The Causal Impact of Motherhood on Female Employment

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I. Introduction

The causal impact of fertility on labor force participation has concerned researchers for decades. While a clear negative relationship between number of children and hours worked has emerged in the literature, it is difficult to disentangle the direction of causality. While some women may decrease their labor force participation in response to the birth of a child, it could be that unobservable characteristics, such as ambition or career-focus, cause both higher fertility and lower attachment to the labor force. Or, it could be that some women work less in anticipation or in order to try to conceive a child. Even if we assume that most women will alter their labor force participation in at least some way in response to a birth, it is hard to imagine that all women would respond identically; rather, the effect of fertility across women and even across parity is likely to be heterogeneous.

Determining the causal impact of having a child on employment is important for a number of reasons. First, disentangling the impact of first birth on employment from other unobserved characteristics that might be affecting both fertility and work is important in itself to quantify the magnitude and importance of first birth for women in the workforce. Second, there is a significant body of literature identifying and attempting to explain the gender wage gap between men and women, where spells out of the workforce are an important explanatory variable (Gronau 1988, Green and Ferber 2008). Being able to quantify the effects in terms of time out of the labor force may shed light on the extent to which career attachment may also be affecting women's wages. Third, the extent to which women take time out of the labor force to spend time with their children—small children in particular, less work among some women may positively impact the development of the next generation of Americans. The literature in developmental psychology suggests that the bond between a child and his or her care-provider formed at young ages is an important determinant of cognitive, emotional and psychological ability for children (Cassidy 1999). Finally, if policy makers are interested in influencing women's behavior around childbirth, whether providing incentives to maintain continuity at work or to spend quality time with young children, it is useful to be able to quantify the impact of having children on participation in the workforce.

II. Background

Previous attempts to attribute changes in employment to fertility have exploited instrumental variables as well as natural experiments. There is a substantial body of literature exploiting the exogeneity of twin births to estimate the causal impact of fertility on employment. Bronars and Grogger (1994) estimate the effect of an unexpected birth on employment for single women using U.S. Census data. Other articles take a similar approach for different samples of women (Jacobsen, Pearce and Rosenbloom 1999, Caceres 2006). Angrist and Evans (1998) exploit the randomness of sex composition of previous children to estimate the impact of a third child on employment, an approach that has also been applied in other analyses.

More recent contributions have attempted to determine the impact of moving from parity zero (having no children) to parity one (having one child) on women's labor force participation. Vere (2008) employs an instrumental variable approach using the Chinese lunar calendar, where certain years are associated with higher fertility. He finds that having one's first child is associated with 26-29 percentage point lower labor force participation among mothers in Hong Kong. While his findings are compelling, no similar analysis would apply to women in the United

States on a large scale. Two studies have explored fecundity (ability to conceive) as a possible way to analyze the effects of a first birth. Cristia (2008) estimates the impact of the progression from zero to one child for a sample of women who have sought out fertility assistance. While his results are illuminating for this particular sample of women, it is far from clear that these results apply to a vast proportion of women in the U.S. Furthermore, this analysis identifies the immediate impact of having a child on labor force participation within the first two years when effects are likely to be quite large, but does not assess how women may eventually adjust over time to having an additional child.

Finally, Agüero and Marks (2008) use fecundity as an instrument for number of children using data from several Latin American countries and find no evidence of significant reductions in labor force participation of women. While their study takes a similar approach to the one employed here, they posit that difficulty getting pregnant or having live births can exogenously determine family size. However, they allow women who have chosen to become infecund through contraceptive surgery to be included as infecund, as well as women who have already had children and then run into trouble having subsequent children. Furthermore, as they focus on developing countries, they may find behavioral responses that differ somewhat from what might occur in the United States, and it may be informal economic activity is more commonplace than salaried employment than in the United States.

It is the contention of this paper that while having family size limited by fecundity may not significantly impact labor force participation, remaining *childless* due to lack of fecundity may indeed have a substantial impact on labor force participation. The contribution of this work is that it estimates the causal impact of becoming a mother at all on the labor force participation of women of prime childbearing ages in the United States. I use fecundity to instrument for having any children in a household. The results from the analysis allow an approximation of the local average treatment effect of moving from being childless to having at least one child for women whose fertility has been affected by infecundity. Since women of all ages are affected by infecundity, these estimates capture the average impact over heterogeneous ages of both mothers and children; that is, we get an estimate not just for the first year or two of life, as in Cristia (2008), and not just for women of higher parity, as in Angrist and Evans (1998), but the average impact for women at varying parity and with children of varying ages.

Overall, I find that moving from being childless to having at least one child is associated with substantial declines in employment for women in their prime childbearing years (age 22 to 35). In particular, it is associated with a decline in participation of 26 percentage points for married or partnered women (whose spouses are present in the household), and 19 percentage points when all women are considered, regardless of marital status. Married or partnered women with one or more children are estimated to work 4.8 fewer months out of the year than those women with no children, while the equivalent result for the sample of all women is 3.2 fewer months.

