Delayed Childbearing and Urban Revival*

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Abstract

This paper highlights the role of delayed childbearing as an important driver of urban revival in U.S. cities. While downtown neighborhoods provide shorter commuting times and more consumption amenities, limited housing space and schools' worse quality considerably reduce the value of this location when children are born. As households postponed parenthood, the life period in which individuals benefit the most from living downtown extended. Consequently, demand for downtown locations increased, contributing to urban revival. We first provide reduced-form evidence of the interaction between delayed childbearing and urban revival. We exploit exogenous variation in access to Assisted Reproductive Technology (ART) to obtain causal estimates of the impact of delayed parenthood. The higher availability of ART increased income downtown by 5.4% relative to the suburbs. We then estimate a spatial equilibrium model that incorporates a fertility timing decision and a within-city location choice. We calculate the counterfactual urban revival keeping the incentives to have children constant at its 1990 level. We explore the incentives coming from (i) taste for children, (ii) downtown amenities, and (iii) income child penalties. We find that the change in incentives to delay childbearing can generate a large share of the faster income growth downtown relative to the suburbs.

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1 Introduction

Fertility decisions and residential within-city location choices are tightly linked in the United States. Families tend to locate in the suburbs, where school quality is higher and houses are larger, while young individuals with no children concentrate downtown, where consumption amenities are abundant. This paper explores whether and how changes in fertility can impact the structure of cities.

In recent decades, both fertility and urban structure have gone through salient changes. In the United States, the age of first-time mothers grew steadily from 21 years old in 1970 to over 26 years old by 2010. This increase was more pronounced for high-skilled women. By 2010, the median age at first birth was 28 years old among college-educated women and 30 years old for women with further education. At the same time, urban revival transformed the structure of cities. The percentage of census tracts located downtown that were above the median income of their respective city grew from 5% in 1970 to almost 25% by 2010.

This paper investigates whether the delay in childbearing contributed to urban revival. As households postponed the arrival of their first child, the number of young individuals without children increases, particularly among the high-skilled. This leads to an increased demand for downtown locations coming from high-skilled households. The increased demand raises housing prices downtown and leads to spatial sorting on income. In addition, the composition of downtown shifts towards higher-skilled households. Moreover, even a small change in the composition could be further amplified by the reaction of endogenous downtown amenities. As the value of downtown raises for households with no children, so do the incentives to further delay parenthood.

To quantify how much urban revival can be accounted for by the delay in childbearing, we proceed in two steps. In the first part of the paper, we provide reduced-form evidence of the link between fertility decisions and urban revival. We start by documenting stylized facts on fertility and residential choices. We then provide causal evidence by exploiting State-level variation in the incentives to delay childbearing. In the second part of the paper, we propose and quantify a structural dynamic model of fertility timing and within-city location choice and use it to evaluate how much urban revival can be generated by counterfactual changes in the incentives to delay childbearing.

The first part of the paper starts by documenting three stylized facts on the link between fertility and residential locations. First, families are over-represented in the suburbs while young individuals are concentrated downtown. Families are around 8 percentage points less likely to reside in downtown neighborhoods and this has been a persistent aspect of U.S. cities since 1980. Moreover, close to 25% of households between 20 and 24 years old lived downtown compared to only around 15% of households between 45 and 54 years old. Second, women have increasingly delayed motherhood. In 1970, only 10% of women had children after 30 years old. This grew to 25% by 2010. The delay was stronger for high-skilled women. Among women with college education or above, 40% had children after the age of 30 in 2010. Third, we look at the cross-city raw correlation between the increase in the age at first birth and urban revival. We find that cities where the age at first birth increased the most from 2000 to 2010 experienced more urban revival, that is, faster income growth downtown relative to the suburbs.

