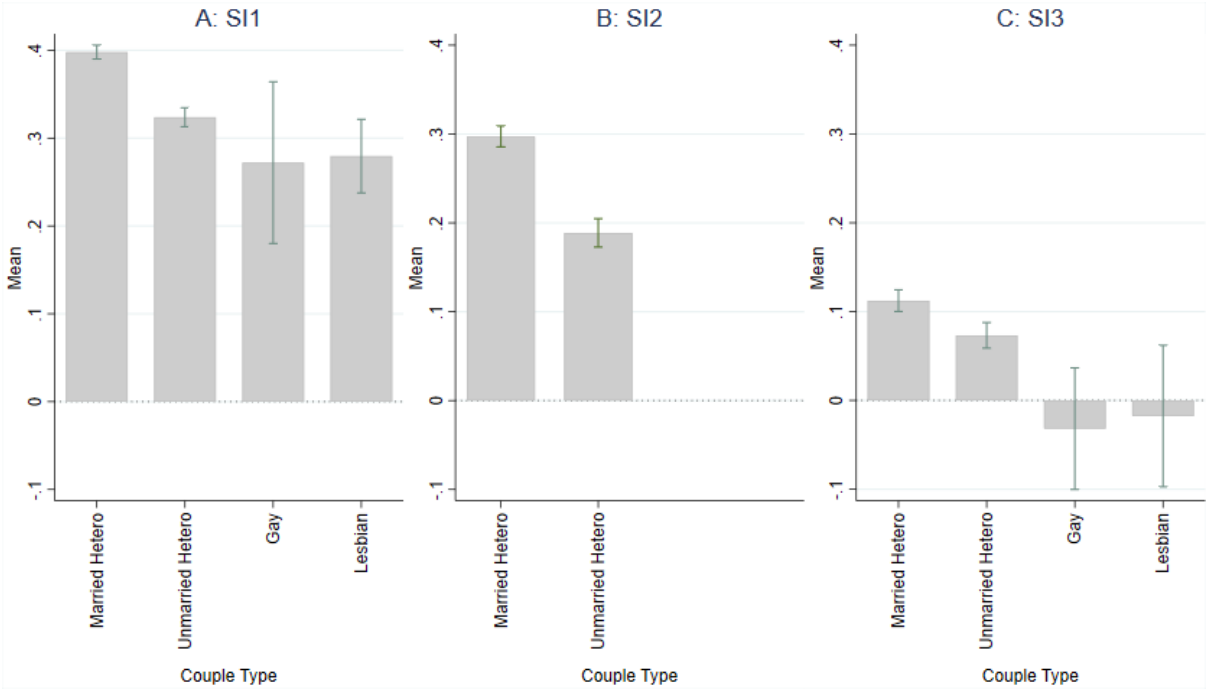
To the extent that same-sex couples cannot benefit from comparative advantage due to sex, we expect to observe less specialization in gay and lesbian households. However, whenever one partner has a comparative advantage in one sphere over the other, the couple may specialize to increase efficiency. AAM should therefore be relevant for same-sex households.

Previous work on couple-type differences in specialization has generally found same-sex couples specialize less than their heterosexual counterparts in the labor market (Black *et al.*, 2007; Antecol & Steinberger, 2013; Giddings *et al.*, 2014). Furthermore, married heterosexual couples exhibit by the far the largest degree of market-work specialization, ahead of unmarried heterosexual and same-sex couples (Jepsen & Jepsen, 2015). Marriage has been shown to encourage specialization and financial pooling due to its contractual nature (Badgett, 2001). This is supported by analyses showing the adoption of unilateral divorce laws in US states in the 70s and 80s reduced investment in marriage-specific human capital (Stevenson, 2007).

Figures 4 shows means of the specialization indices for a range of couple types: married heterosexual, unmarried heterosexual, gay and lesbian.[36] Panel A shows that specialization is prevalent across all couple types. Married heterosexual couples specialize much more than same-sex couples, with unmarried heterosexual couples midway between. This is consistent with earlier work (Giddings *et al.*, 2014; Jepsen & Jepsen, 2015; Black *et al.*, 2007). There are a number of possible explanations for this. In Section 7 we show that these differences are mostly explained by the presence of children, and especially young children.

[36] Whilst Australia enacted legislation in December 2017 allowing same-sex marriage, this would only apply to the most recent wave of the HILDA survey. Further, as HILDA survey data is generally collected in September each year, it is unlikely any same-sex couples identified as married in wave 17 would be legally recognised as such at the time. Less than 4% of all gay couple wave observations and 2% of lesbian couple wave observations identified as married in the data. Of these, only six same-sex couple wave observations were drawn from wave 17 survey data.

Figure 4: Specialization by Couple Type



Panel B of Figure 4 shows the mean of SI_2 for married and unmarried heterosexual couples, respectively.[37] Similarly to SI_1, married heterosexual households specialize consistently with gender considerably more so than unmarried heterosexual households.

Panel C shows the mean for SI_3 for each couple type. The most striking results are for same-sex couples. For them, there is no evidence at all of specialization consistent with AAM. This in turn suggests that comparative advantage is irrelevant in their time allocation decisions, since sex plays no role. An alternate explanation is that productivity in market work is very strongly correlated with (unmeasured) productivity in domestic work. This would imply that AAM is unrelated to comparative advantage, which seems unlikely. Either way, the results suggest that comparative advantage does not at all explain the time allocation decisions made by same sex couples. This in turn raises the question as to whether, or why, only heterosexual couples would allocate their time in a way that reflects comparative advantage. Amongst heterosexual couples, the mean of SI_3 is also much lower than the mean SI_2, confirming that sex plays a much larger role than AAM.[38] In

[37] SI_2 is undefined for same-sex couples.

[38] Similar conclusions are made if the sample is restricted to couples with valid values for both SI_2 and SI_3. For married heterosexual couples in this restricted sample, the mean of SI_2 is 0.236 and the mean of SI_3 is 0.112. For unmarried heterosexual couples, the mean of SI_2 is 0.145 and the mean of SI_3 is 0.073.

Section 7 we examine whether differences in observable characteristics (including children) explain why heterosexual couples are more likely to specialize consistently with AAM.

A threat to the validity of the SI_3 analysis is that wage differences may only be small for some couples. For such couples, the relationship between AAM and comparative advantage may be weak. We can test the sensitivity of the results by restricting the sample to couples who have large wage differences. Table 6 shows the results when the wage gap is at least 5%, 10%, 20% and 40%.

Table 6: Mean of SI_3 by couple type and minimum wage gap

	Couple Type			
	Married Heterosexual	Unmarried Heterosexual	Gay	Lesbian
	A. > 5% wage gap			
Mean SI_3	0.124	0.079	-0.039	-0.023
(SE)	(0.007)	(0.008)	(0.038)	(0.041)
N 22,375	*16,284*	*5,783*	*115*	*193*
	B. > 10% wage gap			
Mean SI_3	0.135	0.091	-0.055	-0.007
(SE)	(0.007)	(0.008)	(0.040)	(0.047)
N 19,788	*14,516*	*5,018*	*97*	*157*
	C. > 20% wage gap			
Mean SI_3	0.161	0.115	-0.069	0.008
(SE)	(0.008)	(0.010)	(0.047)	(0.071)
N 14,750	*11,040*	*3,529*	*75*	*106*
	D. > 40% wage gap			
Mean SI_3	0.216	0.156	-0.072	-0.139
(SE)	(0.011)	(0.016)	(0.071)	(0.159)
N 6,676	*5,215*	*1,405*	*32*	*24*

The most important results are qualitatively similar for any of these restrictions. In particular, there is no evidence of specialization by AAM for same sex couples. For heterosexual couples, the mean of SI_3 increases as the exclusion threshold is raised. Amongst heterosexual couples whose wage differs by at least 40%, mean SI_3 is 0.22 for married couples and 0.16 for unmarried couples. Nevertheless, we again note that for heterosexual couples, AAM may be an outcome of gender norms rather than an independent driver of specialization. It is for this reason that the results for same-sex couples are particularly insightful. For them at least, comparative advantage does not seem to explain time allocation decisions at all. We examine this further in Section 7.3

6. Comparative Advantage and the Sexual Division of Labor

We now revisit the role of comparative advantage in the sexual division of labor. We draw on SI_2, which we have suggested is a better measure of sex-based specialization than the measure we derived directly from the Beckerian model in Section 3. We examine the relationship between SI_2 and AAM in a way that mirrors the analysis in Section 3.2.