III. Using fecundity as an Instrument Variable

In order for an instrument to be valid, it must both be correlated with the independent variable of interest, and not correlated with the dependent variable. That is, the instrument must affect the dependent variable only through the independent variable of interest. There may be some question as to whether infecundity can credibly be treated as an exogenous variable. While there may not be a direct link between fecundity and labor force participation, the lack of ability to become pregnant and have a live birth does appear to be associated with some characteristics. Medical studies have examined risk factors for longer time to pregnancy (a measure of fecundity), the inability to become pregnant within 12 months, and negative pregnancy outcomes. A number of health and even lifestyle characteristics may be significantly associated with these outcomes. First, it is clear that increasing age is associated with fertility impairment (teVelde & Pearson 2002, Kelly-Weeder, Cox and Lorane 2007). In particular, this impairment becomes clear at age 35 and more severe over time, with longer time to conception and higher rates of pregnancy loss (de La Rochebrochard & Thonneau, 2002). Furthermore, as women age, they are susceptible to a wide range of other health disorders which may also affect fertility (Abma et al., 1997; Beckles&Thompson-Reid, 2001). This trend also appears in the data I use for this paper, so I limit the sample to women of prime reproductive age (more information presented in the data section below).

In terms of health behavior, smoking may be associated with lack of fecundity or greater time to pregnancy (Stephen and Chandra 2006, Hassan & Killick 2004, National Women's Law Center & Oregon Health and Science University 2003, CDC 2001, Hull et al. 2000). Excessive caffeine intake may also impair pregnancy outcomes (Hassan and Killick 2004), along with obesity (Hassan and Killick 2004, Kelly-Weeder, Cox and Lorane 2007). While partner's alcohol consumption appears to be associated with a longer time to pregnancy, this relationship was not significant for the woman's alcohol consumption (Hassan and Killck 2004).

While these health behaviors may be significantly associated with fertility impairment, it is not clear that they also might impact employment. There has been no evidence documented in the literature that smoking is significantly related to employment among adult women. One obesity study suggests that there is a positive relationship between body mass index (BMI) and female employment at the aggregate level (Loureiro and Nayga 2005), but there is no evidence that such a relationship exists at the individual level. It may be that women with certain health behaviors are likely to be fecund, but there is no reason to believe that these same health behaviors are driving employment as well. Thus, it is not clear that any bias introduced by these variables would lead to either an over- or under-estimate of the impact of having a child on employment;

rather the error may average to zero bias across individuals. The data used in this paper do allow for controls for obesity but not smoking behavior.

Finally, certain health conditions may be associated with fertility impairment. For example, having certain sexually transmitted diseases, having had a previous ectopic pregnancy, and self-reported health status may be associated with significant differences in fertility (Ness et al. 2004; Workowski, Levine, & Wasserheit 2002, Kelly-Weeder, Cox and Lorane 2007). A recent study of health and labor force participation finds that good health has a positive effect on labor force participation for women, and that there are feedback effects – employment also has a positive effect on health (Lixin 2010). This relationship may also hold for mental health – one study finds that individuals with anxiety or affective disorders had lower levels of employment (Waghorn, Chant, Harris, Acta 2009). Therefore, if individuals in poor health are both more likely to have fertility impairment and less likely to participate in the labor force, we may be introducing bias into the estimate of the effect of having children on labor force participation. In particular, it would lead to an under-estimate of this impact, as those who are infertile and have no children would have lower employment rates. Since an important relationship holds in this case, I explore these relationships in the data section below and limit the sample or implement controls accordingly.

One might also be concerned that having information on fecundity status could affect labor force participation directly. For example, if one has an accident at an early age causing her to lose her uterus, then she might become even more attached to the workforce than she might have otherwise. To the extent that women are aware of their fecundity status and alter their labor force participation accordingly, fecundity would be a weak instrument for number of children. However, one might argue that in most cases, a woman does not know of her fecundity status until she begins trying to conceive (or conceives unintentionally). It is certainly plausible that, save the unusual situation where a woman may lose her ability to have children due to some surgery at a younger age, a woman is likely to spend much of her prime reproductive years unaware of her fecundity status. The following analysis rests upon the assumption that women do not change their attachment to the labor force in response to information about their fecundity status.

III. Data

The data for this paper are from the 2006-2008 National Survey of Family Growth (NSFG). The NSFG is a large, nationally-representative sample of women aged 15 to 44 in the United States. This cross-section contains data for 7,356 females, including extensive information on marriage, contraceptive use, fertility, medical services used for fertility, and a number of other questions relevant to family research. The data also include information about whether a woman is considered fecund (that is, she has no impairment on her ability to become pregnant and have a live birth) and other important covariates. The benefit to this cycle of the NSFG is that it includes additional covariates related to an individual's health which are not available in previous surveys.