Next, we provide causal evidence by exploiting State-level variation in incentives to delay childbearing. Our empirical strategy exploits state variation in the cost of infertility treatments. These treatments offer some insurance against the risk of infertility associated to late childbearing. However, Assisted Reproductive Techniques (ART) are expensive and access to them remains quite limited. For this reason, in the late 80's several U.S. states enacted mandates seeking to enhance access to those treatments by including them in health insurance packages. In practice, the mandates implied a substantial reduction of the price of ART treatments that couples faced. This resulted in a large rise in the access rate to ART and in an increase in the average age at first birth in those states (Hamilton and McManus (2012), Jain et al. (2002), Bitler and Schmidt (2006), Bundorf et al. (2007), Abramowitz (2017)). Therefore, this policy provides a nice scenario to assess the impact of delayed parenthood on the urban revival of downtown neighborhoods. Admittedly, postponed maternity is a much broader phenomenon which it is certainly not limited to the states that enacted infertility mandates. In this sense, our results capture a local marginal effect of delayed childbirth on urban revival. However, it is useful to understand the interaction between demographic change and neighborhood development.

Using a triple difference approach, we find that the existence of a state mandate to cover ART contributes significantly to urban revival. Downtown income relative to the suburbs increases by 5.4% more in treated cities than in cities that belong to the control group, and downtown neighborhoods' income is 5.6 percentage points (p.p.) more likely to be above the median city income. Moreover, the larger average income of residents in the city center goes in parallel with a demographic change. Specifically, the share of college graduates in downtown neighborhoods belonging to treated cities increases by 3.1 p.p. both relative to the suburbs and the non-treated cities. In addition, the age distribution of women also changed in the expected direction, with an increase of 2 p.p. of women between the ages of 25 and 29 and a subsequent decrease of 2 p.p. among those between 30 and 35 years old. The age distribution of men reacts similarly but lagged by a few years, likely due to male partners being slightly older. We argue that these changes in the age composition downtown are fully consistent with couples postponing childbearing and moving to the suburbs.

The second part of the paper proposes and quantifies a structural dynamic model of fertility timing and within-city location choice. We model a city with two types of locations, downtown and suburbs, that differ in amenities and housing supply. The city is a single labor market so income does not differ by location. Households are heterogeneous in their skill and draw idiosyncratic preferences for location and children from independent Fréchet distributions. They live for three periods and decide whether and when to have children, and where to live.

We estimate the model using individual-level census data for the United States from 1980 to 2010. We quantify how much urban revival was generated by changes in the incentives to delay childbearing. In the main counterfactual exercise, we keep fixed at its 1990 level the taste for children, which captures the unobserved benefits and costs of having children both early and late in life. We find that changes in the taste for children can account for almost 30% of the faster income growth downtown relative to the suburbs between 1990 and 2010.

Finally, we compute the welfare implications through housing prices and access to downtown amenities. High-skilled individuals benefited from the delay in childbearing beyond their growth in income. In contrast, low-skilled individuals experienced a welfare growth below their income growth due to the within-city sorting and increase in housing prices that resulted from the delay in childbearing.

Related Literature. This papers contributes to three main strands of the literature. First, our paper relates to a growing literature that analyzes the causes of urban revival. Baum-Snow and Hartley (2019) points out that the propensity of young and high-income individuals to live in the city center is largely driven by two factors: (i) divergent preferences towards downtown amenities between different racial groups, and (ii) the rising suburban concentration of labor market opportunities for low-education workers. Likewise, Couture and Handbury (2017) also emphasize the role of amenity valuations, arguing that increases in urban revival in the 2000-2010 period can be explained by a growing taste for downtown amenities among college graduates. On the other hand, Edlund et al. (2015) argue that longer hours worked among high-skilled workers have increased their distaste for commuting, which in turn has pushed up house and rental prices in the city center. Similarly, Su (2018) examines the growing importance of long work hours in well-paid downtown-located jobs as an exogenous factor driving the demand for central locations by high-skilled workers. Couture et al. (2019) evaluate the impact of top-income growth and its associated rise in income inequality on the location choices of rich households. In order to quantify the welfare consequences of urban urban revival, they introduce idiosyncratic preferences shocks and endogenous amenities to a spatial model of urban sorting. Recent work by Almagro and Dominguez-Iino (2019), Curci and Yusaf (2020) and Hoelzlein (2019) also study how endogenous amenities reinforce sorting by income within cities. We contribute to this literature by outlining a novel important channel that leads to urban revival: delayed parenthood.