As per the discussion in Section 3.2, an association between SI_2 and AAM would be consistent with comparative advantage having a role in the sexual division of labor. However, the causal effect of AAM on SI_2 is of primary interest. Importantly, this relationship between AAM and SI_2 has much less residual variation, which leads to more precise instrumental variable estimates. The analysis provides strong evidence that AAM has little or no causal effect on the sexual division of labor.

Figure 5 shows the mean of SI_2 for each percentile of AAM. This pattern resembles Figure 1 in some respects. SI_2 for each percentile of AAM, showing that couples specialise consistently with sex regardless of the extent of female AAM. The relationship also has a negative slope, which is consistent with AAM having some role in specialization. Visually, the main difference between Figures 1 and 5 is the smaller residual variation in Figure 5. Table 7 show the corresponding regression results. Columns (1) and (2) present estimates with and without controls, showing that controls do little to affect the estimates.

If we use the extrapolation approach to interpret this relationship, we find that a woman would have to be 6.1 times more productive than her husband in market work for the expected value of SI_2 to be zero. This decreases to 2.6 if couples with children are excluded. These are much smaller than the corresponding results using the Beckerian framework. But they are also affected by the same endogeneity issues, and are likely severely biased downwards.

Therefore, we turn to the Bartik-style IV estimator. Columns (3) and (4) of Table 7 show the corresponding IV estimates. These are close to zero and not statistically significant. They suggest that an exogenous change to AAM would have little or no effect on the sexual division of labor. Importantly, the standard errors are reasonably small and so we can rule out relatively small effects.

Figure 5: SI_2 by relative wage

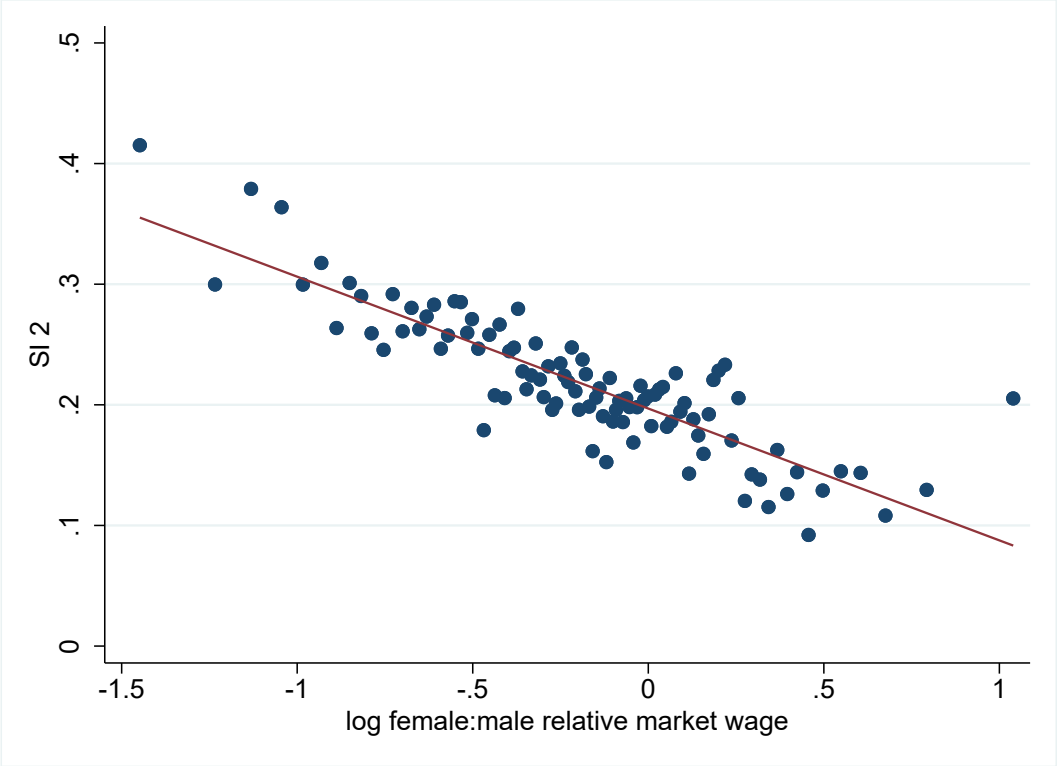


Table 7: Regressions of SI_2 on log relative wage

	(1) OLS no controls	(2) OLS with controls	(3) Bartik-IV no controls	(4) Bartik-IV with controls
		A: All couples		
log (female wage / male wage)	-0.109***	-0.116***	-0.028	-0.038
	(0.010)	(0.010)	(0.031)	(0.029)
Constant	0.197***	0.195***		
	(0.005)	(0.007)		
N	24,213	23,822	44,697	43,980
		B: Couples without children		
log (female wage / male wage)	-0.111***	-0.105***	0.000	0.005
	(0.014)	(0.014)	(0.033)	(0.032)
Constant	0.108***	0.107***		
	(0.006)	(0.009)		
N	13,051	12,844	23,204	22,849

7. Children and Specialization

Children are central in most discussions of specialization. They are often cited as the greatest determinant of a heterosexual couple's division of labor (Lundberg & Rose, 2000; Bonke *et al.*, 2008; Dalmia & Sicilian, 2008) and recent studies have shown children also play a role in how same-sex families divide their labor (Antecol & Steinberger, 2013; Giddings *et al.*, 2014; Martell & Roncolato, 2016). Children have also been shown to act as the catalyst for the gender wage gap (Goldin, 2014; Bertrand *et al.*, 2010). In this section, we consider whether children explain the patterns of specialization in the data: are they the main driver of specialization, and do they explain differences between couple types? For this, we draw on the three specialization indices.

7.1 The Arrival of Children

As Giddings *et al.* (2014) suggest, since children are "usually a deliberate choice on the part of the parents, especially same-sex couples, it is potentially misleading to consider children as exogenous to household's time allocation decisions" (p. 529). For similar reasons, it is problematic to treat changes in time use allocations before and after the arrival of children as causal.

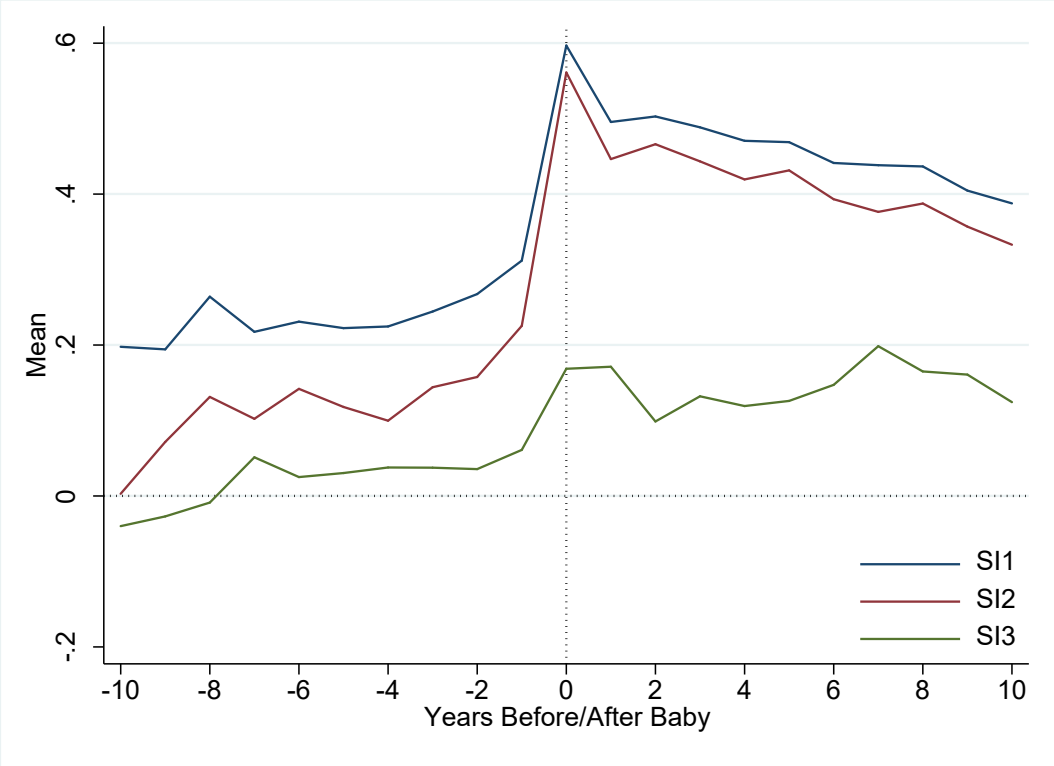
Whilst acknowledging these issues, Figure 6 shows the mean of each specialization index in the years before and after the arrival of children.[39] As expected, the arrival of children is associated with a very sharp increase in specialization overall (SI_1) from 0.31 in the year prior to the birth/adoption of the child up to 0.60 at its arrival. In subsequent years, specialization declines gradually. However, even after ten years, specialization does not decline to the point that it equals its pre-child levels.