Employment is measured in two ways. First, whether an individual worked at all in the past week, which includes either part-time work, full-time work, or absence from regular work due to illness. If an individual is on maternity leave, she is not considered to be working for the purposes of this analysis. The reason for excluding this category is that we do not want to attribute work to women who are taking time out of the labor force, even if it is just temporary. This measure captures general employment status. Second, the data include the number of months during the past year in which the woman had any job for pay. This measure is likely to capture gaps in employment, less stable employment situations for women, or seasonal work.

The number of children is measured in two ways. First, the data contain the number of co-resident children, whether they are biological children, children from other marriages or partners (step-children or partner's children), or adopted children. The benefit of this measure is that we know the total number of children living in the household, but the drawback is we do not know the exact ages of the children. Second, we have detailed information on the dates of each live birth to each respondent, so we can calculate the age and number of biological children who are residing with the respondent at the time of the survey. Clearly, the number of co-resident children will not always match the number of biological children. For this analysis, I consider dummy variables for having any co-resident children, any biological children age 18 or under in the household, and any biological children age 5 or under in the household.

Other covariates of interest in the data include age, years of schooling, race, ethnicity, whether the household owns the dwelling in which they live, whether the woman has a disability, whether a woman's mother worked during the majority of her childhood, whether the woman's mother completed college, respondent's self-reported health status and respondent's BMI. The publicly available NSFG data do not include questions on smoking status so I am not able to control for this health behavior in the analysis.

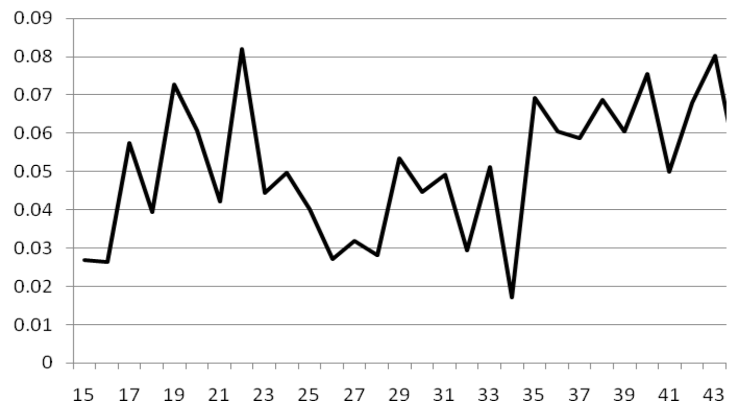
Randomness of infecundity in the data

For the purposes of this analysis, infecundity is used to instrument for number of children. A women is classified as not fecund if (1) she and her partner are either (a) unable to become pregnant due to noncontraceptive surgery, (b) unable to become pregnant for reasons other than surgical sterilization, (c) subfecund, meaning either they have found it difficult to conceive or have been advised not to by a doctor, or (d) were not able to become pregnant after 36 months of unprotected sex. For this analysis, I add the second condition, that (2) she has had no live birth in her lifetime, as most women will eventually be classified as infecund when they age out of their reproductive period. This definition follows the NSFG constructed variable, “fecund,” with three exceptions. First, this is a woman-based measure, so that women facing lack of fecundity exclusively due to their partner’s medical conditions will not be classified as infecund. Second, as I am instrumenting for becoming a mother, I exclude women who have had any live birth in their lifetime. Third, women who are unable to become pregnant due to contraceptive surgery are not considered infecund for this analysis, as they have made a conscious decision not to have (any or more) children and therefore do not constitute a valid comparison group.

Further details on the conditions for being classified as not fecund may be worth mentioning. Noncontraceptive surgery causing one to be unable to become pregnant could include surgery following an accident or to correct an illness, for example. A woman is classified as sub-fecund if she reports having had difficulty getting pregnant or carrying a baby to term, if pregnancy is dangerous to her health, or if she is likely to have an unhealthy baby. Women who report they have been advised not to become pregnant by a doctor report the reason being that it would be dangerous for them or for the baby.

It is important to note that this definition excludes women who may have had difficulty conceiving or having a live birth, but eventually succeeded. Instead, I suggest that the inability (up to the time of the survey) to have children due to biological reasons is what may be considered random for the sample of women in their prime reproductive years. This exclusionary condition is what allows us to examine the effect of becoming a mother as opposed to remaining childless. Also, it is important to emphasize that infecundity is determined at the individual level. A woman could be fecund, but currently with a partner who has difficulty impregnating her.