Second, our work speaks to the literature on women's timing of family formation. Goldin and Katz (2002) and Bailey (2006) examine the impact of the availability of the birth control pill on birth, marriage timing, and female labour supply. Goldin and Katz (2002) show that greater access to the pill reduces the likelihood of marrying before age 23 and therefore increases the likelihood of women being employed in professional and high-skilled occupations. In a similar vein, Bailey (2006) pinpoints that reducing the age at which it becomes legal to access to the pill reduces the likelihood of a first birth before age 22 and increases labor supply on both the intensive and extensive margins. Postponing childbearing may benefit women for several reasons. Caucutt et al. (2002) show that fertility delay is related to changes in marriage and labour markets. Thus, high-skilled women delay marriage and fertility in order to obtain a better match, even in the absence of returns to labour market experience. Moreover, when labour market experience is taken into account, fertility is delayed even further. Using biological fertility shocks to instrument for motherhood delay, Miller (2011) finds that postponing motherhood has a statistically significant and positive impact on earnings and career paths, particularly for the highly educated women. Our contribution to this strand of the literature is therefore to highlight a new set of consequences of delayed maternity, those related to neighborhood development and within-city inequality.

Third, we contribute to a recent but growing literature at the intersection of urban economics and gender widely understood, (Barbanchon et al., 2021; Farré et al., 2020; Jingting and Zou, 2021; Kwon, 2022; Liu and Su, 2020; Moreno-Maldonado, 2020; Petrongolo and Ronchi, 2020; Wilde et al., 2010). The literature has focused on the effect of commuting gaps and housing prices for gender outcomes. To the best of our knowledge, we are the first to estimate a structural spatial equilibrium model that includes the interaction of fertility and within-city location choices.

The paper is also related to previous studies documenting the effectiveness of infertility insurance mandates on increasing ART utilization. Hamilton and McManus (2012) find that mandates to cover ART lead to a substantial increase in the usage of these technologies in the market. Moreover, they show that variations in the insurance regulations of states are largely due to different general political preferences rather than to unobserved preferences for ART. Similarly, Jain et al. (2002) find that states with required coverage for In Vitro Fertilization (IVF) - the most effective and most widely used form of ART - have the highest rates of IVF utilization. While these works provide suggestive evidence on how the mandates have increased IVF usage, they do not control for unobservable differences in patients or clinics that may be state-specific. This gap is filled by Bitler and Schmidt (2006), who use a difference-in-differences approach to show that the sizable increase in the use of infertility treatments as a result of the ART mandates is mainly concentrated among highly- educated older women, with no significant impact on other socioeconomic groups.

In addition, there is another stream of literature which has estimated the causal impact of infertility insurance mandates on several outcomes that are relevant to our framework. First, Schmidt (2007) finds a significant increase on first birth rates for women over 35. Consistent with this, Machado and Sanz-de Galdeano (2015) report a positive association between the mandates and women's mean age at first birth. However, they show that fertility rates over women's reproductive lives are unaffected by these mandates. Second, Buckles (2005) encounters that mandates that cover IVF are associated with an increase in labour force participation and earnings for women under 35 and a reduction in participation for older women. Similarly, Abramowitz (2017) points to an increase in women's age at marriage and at first birth after the enactment of these mandates, though only for college graduate women. Third, Kroeger and La Mattina (2017) find that such mandates led to a rise in the probability that women hold a professional college degree and work in professional occupations. Our contribution to this literature is to uncover another consequence that had not been previously considered, namely, their effect on the spatial distribution of income within cities.

The rest of the paper is organized as follows. Section 2 presents the reduced-form evidence on delayed childbearing and urban revival. Section 3 introduces the structural model of fertility timing and within-city residential location choices. Section 4 quantifies the model. Section 5 presents the main quantitative results from our estimated model and the counterfactual exercises. Finally, Section 6 concludes.