The trend for SI_2 largely mirrors the trend in SI_1, especially in the years after a child is born. In the ten years prior to the arrival of the child, sex-based specialization is quite low, but it increases from close to zero ten years prior to around 0.2 in the year prior to arrival. This increase may reflect the fertility intentions of the parents, as families prepare for the arrival of their child.

In contrast, SI_3 shows no such discontinuity. Further, there seems to be no AAM-based specialization prior to the arrival of children.

[39] For couples with more than one recorded new child during 2002-2017, we include only the first such child.

Figure 6: Specialization before and after children



Overall, Figure 6 suggests that the arrival of children is a major catalyst for increased specialization. Children are a huge positive shock in the demand for domestic labor. They induce sex-based specialization, which seems to have little to do with AAM.

7.2 Children Drive the Extent of Specialization

To further investigate the role of children in specialization, we turn to multivariate analysis. We estimate regressions as per the following specification:

$$SI_{it} = \alpha + \beta_c + \gamma_t + \tau \boldsymbol{X}_{it} + \varepsilon_{it} \qquad (18)$$

Where SI_{it} is one of the Specialization Indices for couple *i* at time *t*, β_c and γ_t are couple-type effects and year effects, respectively, $\boldsymbol{X_{it}}$ is a vector of time-varying couple characteristics[40] which

[40] This includes age, age squared, couple duration, children, fertility intentions and log of relative wage. For a detailed description of how each control variable is constructed, see Appendix 1.

are included sequentially, and ε_{it} is the error term. For all analyses, we show robust standard errors, clustered at couple level, to account for likely serial correlation.

Table 8 shows results for SI_1. Column (1) is from the regression without any of the $\boldsymbol{X_{it}}$ covariates. These are essentially raw differences between couple types, controlling only for wave fixed-effects. The differences mirror those shown in Figure 4. Columns 2 and 3 show that these couple-type differences are largely unexplained by basic demographic differences – namely age and couple duration. Whilst age is statistically significant, it is not a major factor in specialization, as its inclusion barely changes the explanatory power of the model. Couple duration is not a statistically significant factor.

In Column 4 we introduce an indicator for the presence of young children, aged 0-4. This is by far the single strongest predictor of specialization. The results suggest that a young child increases SI_1 by 0.22. This is consistent with Figure 6. Furthermore, this variable appears to explain most of the difference between couple types in the extent of specialization. It explains more than two-thirds of the difference between married and unmarried couples, around half of the difference between married heterosexuals and gay couples, and more than half of the difference between married heterosexuals and lesbian couples. It also increases the explanatory power of the regression by an order of magnitude.

In Column 5 we also include indicators for older children, aged 5-9 and 10-14, respectively. These also have large and significant effects on SI_1 – albeit much smaller effects than do young children, as expected. With the inclusion of these variables, the differences in specialization between couple types are much smaller.[41] In Column 6, we replace the gay and lesbian indicators with a single indicator for same-sex couples. We conclude that children explain around 75% of the difference between couple types in the extent of specialization.

[41] In an earlier version of this paper (Siminski & Yetsenga, 2020) we estimated versions of the model which also include fertility intentions and expectations. These variables are only available in some waves. The inclusion of these variables changes the key results only slightly. But the impact they do have is due to the restricted estimation sample. If we keep the estimation sample constant, the inclusion of those variables affects the key estimates much less. Therefore, we do not show those results here. For the same reasons, we do not show results from regressions which include a variable for the relative wage, but we note that its inclusion also has little effect on the results.

Table 8 Estimates from SI_1 regressions

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Constant	0.432***	0.577***	0.584***	0.417***	0.603***	0.603***
	(0.006)	(0.044)	(0.045)	(0.041)	(0.043)	(0.043)
Unmarried Heterosexual	-0.0728***	-0.0780***	-0.0750***	-0.0236**	-0.0194**	-0.0194**
	(0.007)	(0.007)	(0.008)	(0.008)	(0.008)	(0.008)
Gay	-0.122**	-0.122**	-0.140***	-0.0578	-0.0347	
	(0.047)	(0.047)	(0.050)	(0.049)	(0.049)	
Lesbian	-0.117***	-0.118***	-0.112***	-0.0565***	-0.0391**	
	(0.022)	(0.022)	(0.022)	(0.018)	(0.018)	
Same Sex						-0.0371
						(0.024)
Couple Age		-0.00713***	-0.00743***	-0.00664***	-0.0178***	-0.0178***
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Couple Age Squared		0.00829**	0.00800**	0.0106***	0.0247***	0.0247***
		(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
Couple Duration			0.000661	0.00223***	0.00179***	0.00179***
			(0.000)	(0.000)	(0.000)	(0.000)
Children Aged 0-4				0.220***	0.221***	0.221***
				(0.006)	(0.006)	(0.006)
Children Aged 5-9					0.0665***	0.0665***
					(0.006)	(0.006)
Children Aged 10-14					0.0462***	0.0462***
					(0.006)	(0.006)
Log Relative Wage (SI_1)						
N	45337	45337	44567	44567	44567	44567
R-squared	0.017	0.018	0.018	0.112	0.126	0.126

Notes: Standard errors in parentheses clustered on coupleID. $^{*}\ p < 0.10$, $^{**}\ p < 0.05$, $^{***}\ p < 0.01$

7.3 Children Do Not Explain Why Same-Sex Couples Ignore Absolute Advantage

We now estimate similar regressions for SI_3 (shown in Table 9). Columns (1) through (5) include the same regressors as in Table 8. Columns (6) and (7) also include a relative wage variable.[42] The main insight from these results is that children only explain about one quarter of the differences in SI_3 between heterosexual couples and same-sex couples. They do however, explain most of the difference between married and unmarried heterosexual couples. Put differently, whilst children explain the couple-type differences in the extent of specialization (as shown in Section 7.2), they do not explain why heterosexuals are more likely to specialise consistently with AAM. The obvious explanation seems to be the role of sex in shaping AAM. As argued earlier, for heterosexual couples, AAM is likely to be influenced by gendered human capital accumulation. In other words, for heterosexuals, AAM is confounded by sex, while for same-sex couples AAM does not seem to play a role in time allocation decisions.

Turning to the coefficient estimates in Table 9, children and especially young children continue to have a strong effect. However, these are much smaller than for SI_1. In other words, children induce couples to specialise, but not necessarily in accordance with AAM. This is perhaps unsurprising, since the presence of young children is the foundation for theories of sex-based AAD, and perhaps the origin of cultural gender-roles as well.

[42] See footnote 41 for why the relative wage is not included in Table 8.