Figure 1. Percent of NSFG sample women who are infecund, by age



Source: 2006-2008 NSFG

It is well-known that infecundity is likely to increase with age. Henry (1961) estimates that the average age at which a woman is no longer capable of producing a live birth is 41.7, though clearly many women encounter difficulties even earlier. As discussed previously, the medical literature suggests that difficulty becoming pregnant and poor pregnancy outcomes may begin as early as age 35. Other demographic studies have documented that in natural fertility populations, where no effort at birth control is made, the rate of sterility may be close to 10 percent at age 30 and 20 percent at age 35 (Leridon 2008). However, in modern populations, fertility postponement through the use of contraception has been well documented, so any lack of fecundity at earlier ages may not be yet observed. Furthermore, with access to advanced reproductive technology, modern populations are then able to make up for some of the births that have been postponed (Leridon 2004). Figure 1 shows the percent of women who are classified as infecund in the NSFG sample by the above definition, by age. While infecundity may be increasing in age overall, for a limited sample between the ages of 22 and 35, the relationship is less clear. For the subsequent analysis, I limit the sample to women under age 36, which is the age at which risk factors increase according to the medical literature. Furthermore, in order to focus on women who are likely to have completed their education, I also restrict the sample to women age 22 and above.

Table 1. Differences in means by fecundity, women age 22 to 35

	Infecund (n=155)		Fecund (n=3,415)			
Variable	Mean	Std Dev.	Mean	Std Dev.	Difference	
Age	27.871	4.242	28.210	3.899	-0.339	
Graduated college	0.297	0.458	0.266	0.442	0.031	
Own dwelling	0.400	0.491	0.412	0.492	-0.012	
Black race	0.187	0.391	0.209	0.407	-0.022	
Other race	0.032	0.177	0.059	0.235	-0.027	
Hispanic ethnicity	0.090	0.288	0.237	0.425	-0.146	*
Mom graduated from college	0.265	0.443	0.189	0.391	0.076	*
Mom worked	0.710	0.455	0.714	0.452	-0.004	
Partner/spouse present	0.439	0.498	0.510	0.500	-0.071	*
Disabled	0.194	0.396	0.082	0.274	0.112	*
Obese	0.452	0.499	0.312	0.464	0.139	*
Overweight	0.226	0.419	0.248	0.432	-0.023	
Underweight	0.032	0.177	0.022	0.147	0.010	
Health fair to poor	0.123	0.329	0.069	0.254	0.053	*

*Statistically signficant at p<.05

Table 1 shows differences in means between women classified as fecund and those who are not fecund, ages women age 22 to 35. There are indeed significant differences between these two groups of women for percent Hispanic ethnicity, having a mother who completed college, having a partner or spouse who is present in the household, being disabled, being obese, and having fair to poor self-rated health status. Hispanic ethnicity and having a mother who completed college are highly correlated with age at first birth, so controlling for interactions between these variables and age is important to see such correlations persist when controlling for age-specific fertility patterns. Similarly, obesity and health status are also correlated with age, as individuals are more likely to gain weight over the life course and to have worsening health as they age. In order to check whether fecundity may be random apart from its association with age, I regress infecundity on the explanatory variables of interest and their interactions with age for women age 22 to 35 (table 2).

Table 2. OLS Regression of Infecundity, women aged 22 to 35

Variable	Coefficient	t-statistic
Age	-0.037	-2.72
Age squared	0.001	2.71
College graduate	0.005	0.59
Own home	-0.004	-0.55
Black race	-0.088	-1.36
Other race	-0.019	-0.18
Hispanic	-0.029	-0.45
Mom graduated college	0.015	1.59
Mom worked	-0.009	-1.22
Partner/spouse present	-0.007	-0.99
Disability	0.047	3.76
Obese	0.094	1.58
Underweight	0.036	1.54
Overweight	0.041	0.65
Health fair to poor	0.141	1.42
Age*black	0.002	1.00
Age*Hispanic	0.000	-0.20
Age* Other race	0.000	-0.12
Age*Obese	-0.002	-1.03
Age*Overweight	-0.001	-0.47
Age*health fair to poor	-0.004	-1.18
Constant	0.570	2.96
Observations	3,570	
F(16, 3734) =	4.10	
R squared	0.018	

Including the interaction of age with these variables suggests that they indeed do appear to operate through age-specific patterns, rather than on their own. The only variable that persists in significance is that of having a disability. As disability status is also likely to affect employment, I exclude the disabled from the analysis and focus only on individuals who consider themselves not disabled due to physical, mental, or emotional problems.[1] Excluding the disabled from the sample, there are no significant variables in the regression output, and even when it is included, the F-statistic remains very low at 4.10. These results are quite persuasive that indeed, infecundity may be relatively randomly distributed in the sample of able-bodied women aged 22 to 34.[2]

[1] The question on disability asks ``Are you limited in any way in any activities because of physical, mental, or emotional problems?"

[2] Henceforth, I will refer to able-bodied women, but the definition of not disabled also includes women who are limited from activities due to emotional or mental problems.