2 Reduced-form Evidence: Delayed Childbearing and Urban Revival

2.1 Data Sources and Definitions

Our analysis is conducted at the census tract level, defined as small geographical units encompassing between 2,500 and 8,000 people, which provides a good approximation for our definition of neighborhoods. We combine decennial Census data and the American Community Survey (ACS) 2008-2012, downloaded from the National Historical Geographic Information System (NHGIS), and construct constant 2010 census tract boundaries using the Longitudinal Tract Data Base (LTDB).

Cities. Our definition of city is the Core-Based Statistical Areas (CBSA) constructed by the Census Bureau. Given that urban revival is a big city phenomenon (Hwang and Lin (2016)), we restrict our sample to neighborhoods located in metropolitan areas with more than 1 million inhabitants.[1] The sample size includes 82,129 census tract–census year observations (51,469 in the treated group and 30,660 in the control group).

Downtown and suburbs. In line with the previous literature, we normalize distance to the city center using the cumulative share of the metropolitan population who lives in the nearest locations. That is, we consider rings of population around the city center such that a given share of population is included; e.g. a distance equal to 0.3 includes the area of the city including the 30 percent of population that is the closest to the city center. In particular, we use data from Lee and Lin (2018) to locate the geographical center of each CBSA and define the city center as the area within 0.1 distance from it. The main advantage of this definition is its flexibility as compared to geographical distances, since it adjusts for the fact that downtowns are generally more extensive in larger metropolitan areas. Similarly, we define the suburbs as the area of the city that contains the 50 percent of population that lives the furthest away from the city center.

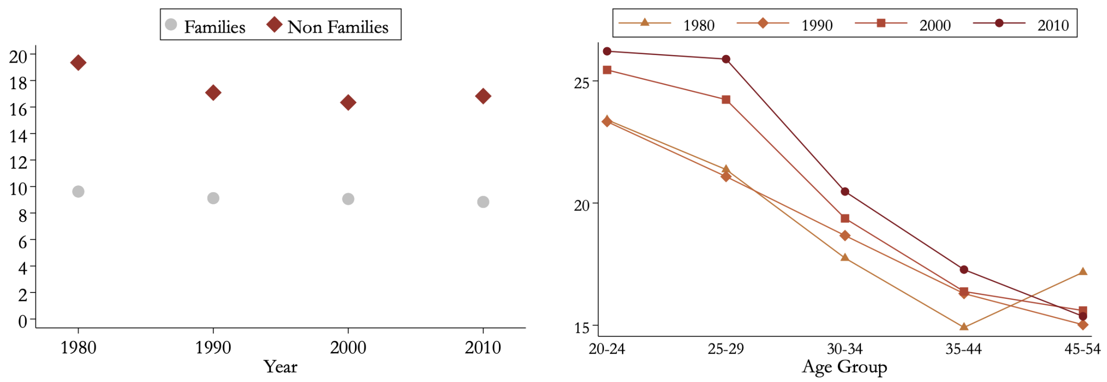
Urban revival. Several measures of urban revival are used in this paper. First, we use the probability that the average income in a specific census tract is above the median income in the city. This measure provides a good metric to describe urban revival processes, as it captures the income in that particular area relative to the median income in the entire city. However, it potentially misses changes

[1] In the Appendix, we relax this restriction by replicating our main results for a sample which includes all cities that have more than 100,000 inhabitants, and obtain similar estimates.

in income at the tails of the distribution. This pitfall is overcome by our second measure, the (log) average household income in the census tract. Third, we use the percentage of college graduates in the neighborhood, as urban revival is mostly driven by high-skilled individuals (Couture and Handbury, 2017).

2.2 Stylized Facts

In this section, we highlight the most relevant data patterns for our research question. We want to assess whether postponing the arrival of children leads to urban revival. Thus, we start by showing that young individuals without children are overrepresented downtown while families are more likely to settle down in the suburbs. We go on by illustrating the pronounced increase in the age of first-time mothers over the last few decades and its correlation with neighborhood change.