Table 9 Estimates from SI_3 regressions

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7
Constant	0.130***	-0.0955	-0.110	-0.143**	-0.0147	-0.0570	-0.0570
	(0.012)	(0.069)	(0.071)	(0.071)	(0.074)	(0.073)	(0.073)
Unmarried Heterosexual	-0.0388***	-0.0340***	-0.0259**	-0.0107	-0.00807	-0.00286	-0.00284
	(0.010)	(0.011)	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Gay	-0.143***	-0.161***	-0.143***	-0.118**	-0.105**	-0.102*	
	(0.035)	(0.046)	(0.051)	(0.050)	(0.049)	(0.058)	
Lesbian	-0.130**	-0.143***	-0.135***	-0.121***	-0.110**	-0.0858*	
	(0.041)	(0.041)	(0.044)	(0.045)	(0.046)	(0.047)	
Same-Sex							-0.0922**
							(0.037)
Age		0.0406***	0.0404***	0.0407***	0.0369***	0.0342***	0.0342***
(Higher Hourly Wage Earner)		(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)
Age		-0.0300***	-0.0292***	-0.0298***	-0.0336***	-0.0316***	-0.0316***
(Lower Hourly Wage Earner)		(0.006)	(0.006)	(0.006)	(0.006)	(0.005)	(0.005)
Age squared		-0.0305***	-0.0307***	-0.0304***	-0.0256***	-0.0244***	-0.0244***
(Higher Hourly Wage Earner)		(0.007)	(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Age squared		0.0181***	0.0165**	0.0177***	0.0225***	0.0214***	0.0214***
(Higher Hourly Wage Earner)		(0.007)	(0.007)	(0.007)	(0.007)	(0.006)	(0.006)
Couple Duration			0.00114	0.00161**	0.00131	0.00116	0.00117
			(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Children Aged 0-4				0.0648***	0.0680***	0.0644***	0.0644***
				(0.013)	(0.013)	(0.012)	(0.012)
Children Aged 5-9					0.0397***	0.0354***	0.0354***
					(0.014)	(0.011)	(0.011)
Children Aged 10-14					0.0357***	0.0334***	0.0334***
					(0.014)	(0.010)	(0.010)
Log Relative Wage (SI_3)						0.196***	0.196***
						(0.017)	(0.017)
N	24715	24715	24286	24286	24286	24286	24286
R-squared	0.003	0.039	0.039	0.043	0.046	0.074	0.074

Notes: Standard errors in parentheses clustered on coupleID. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

8. Conclusion

Family economics has evolved considerably since Becker's seminal contributions. Recent work has situated gender norms as a driver of the sexual division of labor. Despite this, we still do not have a strong understanding of the explanatory power of Becker's seminal explanation for the sexual division of labor - comparative advantage within households. Within-household specialization has not even been directly measured previously.

This paper has sought to address these gaps. We have shown that comparative advantage plays little or no role in explaining the sexual division of labor through two complementary analyses. We outline and test the predictions of a formal Beckerian domestic production model. Whilst there are considerable challenges in testing this model, we find that women are expected to do more domestic work that their male spouse at every point in the support of the relative wage distribution. The relative wage only has a weak relationship with the allocation of domestic work time. If we are to extrapolate outside the support of the data, a woman would need to be 109 times more productive in market work than her husband before reaching expected parity in domestic work. Even this estimate is likely severely biased downwards due to endogeneity of relative wages from earlier time use decisions. Furthermore, only women's domestic work time is associated with relative wages, not men's. This provides further support for the endogenous AAM interpretation, since such endogeneity is likely to affect women more than men, since women's market work hours vary much more.

But the canonical Beckerian model only provides a limited treatment of specialization because it rules out important realistic behavioral responses to wages. It assumes that an increase in MW is exactly offset by a decrease in DW, with no role for personal leisure time. We address this through a complementary approach, which starts with new measures of specialization. Using these, we confirm that AAM has little or no role in sex-based specialization, through a variety of approaches. This includes a Bartik-style instrumental variable analysis, which shows that exogenous changes to AAM (and hence comparative advantage) have little or no effect on specialization decisions.

We have attempted to contribute to the understanding of specialization and the sexual division of labor in the 21st century. However, the role of men and women in contemporary society is changing rapidly, and as such it is necessary to continually revisit the role of gender at home and at work, and the implications this has for couple-behavior more broadly. With non-traditional households

becoming more prevalent in society (for example, same-sex, polyamorous, single-parent, childless, *etc.*), and the construct of gender becoming more complex, typical household structures will continue to shift, and the study of such behavior will become more relevant. Thus more work is needed, and needed often, for this field to keep pace with societal change more broadly.

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Online Appendices for 'Specialization, Comparative Advantage, and the Division of Labor within Couple Households'

Appendix 1 Description of Variables

Table A1: Description of Variables

Variable	HILDA Identifier	Construction
Hourly Wage	wscmei jbmhruc	Hourly wages defined as current weekly gross wages in main job divided by hours usually worked per week in main job. For each individual, we construct hourly wages based on their median non-missing hourly wage in a five-year window; 2 year preceding and 2 years following the current wave. Hourly wages are restricted to between AUD $1.90 and AUD $211.
Couple Type	hhpxid hgsex mrcurr	Couples are matched together based on their unique partner identifier. Gay and lesbian households are determined when corresponding partners are the same-sex, whilst heterosexual couples are different-sex. Both heterosexual partners must be recorded as married to be classified as such, else the couple is listed as unmarried. Couple type is equal to one if classified as married heterosexual, two if unmarried heterosexual, three if gay and four if lesbian.
Children Aged 0-4	hhd0_4	Dummy variable equal to one if there are one or more dependent children between the ages of 0 and 4 living in the household, zero otherwise.
Children Aged 5-9	hhd5_9	Dummy variable equal to one if there are one or more dependent children between the ages of 5 and 9 living in the household, zero otherwise.
Children Aged 10-14	hhd1014	Dummy variable equal to one if there are one or more dependent children between the ages of 10 and 14 living in the household, zero otherwise.
Couple Duration	orcdur mrcdur mrplvt	For unmarried heterosexual and same-sex couples, duration is equal to orcdur (current de-facto duration). For married heterosexual couples, duration is equal to mrcdur (current marriage duration) plus mrplvt (years living together before present marriage).
Likely to Have [More Children]	icexpct	Constructed using the average score of both couple members per couple wave observation. Considers whether the respondent is likely to have children in the future. Ranges from zero to 10.
Desires [More] Children	iclike	Constructed using the average score of both couple members per couple wave observation. Considers whether the respondent would like to have children in the future. Ranges from zero to 10.
Additional Explanatory Variables used in Regression Models for SI_1		
Couple Age	hgage	Constructed by taking the average age of both couple members.
Couple Age Squared	hgage	Constructed by squaring the couple age variable.

Log Relative Wage (SI_1)		Equal to the absolute value of the log of relative wages between couple members i.e. | ln (hourly wage partner 1 / hourly wage partner 2) |
Additional Explanatory Variables used in Regression Models for SI_2		
Female Age	hgage	The age of the female partner.
Male Age	hgage	The age of the male partner.
Female Age Squared	hgage	Constructed by squaring the female age variable.
Male Age Squared	hgage	Constructed by squaring the male age variable.
Log Relative Wage		ln (hourly wage female partner/ hourly wage male partner)
Additional Explanatory Variables used in Regression Models for SI_3		
Age Higher Hourly Wage Earner	hgage	The age of the partner with the higher hourly wage.
Age Lower Hourly Wage Earner	hgage	The age of the partner with the lower hourly wage.
Age Squared – Higher Hourly Wage Earner	hgage	Constructed by the squaring the age of the higher hourly wage earner variable.
Age Squared – Lower Hourly Wage Earner	Hgage	Constructed by the squaring the age of the lower hourly wage earner variable.
Log Relative Wage (SI_3)		ln (hourly wage of the partner with the higher hourly wage/ hourly wage of the partner with the lower hourly wage)