Sample definition

First, to focus on a population of women that is more likely to have completed schooling and to be participating in the labor market, I limit the sample to women aged 22 and over.[3] As discussed above, the sample is further limited to women aged 34 and under to eliminate bias from greater likelihood of infecundity at older ages. Second, as disability appears to be correlated with fecundity, I remove the disabled from the analysis and focus on able-bodied women between the ages of 22 and 34. Since we are particularly interested in women who are at risk of having a birth, I also consider a limited sample of married or partnered women who are co-residing with their spouses/partners. It is well known that employment rates are likely to differ substantially for single mothers, which we may expect to see reflected in these two analyses. Therefore, the final estimation samples are defined as follows:

		Sample size
1.	Total number of women in the sample	7,356
2.	Delete women under age 22 and over age 34	3,570
3.	Delete women with disability	3,260 (sample 1, all women)
4.	Delete women without spouse or partner	1,693 (sample 2, married/partnered women)

Correlation of infecundity with number of children

Infecundity is highly correlated with the variables for which it will be used as an instrument –any children in the household, any biological children aged 18 or under and any biological children aged 5 or under in the household. In particular, the correlation between infecundity and any children in the household is -0.277 for married women, and -0.234 for all women, respectively. For any biological children aged 18 or under in the household, the figures are -0.303 for married/partnered women and -0.247 for all women. For any biological children aged 5 or under in the household, the correlation coefficients are -0.220 for married/partnered women and -0.184

[3] The percent of females attending school drops from greater than 50 percent for ages 20-21 to 30 percent for ages 22-24, all races. Source: Table 1. Enrollment Status of the Population 3 Years Old and Over, by Sex, Age, Race, Hispanic Origin, Foreign Born, and Foreign-Born Parentage, U.S. Census Bureau, Current Population Survey, October 2008.

for all women. There are differences between infecundity and number of children by birth cohort, with the correlation generally becoming stronger among older individuals. However, it is not possible to disentangle any differences by birth cohort (for example, access to advanced reproductive technology) from those by age, since only one cross-section of data is utilized (the previous cycles of NSFG data do not include information on BMI and self-rated health status).

It is important to recall that number of children reflects all co-resident children in the household, whether or not they are the biological children of the respondent. Therefore, some women are infecund but do have co-resident children. For example, a woman may be living with her spouse's or partner's children. Any bias resulting from this measure, however, would lead to a conservative estimate of the effects of fertility on employment, since presumably, the woman that has a co-resident child but is classified as infecund would be subject to some effects of caring for a dependent child (possibly working less). Table 4 shows the number of children by fecundity status. As one would expect, infecund women have a much higher propensity to have no children, whether considering the number of co-resident or biological children. By definition, women who are not fecund have no biological children.

Table 4. Number of children by fecundity

	Married/partnered n=1,693		All women n=3,260	
	Fecund	Not fecund	Fecund	Not fecund
Number of children in household				
0	25.5	93.2	36.7	96.0
1	25.3	1.7	22.2	1.6
2	28.0	5.1	23.3	2.4
3	13.3	0.0	11.7	0.0
4	5.5	0.0	4.6	0.0
5 or more	2.4	0.0	1.7	0.0
Biological children 18 or under				
0	25.6	100.0	37.0	100.0
1	26.4	0.0	23.3	0.0
2	28.4	0.0	23.4	0.0
3	12.9	0.0	11.1	0.0
4	4.6	0.0	3.8	0.0
5 or more	2.1	0.0	1.4	0.0

It is also worth examining the age pattern of fertility for this sample of women (table 5). Most women who married or living with a partner at age 22 already have at least one child. The percent declines at certain ages (age 23, age 26) as presumably more women become married without children, and then begins to increase at each age. For the sample of all women, the percent with any children in the household rises over the life course.

Table 5. Age pattern of fertility, women ages 22-34

	Married/partnered				Any marital status			
Age	Percent with any children in HH	Percent with biological children 18 and under in HH	Average number of children in HH	Average number of biological children 18 and under in HH	Percent with any children in HH	Percent with biological children 18 and under in HH	Average number of children	Average number of biological children 18 and under in HH
22	57.9	57.9	0.9	0.8	36.6	37.9	0.5	0.5
23	44.6	42.4	0.7	0.7	35.2	34.4	0.6	0.5
24	53.0	53.0	1.0	1.0	45.3	44.1	0.8	0.8
25	57.9	56.1	1.1	1.0	47.6	44.8	0.9	0.8
26	66.9	67.6	1.3	1.3	57.9	58.3	1.2	1.1
27	67.9	67.2	1.3	1.3	62.4	61.2	1.2	1.2
28	76.2	76.2	1.6	1.6	68.3	68.7	1.4	1.4
29	71.2	72.0	1.6	1.5	65.8	65.8	1.4	1.4
30	73.8	76.6	1.7	1.7	69.5	71.6	1.6	1.6
31	76.9	73.1	1.8	1.7	68.6	65.7	1.5	1.4
32	85.0	83.5	1.8	1.7	76.4	76.0	1.6	1.6
33	89.1	88.2	1.9	1.9	80.0	78.9	1.7	1.7
34	87.8	88.5	1.9	1.9	78.5	79.0	1.8	1.7
35	82.9	82.0	1.9	1.8	77.7	76.1	1.7	1.6
Total	72.2	71.8	1.5	1.5	61.1	60.6	1.3	1.2

In a regression framework, infecundity does a relatively good job of explaining variation in the number of children (discussed below). Therefore, if we accept the claim that for this sample of able-bodied women aged 22 to 35, infecundity can be treated as random apart from its association with age, we have quite a powerful instrument for fertility.