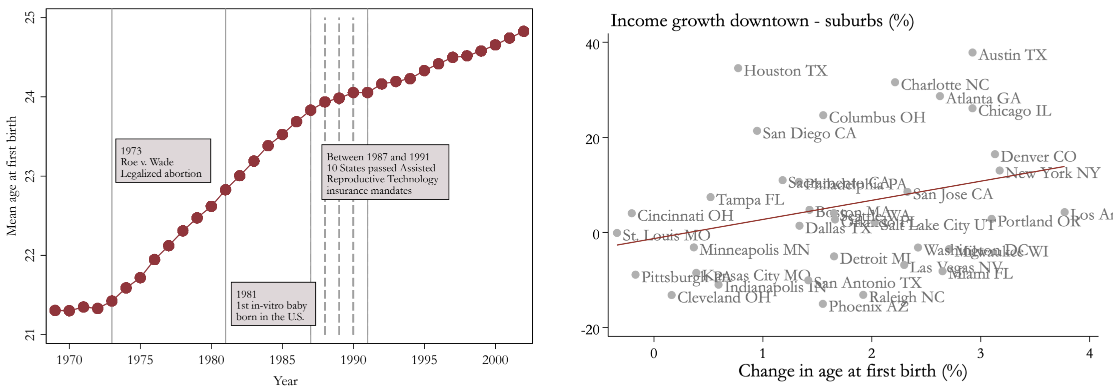
(a) Family type (b) Age

Figure 1: Propensity to locate downtown

Notes: This figure shows the average percentage living in the center for different demographic groups in the US from 1980 to 2010. In panel 1a, we distinguish between families and non families (households without children). Panel 1b display the propensity to locate downtown for different age groups.

Panel 1a in Figure 1 exhibits differences in location choices by families and individuals without children. It can be seen that families are around 8 percentage points less likely to reside in downtown neighborhoods and that this has been a persistent aspect of U.S. cities since 1980. Moreover, in the right panel of the figure, we show that young individuals are more likely to live downtown than older individuals. These residential patterns are consistent with the main characteristics of amenities in each city area. Since downtown neighborhoods concentrate a high density of consumption amenities that are mostly enjoyed by young childless individuals, this group is particularly attracted to this area. On the contrary, families are in need of space and place a big weight in school quality, making suburban neighborhoods especially appealing.

Next, we show that, the fraction of families in the population have changed substantially. Panel 2a in Figure 2 summarizes which is probably the most important demographic change of recent times: the delay in childbearing. This graph plots the average age of women at their first birth from 1970 to 2005, as well as some of the potential reasons behind this trend. We can see that average age at first birth increased substantially after the legalization of abortion and has been rising ever since. This rise in childbearing age translates into a greater proportion of young individuals without children in the population, which, as we have just showed, have the highest propensity to locate downtown. Hence, this demographic change could have fueled demand for downtown neighborhoods and, ultimately, induced spatial sorting on income as a result of housing price increases in this area. In the right panel of Figure 2, we plot the difference in income growth between downtown and the suburbs as a function of the change in the average age of first time mothers for big cities in the U.S. from 2000 to 2010. Although there is substantial variation, the correlation is clearly positive, suggesting that cities in which couples delay the arrival of children for longer experience a higher degree of urban revival.



(a) Delay in Childbearing (b) Urban revival and first time mothers' age

Figure 2: Delay in Childbearing and Urban Revival

Notes: this figure illustrates the delay in childbearing from 1970 to 2005 and its correlation with urban revival. Panel 2a plots the average age of first time mothers in the US, together with some important events that may be related to this trend. Panel 2b displays the difference in percentage growth between downtown and the suburbs from 2000 to 2010 as a function of the 2000-2010 change in the average age of first time mothers for big cities in the US.

Therefore, we have shown that our story seems in line with the data. However, there are several reasons to be cautious in the interpretation of these stylized facts. First, we cannot rule out reversed causality or the possibility that, as downtowns became more vibrant for whichever reason, young individuals chose to postpone childbearing in order to enjoy downtown amenities for longer. Second, we are worried about confounders: there could be a trend driving both urban revival and the delay in childbearing. In the next section we provide further evidence on our proposed mechanism by exploiting arguably exogenous variation in the age at first time mother at the state level.