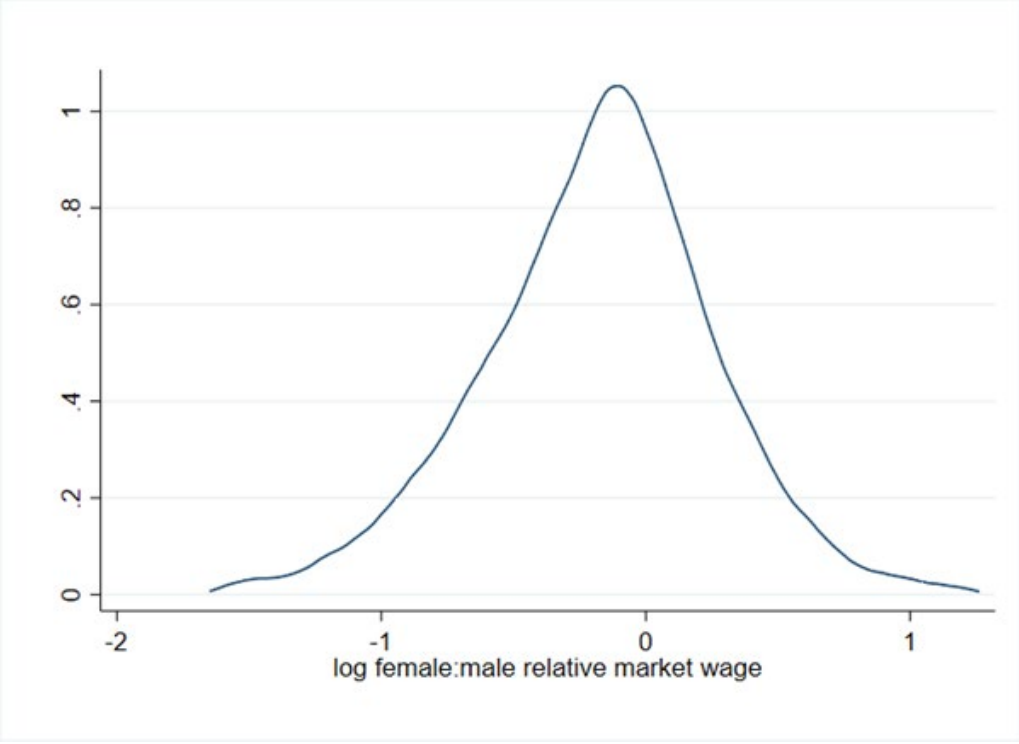
Appendix 2 Additional Descriptive Statistics

Table A2: Descriptive statistics by Couple Type (Mean and Standard Deviation)

Variable	Married Heterosexual	Unmarried Heterosexual	Gay	Lesbian
SI_1	0.398	0.324	0.272	0.279
	(0.271)	(0.258)	(0.256)	(0.242)
SI_2	0.297	0.189	n/a	n/a
	(0.379)	(0.368)		
$SI_2 > 0$	0.795	0.690	n/a	n/a
	(0.404)	(0.463)		
SI_3	0.112	0.073	-0.032	-0.018
	(0.396)	(0.348)	(0.284)	(0.360)
$SI_3 > 0$	0.617	0.578	0.480	0.482
	(0.486)	(0.494)	(0.502)	(0.501)
Couple Age	44.023	36.076	40.169	38.813
	(9.855)	(10.661)	(9.803)	(9.625)
Couple Duration	18.427	6.072	6.201	7.034
	(10.814)	(6.367)	(4.931)	(5.526)
Children Aged 0-4	0.248	0.206	0.003	0.152
	(0.432)	(0.404)	(0.059)	(0.359)
Children Aged 5-9	0.233	0.144	0.007	0.078
	(0.423)	(0.351)	(0.083)	(0.268)
Children Aged 10-14	0.230	0.129	0.000	0.038
	(0.421)	(0.335)	(0.000)	(0.191)
Any Children < 15	0.518	0.357	0.007	0.221
	(0.500)	(0.479)	(0.083)	(0.415)
Likely to Have [More] Children	3.113	5.518	2.130	3.925
	(3.925)	(3.920)	(2.488)	(3.800)
Desires [More] Children	3.700	5.923	3.179	4.724
	(3.984)	(3.790)	(3.150)	(4.000)
Log Absolute Relative Wage	0.403	0.337	0.342	0.246
	(0.355)	(0.314)	(0.333)	(0.181)
Log Female: Male Wage	-0.195	-0.152		
	(0.454)	(0.408)		
Log Male Wage	3.394	3.281	3.344	
	(0.438)	(0.415)	(0.406)	
Log Female Wage	3.199	3.129		3.321
	(0.393)	(0.374)		(0.359)
Time-use (hours in a typical week, per couple)				
Domestic Work	63.159	50.881	26.560	46.437
	(37.372)	(39.328)	(13.546)	(38.950)

Housework	24.400	19.245	13.313	18.658
	(13.863)	(12.732)	(6.844)	(10.596)
Household Errands	9.212	8.114	7.622	7.848
	(7.016)	(6.311)	(6.125)	(5.529)
Childcare	21.446	16.302	1.713	14.263
	(27.686)	(27.639)	(7.477)	(30.890)
Outdoor Tasks	8.100	7.220	3.912	5.668
	(7.837)	(8.487)	(4.280)	(6.163)
Market Work	71.462	75.380	76.994	71.804
	(25.627)	(26.167)	(27.060)	(27.443)
Paid Employment	64.210	67.778	69.692	64.018
	(23.330)	(23.756)	(24.086)	(25.317)
Commuting	7.251	7.603	7.302	7.786
	(5.790)	(5.895)	(5.030)	(6.285)

Figure A2: Density of Log female: male hourly wage distribution among heterosexual couples



Appendix 3 Extension of the Theoretical Model to a More General Class of Production Functions

In this Appendix, we extend the analysis in Section 5 (which draws on a Cobb-Douglas production function) to the more general class of CES productions functions. The CES production function which corresponds with Equation (1) is:

$$Z_i = x_i^{\beta}\left[at_{mi}^{r}+(1-a)t_{fi}^{r}\right]^{1/r} \quad \text{(A1)}$$

Where $\frac{1}{1-r} = s$, where s is the elasticity of substitution between t_{mi} and t_{fi}. Productivity in domestic work for the male and female are represented by a, and $1-a$ respectively. As with the Cobb-Douglas function, these productivities are relative, and are individually specific.

Substituting the same constraints as previously: (2), (3) and (4) into (A1), the couple's problem is to maximise:

$$Z_i = [w_{mi}(T_{mi}-t_{mi}) + w_{fi}(T_{fi}-t_{fi})]^{\beta}\left[at_{mi}^{r}+(1-a)t_{fi}^{r}\right]^{1/r} \quad \text{(A2)}$$

Taking logs:

$$\ln Z_i = \beta \ln[w_{mi}(T_{mi}-t_{mi}) + w_{fi}(T_{fi}-t_{fi})] + {}^{1}/_{r} \ln\left[at_{mi}^{r}+(1-a)t_{fi}^{r}\right] \quad \text{(A3)}$$

The first order conditions are:

$$\frac{\partial Z_i}{\partial t_{mi}} = \frac{-\beta w_{mi}}{w_{mi}(T_{mi}-t_{mi})+w_{fi}(T_{fi}-t_{fi})} + \frac{at_{mi}^{r-1}}{at_{mi}^{r}+(1-a)t_{fi}^{r}} = 0 \quad \text{(A4)}$$

$$\frac{\partial Z_i}{\partial t_{fi}} = \frac{-\beta w_{fi}}{w_{mi}(T_{mi}-t_{mi})+w_{fi}(T_{fi}-t_{fi})} + \frac{(1-a)t_{fi}^{r-1}}{at_{mi}^{r}+(1-a)t_{fi}^{r}} = 0 \quad \text{(A5)}$$

Equations (A4) and (A5) imply:

$$\frac{t_{fi}}{t_{mi}} = \left[\frac{(1-a)}{a} \Big/ \frac{w_{fi}}{w_{mi}}\right]^{s} \quad \text{(A6)}$$

Or in logs:

$$\ln \frac{t_{fi}}{t_{mi}} = s \ln \frac{(1-a)}{a} - s \ln \frac{w_{fi}}{w_{mi}} \quad \text{(A7)}$$

This implies a linear relationship between the log relative domestic time allocation and log relative wage, similarly to the Cobb-Douglas production function as per equation (11). The only substantive difference between equations (A7) and (11) is s, the elasticity of substitution between male and female domestic work: s appears as a coefficient on both terms on the right side of equation (A7). The other apparent difference between the equations is only notational: with $\frac{(1-a)}{a}$ in (A7) and $\frac{c}{b}$ in (11) both representing female:male relative productivity in domestic work.