III. Methods

This paper employs two stage least squares to estimate the causal impact of moving from having no children to at least one child. In general, we would like to estimate the effect of number of children, C, on employment, L. However, there is a concern that there may be two-directional causality (that is, not only may the number of children affect employment, but employment may also determine number of children). It may also be that unobserved characteristics drive both employment and the number of children a woman has. As a result, the coefficient estimates of an ordinary least squares (OLS) regression of L on C would be biased. The benefit of the instrumental variable approach is that it allows us to isolate causality in one direction, and estimate what may be the change in employment specifically due to the number of children.

The two equations that define this approach are as follows:

$$L = \alpha * C + \beta * X + \varepsilon \qquad (1)$$

$$C^{*} = \gamma * Z + \delta * X + \upsilon \qquad (2)$$

where L is employment, C is number of children, and X is a vector of individual characteristics. C^{*} represents one's latent propensity to have children, which is estimated using the instrumental variable Z, infecundity. As shown previously, infecundity is relevant because it is an important predictor of number of children, yet it is arguably exogenous to the employment decision. As a result, by plugging the predicted values of C^{*} from equation (2), rather than C itself, into equation (1), we can capture the change in L induced exclusively by variation in Z. Employment is captured by both the probability of being in the workforce in the week prior to the survey response, and the total number of months in which a woman worked in the last year.

I conduct the first and second stage regressions for the sample of married or partnered women and for the sample of all women able-bodied women. I capture the impact of moving from having no children to having at least one child, and do the analysis separately for all women and for the sub-sample of women who are married or living with a partner (and spouse/partner is present in the household).

This analysis does not attempt to estimate heterogeneous treatment effects, though it is likely that women react differently to the birth of a child. Rather, the estimates presented here represent the local average treatment effect on employment for women who have been affected be infecundity.

IV. Results

A. Wald Estimates

The Wald estimate can be estimated from equations (1) and (2) as $\beta_{IV} = (\mathbf{y}_{(z=1)} - \mathbf{y}_{(z=0)})/(\mathbf{x}_{(z=1)} - \mathbf{x}_{(z=0)})$, where $\mathbf{y}_{(z=0)}$ is the average employment level for women who are fecund, $\mathbf{y}_{(z=1)}$ is the average employment level for women who are infecund, and $\mathbf{x}_{(z=1)}$ is the average number of children for women who are infecund and $\mathbf{x}_{(z=0)}$ is the average number of children for women who are fecund.

Here the Wald estimate estimates the local average treatment effect of fertility on employment for women whose fertility has been affected by their fecundity status. These estimates do not control for individual characteristics that may be operating simultaneously. Table 6 shows the Wald estimates for the two samples of women. These figures suggest that having at least one child is associated with 21.4 percentage points lower labor force participation than women with no children. For married women, employment is 28.2 percentage points lower. In terms of months worked, women with at least one child work 3.0 fewer months, while this figure is even more substantial for married/partnered women, who have work 4.4 fewer months in the past year. Numbers are similar when considering biological children 18 and under, and quite a bit greater in magnitude when only considering children age 5 and under.

Table 6. Wald Estimates of the Effect of Having at Least One Child on Employment

	Married/Partnered Women			Women of Any Marital Status		
	Wald estimate	p-value	Obs	Wald estimate	p-value	Obs
A. Working at all last week						
Using as covariate:						
Any children	-0.282	0.002	1,693	-0.214	0.002	3,260
Any biological 18 or under	-0.257	0.002	1,693	-0.202	0.002	3,260
Any biological 5 or under	-0.323	0.002	1,693	-0.266	0.002	3,260
B. Months worked in last year						
Using as covariate:						
Any children	-4.417	0.000	1,690	-2.984	0.000	3,256
Any biological 18 or under	-4.025	0.000	1,690	-2.812	0.000	3,256
Any biological 5 or under	-5.045	0.000	1,690	-3.703	0.000	3,256

B. Instrumental Variables Estimates

While the Wald estimates are informative for estimating the simple relationship between employment and number of children, a two-stage least squares approach allows us to control for covariates that may also affect whether women are working. Appendix A1 shows the full results for the first stage OLS regression of having any children in the household on infecundity. The regression controls for age, the square of age, race, ethnicity, whether the mother of the respondent completed college, whether the mother of the respondent worked while the respondent was age 5-15, whether the respondent and her family own their dwelling, whether a woman is obese, overweight or underweight, self-reported health status of the respondent, and age interactions with race, ethnicity, BMI and self-reported health status.