2.3 The Impact of Infertility Insurance Mandates on Urban Revival

2.3.1 Infertility insurance mandates and delayed childbearing

While several studies have found positive effects of delaying childbearing on women's lifetime earnings (Buckles 2008; Caucutt et al. 2002; Miller 2011; Wilde et al. 2010), it is well known that fertility decays sharply with age (Menken et al. 1986; van Noord-Zaadstra et al. 1991). Therefore, women willing to postpone motherhood may be discouraged from doing so due to the risk of future infertility. In this context, ARTs may relax the career-family trade-off by enabling women to have children later without much risk. However, ART treatments (specially IVF) are very expensive and it is rare that insurers cover their cost unless required by law.[2]

Starting at the end of the 80's, several US states enacted mandates to enhance ART access. In essence, the mandates seek to decrease the price of infertility treatments borne by patients by including these treatments in insurance packages, which is expected to increase utilization by making it affordable to a broader segment of the female population. Indeed, Hamilton and McManus (2012) and Jain et al. (2002) show that utilization rates in mandate states are significantly larger after the mandates and Bitler and Schmidt (2012) estimate a 4.1 percentage point increase in the probability of using ART treatments for high-skilled women older than 30, using a difference-in-differences strategy.

Even though the abovementioned effects are already large, it is important to notice that the main impact of these policies in delaying childbearing is not coming from increases in ART utilization but from changes in younger women's decisions. The reason is that infertility insurance mandates affect the expected value of delaying childbearing: by lowering the cost of ART treatments, they reduce the risk associated with infertility at older ages, lowering the cost of postponing motherhood. On top of that, they may have increased awareness about the availability of IVF and consequently changed women's misconceptions about its effectiveness. Lastly, increased IVF usage may have reduced the stigma associated to marrying and having children at an older age for the whole population of women. Consistent with this, Bundorf et al. (2007) estimate a 3% decrease in birth rates for women 25-29

[2]According to Hamilton and McManus (2012), one cycle of IVF entails an out-of-pocket cost of $10,000 to $15,000 to the patient and it is common to attempt multiple cycles of treatment.

and a 4% increase for women 35-39, using a difference-in-differences model. Similarly, Abramowitz (2017) employs duration and competing risks analyses, exploiting the exogeneity of mandates, to document a significant delay in both marriage and childbearing for college graduate women 30 and older.

Therefore, the mandates provide us with a good scenario to measure whether delayed childbearing drives urban revival, since they created plausibly exogenous differences in the age at first time mother by state.

2.3.2 Assignment to the treatment and balancedness

There is substantial heterogeneity in the strength of the mandates across states. First, while most states require insurers to *cover* ARTs treatments in every available insurance policy, mandates in California and Texas only require insurers to *offer* infertility treatments. In addition, not all mandates include in-vitro fertilization (IVF) treatments, the most expensive and effective infertility treatment.[3]

As shown by Hamilton and McManus (2012), this heterogeneity is very relevant. These authors document that "universal mandates" (those requiring all insurers to cover IVF) led to a substantial increase in IVF utilization while other types of insurance mandates had a smaller effect. Consistent with this, studies focusing on the impact of the mandates on different outcomes (see, inter alia, Kroeger and La Mattina (2017), Machado and Sanz-de Galdeano (2015) or Schmidt (2007)) have found larger effects in states with universal mandates.

In order to address potential concerns about the endogeneity of the decision to enact a mandate at the state level, in this paper we choose to restrict our attention to states that passed any mandate and make comparisons along the intensity of the insurance coverage. This means that our group of treated cities include those in states that mandated health insurers to cover infertility treatments (as opposed to only offer them) and that included IVF, while our control group is formed of cities in states with a mandate to offer or that excluded IVF coverage from the mandate. In addition, we eliminate variation in the timing in which the mandates were enacted by pooling together all states that passed reforms between 1980 and 1990.[4] Moreover, there are some US metropolitan areas which belong to several states, such as Boston. In these cases, we consider that a city is treated if at least 5 percent of its population belongs to a state in our treated group. The rationale for

[3]Table 8 in the Appendix lists all states that have enacted mandates affecting the insurance of ART procedures over the five decades covering our census samples (1970-2010) and summarises their main features.