Appendix 4 Robustness tests – treatment of missing wage observations

This Appendix shows robustness of results to alternate approaches to address missing wage observations. Such issues are only relevant to the components of the analysis that use wage variables. They also do not affect the instrumental variable estimates, which do not draw on imputed wages, for the reasons given in footnote 26.

In the main analysis, we have already partially addressed missing wages, by drawing on the panel dimension of the data. Specifically, rather than drawing only on contemporaneous observations of wages, we have used each person's median observed wage over a 5 year period. Nevertheless, for many couple-year observations, at least one member does not have a wage observation over such a 5-year period, and so they are excluded from the components of the analysis that require the wage variable. In this section we assess three alternate approaches to deal with such missing data, which lead to progressively larger samples. We also consider an alternative approach, which accounts for non-random labor-force participation. We elaborate on each approach below.

Extending the five-year wage window

First, for individuals with a missing wage in the main analysis, we extend the 5-year window as far as necessary until we observe a non-missing wage observation. Under this approach, our sample for SI_3 grows from 24,715 to 31,127, an increase of 26%. As shown in Table A4.1, the mean of SI_3 increases marginally under this approach, from 0.103 to 0.119. The means of SI_3 by couple type are also quite similar, as are the remaining couple-type differences after observed characteristics are held constant.

Imputing a wage for self-employed persons

Next, we impute a crude wage for self-employed people for whom we still do not have an hourly wage observation. For them, we assign a wage equal to the median weekly own-business income for Australian business owners, divided by 37.5, using ABS data.[43] This approach increases the sample by a further 3,056 observations. Column (3) of Table A4.1 shows that key results drawn from this sample are very similar to those from the original sample.

[43] ABS 2018, Cat No. 2071.0. This data was collected during the 2016 Australian census. For earlier (later) years, we deflate (inflate) this hourly wage estimate by 3.5% per annum.

Assigning the minimum wage to remaining observations

Next, we assign the minimum wage for any remaining people who do not yet have an hourly wage observation. These are people who are not self-employed, and who did not work as an employee at any wave of their time in the HILDA survey (or did not provide a valid response to the questions about earnings and hours worked in any given wave). This imputation adds another 2,831 couple-year observations for the SI_3 analysis, for a total of 37,014 observations. Key results from this sample are shown in Column (4) of Table A4.1. These are, in most respects, again very similar to those from the original sample. The exception to this is the coefficient for gay couples in Panel C, which (whilst remaining statistically insignificant) has a different sign to the earlier columns.

Alternate Imputation Accounting for Non-Random Labor Force Participation

In the main analysis, we use the median non-missing wage over a five-year window for each person-year observation. This implicitly assumes that labor force participation is random, or unrelated to fluctuations in the potential wage. Labor force participation, however, is likely to be a function of the potential wage. In a given year, a person will only participate if their potential wage exceeds their reservation wage. One approach to address this is to assume that missing wages are no greater than any observed wage for that person. We note that such an approach imposes a major assumption that reservation wages are stable over time. In reality the reservation wage is likely to vary with changes in personal and family circumstances. Indeed, the reservation wage may vary much more than the potential wage over time for a given person. Therefore, it is unlikely that such an approach is superior to the approached used in the main analysis. Nevertheless, we adopt this approach here. We recalculate each person's moving-median wage after setting missing wage observations to equal their lowest observed wage. This is similar to the approach used in other contexts by Johnson *et al.* (2000), Neal (2004) and Olivetti and Petrongolo (2008). Results from this version of the analysis are shown in Column (5) of Table A4.1. Like the other columns, these results are generally quite similar to that of the main analysis.

Table A4.1: Sensitivity of key results to treatment of missing wage observations

	Original sample (1)	Extended sample 2 (2)	Extended sample 3 (3)	Extended sample 4 (4)	Alternate Imputation (5)
A: Number of couple observations					
No. of couples with non-missing wage	24,715	31,127	34,183	37,014	24,715
B: Mean of SI_3					
Overall	0.103	0.119	0.109	0.147	0.118
by couple type:					
Married heterosexual	0.112	0.130	0.120	0.160	0.129
Unmarried heterosexual	0.073	0.075	0.068	0.095	0.079
Gay	-0.032	-0.040	-0.016	0.051	0.011
Lesbian	-0.018	0.010	-0.004	0.009	0.017
C: Couple-type differences in SI_3 (relative to married couples) after controlling for observed characteristics					
Unmarried heterosexual	-0.003	-0.016	-0.018	-0.016	-0.007
Gay	-0.102*	-0.120*	-0.082	0.000	-0.060
Lesbian	-0.086*	-0.069*	-0.090**	-0.087**	-0.057

Notes: The extended samples allocate non-missing wages using an increasing liberal approach as described in the text. Estimates have been weighted, consistent with the main analysis. The results shown in Panel C correspond with the coefficients of each couple type in Column (6) of Table 9. Standard errors in parentheses clustered on coupleID. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Relationship between relative domestic work time or SI_2 and log relative wage

Table A4.2 shows robustness to wage imputation for the key OLS estimates on the relationship between sex-based specialization and AAM. Columns (1) and (2) correspond to the Beckerian framework, for which the main results were reported in Table 2. Columns (3) and (4) correspond with the analysis of SI_2 reported in Table 7. Panels A-E are for the full set of heterosexual couples, while Panels F-J are for the set of couples without children.

Table A4.2: Sensitivity of OLS regression results to treatment of missing wage observations

	log relative domestic work time				SI_2			
	No controls		With controls		No controls		With controls	
	(1)		(2)		(3)		(4)	
				A: Baseline				
log (female wage / male wage)	-0.095***	(0.030)	-0.101***	(0.029)	-0.109***	(0.010)	-0.116***	(0.010)
Constant	0.446***	(0.015)	0.434***	(0.021)	0.197***	(0.005)	0.195***	(0.007)
N	24003		23622		24213		23822	
				B: Extended Sample 2				
log (female wage / male wage)	-0.122***	(0.028)	-0.118***	(0.027)	-0.129***	(0.011)	-0.129***	(0.011)
Constant	0.494***	(0.015)	0.498***	(0.020)	0.223***	(0.006)	0.227***	(0.008)
N	30299		29823		30587		30099	
				C: Extended Sample 3				
log (female wage / male wage)	-0.084***	(0.027)	-0.081***	(0.026)	-0.107***	(0.011)	-0.107***	(0.010)
Constant	0.539***	(0.014)	0.535***	(0.019)	0.241***	(0.006)	0.241***	(0.007)
N	33820		33317		34144		33627	
				D: Extended Sample 4				
log (female wage / male wage)	-0.145***	(0.026)	-0.128***	(0.025)	-0.166***	(0.010)	-0.158***	(0.010)
Constant	0.555***	(0.014)	0.543***	(0.018)	0.247***	(0.006)	0.243***	(0.007)
N	36592		36037		36977		36407	
				E: Alternate Imputation				
log (female wage / male wage)	-0.124***	(0.028)	-0.118***	(0.027)	-0.134***	(0.010)	-0.132***	(0.009)
Constant	0.439***	(0.015)	0.428***	(0.021)	0.190***	(0.005)	0.189***	(0.007)
N	24002		23623		24213		23824	
				F: Couples Without Children Baseline				
log (female wage / male wage)	-0.115***	(0.040)	-0.099**	(0.041)	-0.111***	(0.014)	-0.105***	(0.014)
Constant	0.291***	(0.020)	0.277***	(0.030)	0.108***	(0.006)	0.107***	(0.009)
N	12917		12718		13051		12844	
				G: Couples Without Children Extended Sample 2				
log (female wage / male wage)	-0.139***	(0.039)	-0.124***	(0.040)	-0.137***	(0.016)	-0.131***	(0.016)
Constant	0.320***	(0.020)	0.321***	(0.030)	0.117***	(0.008)	0.120***	(0.010)
N	15578		15345		15756		15514	
				H: Couples Without Children Extended Sample 3				
log (female wage / male wage)	-0.106***	(0.038)	-0.097**	(0.039)	-0.118***	(0.015)	-0.114***	(0.015)
Constant	0.371***	(0.020)	0.358***	(0.028)	0.139***	(0.007)	0.134***	(0.009)
N	17422		17175		17629		17372	
				I: Couples Without Children Extended Sample 4				
log (female wage / male wage)	-0.163***	(0.036)	-0.140***	(0.037)	-0.186***	(0.014)	-0.176***	(0.015)
Constant	0.393***	(0.019)	0.367***	(0.027)	0.145***	(0.007)	0.134***	(0.010)
N	18910		18632		19152		18863	
				J: Couples Without Children Alternate Imputation				
log (female wage / male wage)	-0.116***	(0.036)	-0.109***	(0.037)	-0.121***	(0.012)	-0.117***	(0.012)
Constant	0.291***	(0.020)	0.275***	(0.030)	0.105***	(0.006)	0.104***	(0.009)
N	12923		12725		13057		12851	