Fecundity appears to be a relatively strong predictor of whether there are any children in the household and whether a woman has any biological children age 18 or under. Infecundity along with other important covariates can explain 24 percent of the variation in whether a married or partnered woman lives in a household with any children. Results are similar for having any biological children age 18 and under, explaining 28 percent of the variance. These same covariates explain relatively less of the variance in the number of children age 5 and under (11 percent of the variance, results available upon request), since fecundity operates as a weaker instrument (fewer women will be identified as having children age 5 and under, while those with children over age 5 will be treated as the comparison in this case). We also see that a married/partnered woman who is not fecund has a 65.9 percentage point lower probability of having any children in the household, controlling for individual characteristics. When all women are considered, this figure 55.7 percentage points lower.

Table 8. OLS and 2SLS Regressions of Employment on Fertility, women ages 22-35

	Married/Partnered		Any marital status	
	OLS	2SLS	OLS	2SLS
A. Working at all last week				
Using as covariate:				
Any children	-0.253***	-0.254***	-0.193***	-0.196***
	-0.027	-0.091	-0.018	-0.073
Any biological 18 or under	-0.251***	-0.233***	-0.192***	-0.184***
	-0.027	-0.083	-0.018	-0.069
Any biological 5 or under	-0.221***	-0.296***	-0.195***	-0.245***
	-0.023	-0.106	-0.016	-0.091
B. Months worked in last year				
Using as covariate:				
Any children	-2.912***	-4.010***	-2.238***	-2.645***
	-0.28	-0.949	-0.184	-0.741
Any biological 18 or under	-2.951***	-3.674***	-2.313***	-2.493***
	-0.279	-0.866	-0.183	-0.697
Any biological 5 or under	-2.582***	-4.665***	-2.424***	-3.306***
	-0.237	-1.121	-0.164	-0.921

The OLS and 2SLS regression results are presented in table 8. The 2SLS results suggest that the effect of having at least one child in the household is associated with a 25.4 percentage point decline in employment in the last week for married or partnered women between the ages of 22 and 35. When considering all women ages 22-35, results are smaller in absolute magnitude, with the 2SLS predicting a 19.6 percentage point decline in participation. Instrumenting for having at least one biological child age 18 or under, results are similar but slightly diminished. Instrumenting for having at least one biological child age five or under, we see an even greater magnitude of the impact of motherhood on employment when at least one child is not yet of school age. Here, married and partnered women with at least one child are estimated to have lower employment by 29.6 percentage points, and estimates are also sizeable for all women with at least one biological child age 5 or under. Given that overall maternal labor force participation in the sample of all women is 70 percent and for married partnered women is 66 percent, women respond quite strongly to having children, particularly when non-school age children are present in the household.

While employment in the past week is an important outcome, we are also able to consider gaps and continuity in employment by examining the number of months worked in the past year. Turning to the estimates of number of months worked in the past year, the OLS estimates are substantially lower than 2SLS estimates, suggesting that the OLS results are under-estimated, possibly because maternal employment has a negative impact on women's fertility. Married/partnered women with at least one child in the household are estimated to work 4.0 fewer months in the past year, while the same figure for all women is 2.6. Instrumenting for having at least one biological child age 18 or under, motherhood is associated with working 3.6 fewer months in the past year for married/partnered women, and 2.4 months if considering all women regardless of marital status. Instrumenting for having at least one child age 5 or under, we see even greater magnitudes, with married/partnered women working 4.6 fewer months per year, and women of any marital status working 3.3 fewer months per year. The average number of months worked is 7.9 for married/partnered women and 8.5 for all women regardless of marital status. Again, women respond to having children very strongly, working substantially fewer months in the year.

V. Discussion

Clearly, motherhood is associated with substantial declines in formal employment as women adjust to the responsibilities of having children. These findings are in stark contrast to Agüero and Marks (2008), illustrating the difference between instrumenting for family size overall as opposed to instrumenting for motherhood in general. In this analysis, we capture the change from being childless to having at least one child, which does indeed have a substantial and statistically significant impact on women's employment.

The estimates presented above constitute the average the impact over women of varying ages and women with varying number of children. However, the results presented here are consistent with previous findings in the literature. Cristia (2008) finds a decline in employment of roughly 25 percentage points at 21 months after the birth of the first child. Here, for married/partnered women ages 22-35 with at least one biological child under 5, we find a decline of 24.5 percentage points, or 29.6 for married/partnered women. Interestingly, the impact on employment of becoming mothers for married women in the U.S. are also similar to those found by Vere (2008) using a very different study sample and considering only a woman's first birth, where first birth for women under age 40 leads to a decline in employment by 26-29 percentage points. It is not clear what percent of the Vere sample is married, though one might suspect that a greater percentage of births occur within marriage or cohabitation in Hong Kong. Furthermore, women in Hong Kong may be more likely to step out of the workforce immediately following the first child, whereas women in the U.S. may be more likely to sustain employment after the first child and then demonstrate larger responses after subsequent children.