[4]In our analysis, we use census data because it allows us to identify neighborhoods' location. However, since these data are only available every ten years, we include 1970 and 1980 in the pre-treatment period, and consider 1990, 2000, and 2010, as being part of the post-treament period.

this choice is that we think it is likely that residents in parts of the metropolitan area belonging to other states were also affected by the policy, as metropolitan statistical areas have a high degree of economic and social integration. Lastly, given that urban revival is a big city phenomenom, we focus on cities whose population in 2010 was above 1.5 million inhabitants.

After applying the abovementioned criteria, we are left with the following list of treated and non-treated cities:

Table 1: List of cities by treatment

Control	**Treated**
San Jose CA	Boston MA
San Antonio TX	Cincinnati OH
Dallas TX	Columbus OH
Los Angeles CA	New York NY
Sacramento CA	Cleveland OH
Houston TX	Philadelphia PA
San Diego CA	Chicago IL
Austin TX	St. Louis MO
	Washington DC

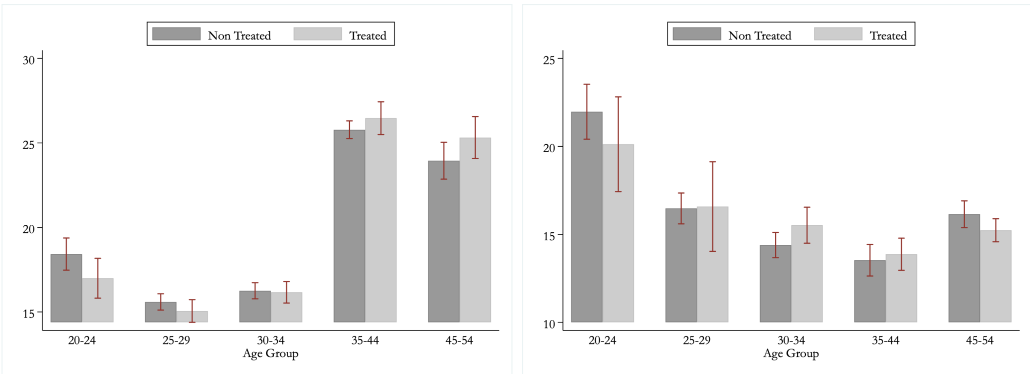
Table 2: Summary Statistics before Mandates

	Non Treated	Treated	Difference	P-value
Avg City Population	2,798,663	5,621,383	2,822,720	0.21
	(1,119,883)	(1,792,571)		
Avg City Household Income	11,080	11,950	870	0.06
	(216)	(361)		
Avg City Housing Value	21,157	22,101	944	0.63
	(1,327)	(1,367)		
% College Graduate in the City	7	7	-1	0.50
	(1)	(1)		
Downtown Household Income	9,634	7,666	-1,968	0.37
	(2,239)	(383)		
Downtown Housing Value	16,666	11,793	-4,872	0.11
	(2,611)	(1,354)		
Downtown % College Graduate	6	4	-2	0.10
	(1)	(1)		

Notes: This table displays city averages regarding some relevant characteristics in treated and non-treated states in 1970. Standard errors are in parenthesis. The last two columns show the difference between treated and non-treated states and the p-value of this difference, for each reported variable.

Comparing treated and non-treated cities. Table 2 summarizes the main descriptive statistics of cities in the treated and in the control groups before the mandates were introduced. As can be observed, cities in treated cities were larger and had higher household income. Unfortunately, there is not a clear way to address this potential concern. In Table 9 we show that our results are robust to the inclusion of city population and (log) average city income each year in the regressions.

Finally, Figure 3 shows that there were not significant differences in the age distribution across treated and non-treated cities before the reform. This can be seen in Panel 3a, which displays the percentage of population by age bin in treated and non-treated cities prior to the mandates. In addition, both groups of cities exhibited a similar spatial distribution of individuals for a given age group. Panel 3b in Figure 3 documents the absence of significant differences in the percentage of individuals that live downtown within each age group in 1970 between treated and non-treated cities.