Standard errors in parentheses clustered on coupleID. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Appendix 5 Sensitivity analysis – outlying reported time-use

This Appendix addresses sensitivity of key results to the treatment of extreme outliers in time use data - specifically, any observations whose reported time in paid work and domestic work exceeds the reasonable limits of non-sleeping time.

Assuming eight hours of sleeping time every day, this leaves a maximum of 112 hours that are able to be allocated between paid work and domestic labor, in line with Becker's (1991) approach. In our main estimation sample, the sum of at least one partner's reported hours in housework and domestic work exceeds 112 hours in 8% of observations.

Estimates testing the sensitivity of key results to the exclusion of those observations are shown in Table A5.1.

After dropping those observations, the mean of SI_1 declines marginally from 0.383 to 0.375. With respect to the regression estimates for SI_1, the exclusion of outliers does not change the couple-type coefficients greatly, and certainly not qualitatively, with differences in the extent of specialization between couple types being mostly explained by observed characteristics, consistent with the main analysis.

The exclusion of these observations also has only a minor effect on the means of SI_2, overall, or by couple type.

Finally, for SI_3, the sample excluding outliers is 22,869, reflecting 93% of the original sample. The mean of SI_3 decreases marginally for all couple types, with the overall mean declining from 0.103 to 0.101. Similarly, the exclusion of outliers does not change the couple-type coefficients greatly.

Table A5.1: Sensitivity of key results to exclusion of time-use outliers

	SI_1		SI_2		SI_3	
	Original sample (1)	Excluding outliers (2)	Original sample (3)	Excluding outliers (4)	Original sample (5)	Excluding outliers (6)
	A: Number of couple observations					
No. of couples	45,337	41,797	44,697	41,179	24,715	22,869
% of original sample	100%	92.19%	100%	92.13%	100%	92.53%
	B: Mean					
Overall	0.383	0.375	0.278	0.265	0.103	0.101
by couple type:						
Married heterosexual	0.398	0.390	0.297	0.285	0.112	0.111
Unmarried heterosexual	0.324	0.312	0.189	0.172	0.073	0.069
Gay	0.272	0.272	n/a	n/a	-0.032	-0.032
Lesbian	0.279	0.271	n/a	n/a	-0.018	-0.027
C: Couple-type differences (relative to married couples) after controlling for observed characteristics						
Unmarried heterosexual	-0.019**	-0.020***			-0.003	-0.004
Gay	-0.035	-0.033			-0.102*	-0.100*
Lesbian	-0.039**	-0.039**			-0.086*	-0.092*

Notes: The results in column (1) and (5) of Panel C correspond with the coefficients of each couple type in Column (5) of Table 8 and Column (6) of Table 9, respectively. Estimates have been weighted consistently with the main analysis. Standard errors in parentheses clustered on coupleID. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A5.2 shows sensitivity of the key regression results on the role of AAM on sex-based specialization. These estimates are all similar to those in the main analysis.

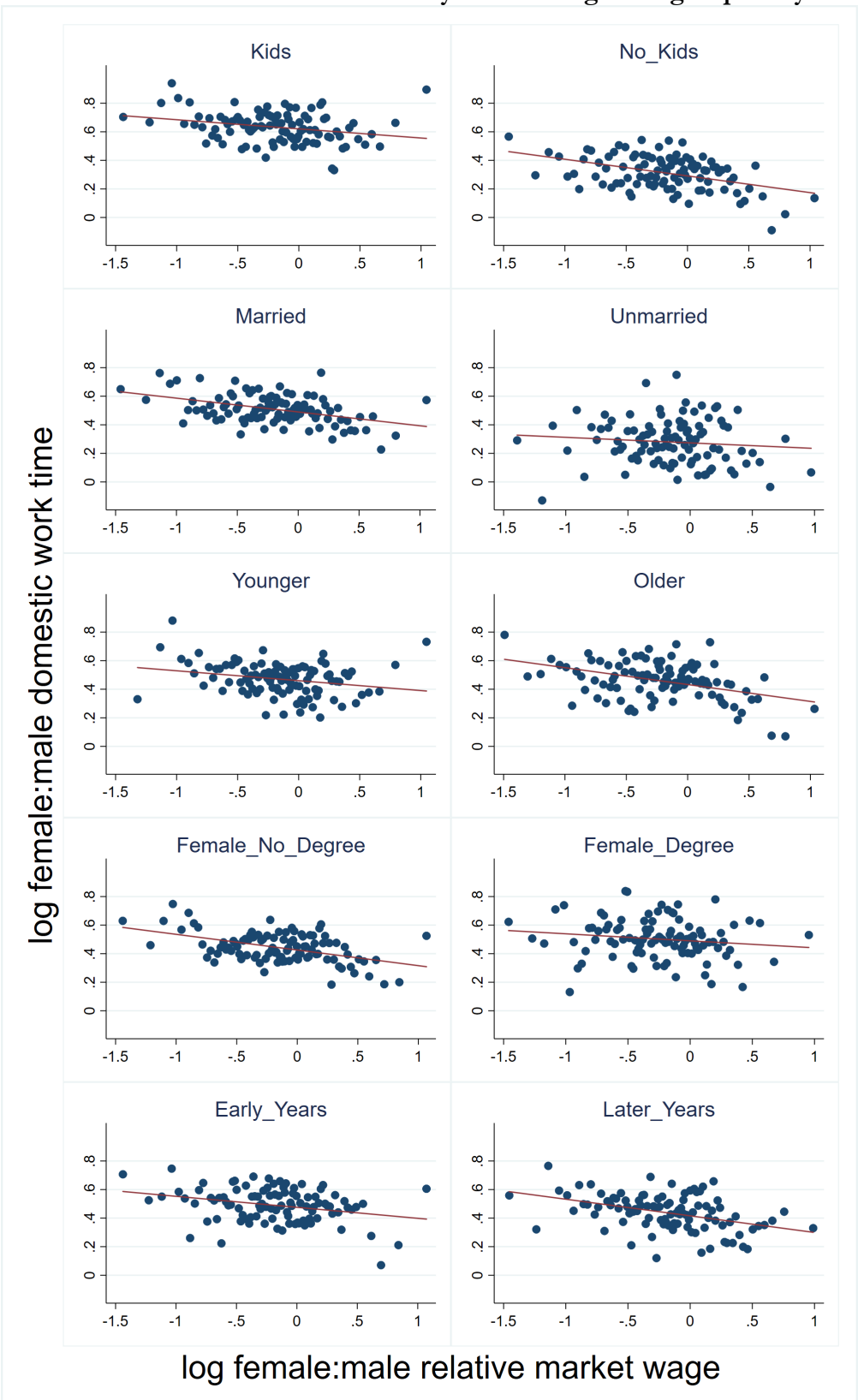
Overall, the results are quite robust to the exclusion of time-use outliers.