This analysis also finds that women substantially reduce the number of months worked in a year substantially in response to motherhood, suggesting that work stoppage, lack of career continuity, or seasonal work could be an important driver of wage differences for men and women. Sustaining work for fewer months out of the year could lead to lower wages, fewer promotional opportunities, or may reflect more low-status positions, such as seasonal work or non-professional work. It may be that mothers work fewer months in order to spend more time with their children, and that foregoing promotional or career opportunities may be their own choice and reveal their true preference. On the other hand, it could be that women are expected to take on greater responsibilities for child-rearing and thus to make sacrifices in their career that they might not otherwise wish to take. Certainly, it is possible that both stories are true, and we can only turn to qualitative analysis to discover what is truly driving mothers to work less than childless women. However, it remains clear that working less could help explain the wage differences between men and women observed in the literature. If more time with one's children is good for society, leading to more well-adjusted workers, women may be privately bearing the costs of raising children while benefits are shared publicly.

Finally, this study provides a useful benchmark with which policymakers or employers can approach the effect of motherhood on months per year dedicated to and likelihood of return to formal employment. If policymakers wish to encourage more continuous employment or longer lengths of time working, then they might consider parental leave policies permitting flexibility around the workplace, such as working from home, flexible hours, or part-time options. Such flexible policies might allow parents to fulfill responsibilities around child-rearing without having to give up working or reduce the number of months they spend per year in the workforce.

Appendix A1. First stage regression results

Predicting:	Married women: Any children in HH		Married women: Any biological children 18 or under in HH		All Women: Any children in HH		All Women: Any biological children 18 or under in HH	
Infecund	-0.678***	-0.659***	-0.744***	-0.719***	-0.593***	-0.557***	-0.630***	-0.591***
	-0.057	-0.052	-0.057	-0.052	-0.04	-0.038	-0.043	-0.038
Age		0.059		0.066		0.149***		0.147***
		-0.04		-0.04		-0.029		-0.029
Age squared		0.00		0.00		-0.002***		-0.002***
		-0.001		-0.001		-0.001		-0.001
College graduate		-0.217***		-0.221***		-0.304***		-0.311***
		-0.023		-0.023		-0.018		-0.018
Own residence		0.049**		0.051**		0.043***		0.033**
		-0.02		-0.02		-0.015		-0.015
Black, nonhispanic		0.616***		0.529**		0.575***		0.570***
		-0.233		-0.231		-0.139		-0.139
Other race, nonhispanic		0.205		0.237		-0.228		-0.291
		-0.333		-0.331		-0.232		-0.231
Hispanic origin		0.767***		0.653***		0.377***		0.323**
		-0.177		-0.176		-0.135		-0.134
Mother completed college		-0.053**		-0.050*		-0.066***		-0.052***
		-0.027		-0.026		-0.02		-0.02
Mother worked		-0.035		-0.033		-0.029*		-0.031*
		-0.021		-0.021		-0.017		-0.017
Obese (BMI>30)		0.561***		0.669***		0.561***		0.608***
		-0.18		-0.179		-0.129		-0.129
Overweight (BMI 25-29.9)		0.226		0.234		0.202		0.171
		-0.183		-0.181		-0.133		-0.133
Underweight (BMI<18.5)		0.039		0.004		-0.014		-0.027
		-0.069		-0.069		-0.049		-0.049
General health status fair to poor		0.023		0.026		0.039		0.038
		-0.043		-0.043		-0.033		-0.033
Age*black		-0.017**		-0.014*		-0.016***		-0.016***
		-0.008		-0.008		-0.005		-0.005
Age*Hispanic		-0.024***		-0.019***		-0.011**		-0.008*
		-0.006		-0.006		-0.005		-0.005
Age*other race		-0.006		-0.006		0.008		0.011
		-0.011		-0.011		-0.008		-0.008
Age*obese		-0.017***		-0.021***		-0.018***		-0.020***
		-0.006		-0.006		-0.005		-0.005
Age*overweight		-0.006		-0.007		-0.006		-0.005
		-0.006		-0.006		-0.005		-0.005
Constant	0.745***	-0.747	0.744***	-0.845	0.633***	-2.069***	0.630***	-2.036***
	-0.011	-0.573	-0.011	-0.569	-0.01	-0.415	-0.008	-0.415
Observations	1693	1693	1693	1693	3260	3260	3260	3260
R-squared	0.077	0.244	0.092	0.261	0.055	0.276	0.061	0.281

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

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