Table A5.2: Sensitivity of key regression results to exclusion of time-use outliers

	(1) OLS no controls	(2) OLS with controls	(3) Bartik-IV no controls	(4) Bartik-IV with controls
		A: Log-relative housework, all couples		
log (female wage / male wage)	-0.094***	-0.094***	-0.016	-0.015
	(0.030)	(0.029)	(0.085)	(0.084)
Constant	0.420***	0.407***		
	(0.015)	(0.021)		
N	22,185	21,835	40,745	40,097
		B: Log-relative housework, without children		
log (female wage / male wage)	-0.109***	-0.093**	0.090	0.099
	(0.039)	(0.040)	(0.090)	(0.091)
Constant	0.292***	0.278***		
	(0.020)	(0.030)		
N	12,707	12,508	22,502	22,159
		C: SI_2, all couples		
log (female wage / male wage)	-0.111***	-0.114***	-0.030	-0.033
	(0.011)	(0.010)	(0.037)	(0.035)
Constant	0.184***	0.183***		
	(0.005)	(0.007)		
N	22,387	22,028	41,179	40,517
		D: SI_2, couples without children		
log (female wage / male wage)	-0.109***	-0.103***	0.000	0.005
	(0.014)	(0.014)	(0.033)	(0.033)
Constant	0.108***	0.107***		
	(0.006)	(0.009)		
N	12,839	12,632	22,787	22,434

Appendix 6 Relative domestic work time by relative wage: Subgroup analysis

Figure A6: Relative domestic work time by relative wage: Subgroup analysis



Notes: Each panel is based on Figure 1, restricted to a sub-population. Younger refers to couples whose average age is less than 40. Early_Years refers to 2003-2009. Later_Years refers to 2010-2015.

Appendix 7 Alternate Version of the Specialization Indices

In this Appendix, we outline an alternate version of the specialization indices, and show that key results are very similar with this version. These alternate indices have the same interpretation as the main indices and have the same range. But they give more weight to the activities which each couple spends more time on.

$$SI_{1\ ALT} = \left|\frac{(DW_1 - DW_2) - (MW_1 - MW_2)}{(MW_1 + MW_2 + DW_1 + DW_2)}\right| \quad \text{(A8)}$$

$$SI_{2\ ALT} = \frac{(DW_F - DW_M) - (MW_F - MW_M)}{(MW_F + MW_M + DW_F + DW_M)} \quad \text{(A9)}$$

$$SI_{3\ ALT} = \frac{(MW_H - MW_L) - (DW_H - DW_L)}{(MW_H + MW_L + DW_H + DW_L)} \quad \text{(A10)}$$

Figure A7 shows the mean of each alternate index by couple type. These are very similar to those in the main analysis (Figure 4).

Figure A7: Specialization by Couple Type, Alternate Indices

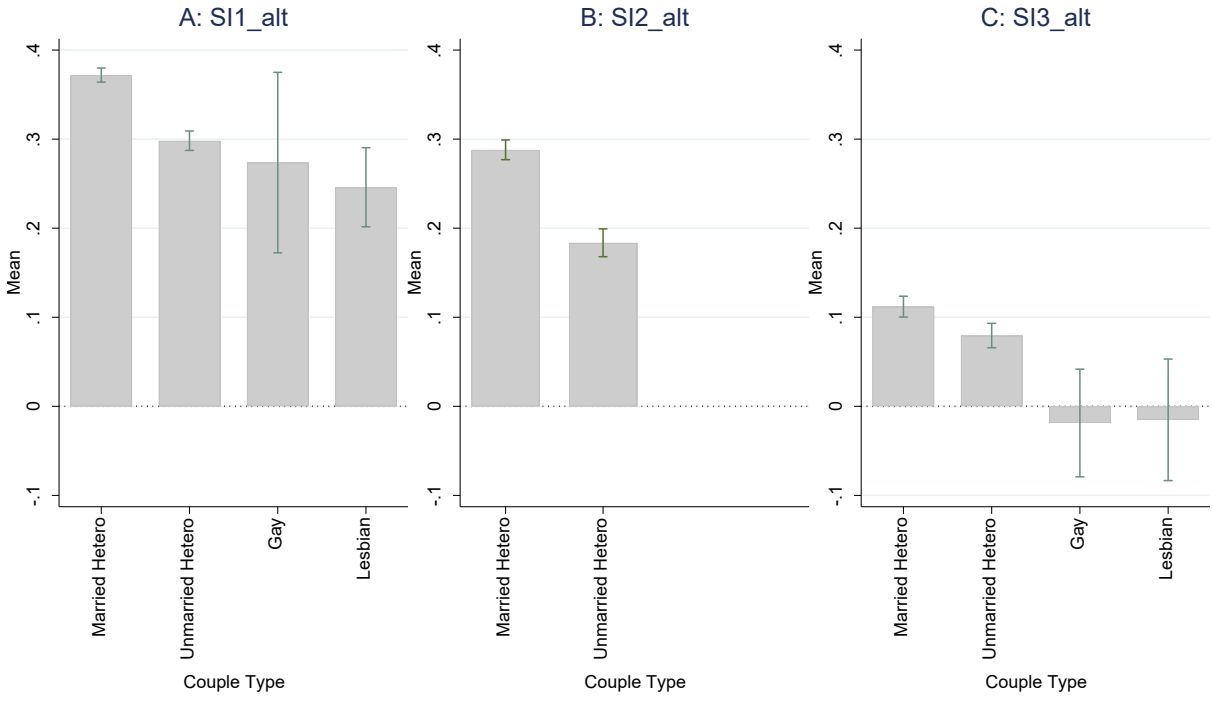


Table A7.1 shows results from regressions of SI_2 on the log relative wage using the alternate index. Overall, these results are similar to the main analysis (Table 7). The association between SI_2 and the log relative wage is slightly stronger here in the OLS models than in Table 7. But the estimated causal effects are slightly smaller (columns (3) and (4)).

Table A7.1: Regressions of Alternate SI_2 on log relative wage

	(1) OLS no controls	(2) OLS with controls	(3) Bartik-IV no controls	(4) Bartik-IV with controls
		A: All couples		
log (female wage / male wage)	-0.118***	-0.124***	-0.014	-0.024
	(0.010)	(0.009)	(0.029)	(0.029)
Constant	0.188***	0.186***		
	(0.005)	(0.006)		
N	24213	23822	44,697	43,980
		B: Couples without children		
log (female wage / male wage)	-0.128***	-0.123***	0.008	0.013
	(0.013)	(0.013)	(0.032)	(0.032)
Constant	0.105***	0.098***		
	(0.006)	(0.009)		
N	13051	12844	23,204	22,849

Notes: Standard errors in parentheses clustered on coupleID. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Table A7.2 shows results which summarise sensitivity of key results in Tables 8 and 9 to the use of the alternate indices. It shows the coefficient estimates of the couple type indicators, after controlling for observed characteristics. Column (1) corresponds with Table 8 Column (5), while column (2) corresponds with Table 9 column (6). In column (1), the coefficient of gay is smaller here, while the coefficient of lesbian is larger. If, however, these indicators are replaced by a single indicator 'same sex'. it's coefficient (-0.0334) and standard error (0.028) are similar to those in the main analysis in Table 8 Column 6. The results in column (2) are similar to those in the main analysis. When using a single indicator for same sex, its coefficient is -0.0820 and standard error is 0.033.

Table A7.2: Couple-type differences in Specialization (relative to married couples) after controlling for observed characteristics, Alternate Indices

	SI_1	SI_3
	(1)	(2)
Unmarried heterosexual	-0.0202**	0.0030
	(0.008)	(0.011)
Gay	-0.0136	-0.0811
	(0.054)	(0.051)
Lesbian	-0.0497**	-0.0826*
	(0.021)	(0.043)

Notes: Standard errors in parentheses clustered on coupleID. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$