(a) % Pop. in the city

(b) % Pop. living in the center

Figure 3: Age Distribution before Mandates

Notes: This figure displays the age distribution of treated and non-treated cities in 1970, before mandates were enacted. Panel 3b shows the percentage of individuals that locate downtown within each age bin.Panel 3a displays the percentage of population in treated and non-treated cities by age bin.

2.3.3 Econometric specification

In order to estimate the effect of insurance mandates on urban revival, we employ a triple difference specification. The first difference is taken between the pre-treatment and the post-treatment period. As explained in section 2.3.2, we consider that the post-treatment period starts in 1990 for all cities. The second difference is taken between treated and non-treated cities. It captures how different the change in the variable of interest in census tracts that were treated versus those that were not treated between the pre-treatment and the post-treatment periods was. The third difference is taken between being part of the city center or of the suburbs. Hence, this triple difference captures how different was the change in the outcome variable of interest: (i) before and after treatment date, (ii) between the city center and the suburbs, and (iii), in treated cities compared to non-treated cities. The general form of the regression we run is:

$$\begin{aligned} y_{i,t} = \beta_0 &+ \beta_1 \text{Treated}_i + \beta_2 \text{Post}_t + \beta_3 \text{Center}_i + \beta_4 \text{Treated}_i \times \text{Post}_t \\ &+ \beta_5 \text{Treated}_i \times \text{Center}_i + \beta_6 \text{Post}_t \times \text{Center}_i \\ &+ \beta_7 \text{Treated}_i \times \text{Post}_t \times \text{Center}_i \\ &+ \delta_t + \delta_c + \delta_{tc} + \epsilon_{it} \end{aligned} \tag{1}$$

where $y_{i,t}$ is the outcome of interest for a census tract i at time period t. There are three indicator variables: Treated, which takes value one for those states which enacted an insurance mandate between 1980 and 1990; Post, which takes value one for periods after 1980, both for treated and non-treated states; and Center, which takes value one if the census tract is within the radius around the city center which contains 10 percent of the population of the city and 0 if the census tract is within the area containing the 50 percent of population living the furthest from the city center. Finally, we include city and year fixed effects (δ_c and δ_t), as well as city time trends (δ_{tc}).[5]

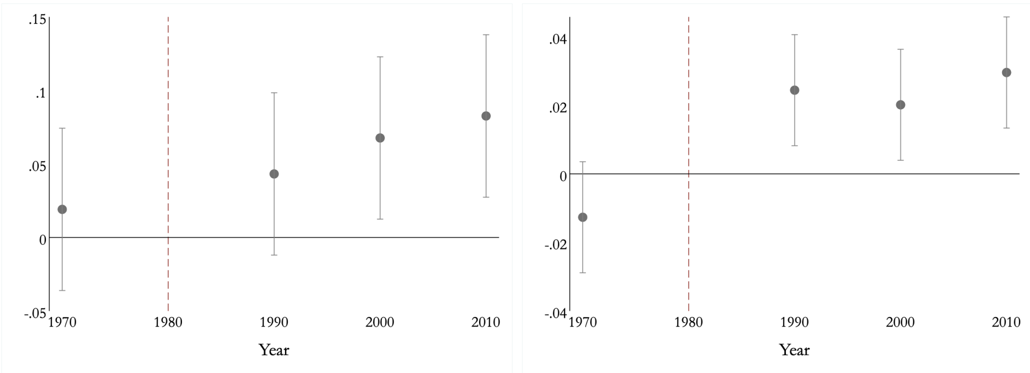
2.4 Parallel trends

Our identification strategy relies on the existence of parallel trends in the outcomes of interest before mandates were introduced. In Figure 4, we provide event study graphs for the (log) average income in the census tract (panel 4a) and for the percentage of college graduates in the census tract (panel 4b). More specifically, these graphs show the estimated coefficients (and 95% confidence intervals) of treatment leads and lags. Given that the time of treatment is uniform in our sample, the concrete specification we use is:

[5] In Table **??** in the Appendix, we show that our results are robust in the absence of city trends.

$$y_{i,t} = \gamma_0 + \gamma_1 \text{Treated}_i + \gamma_2 \text{Center}_i + \gamma_3 \text{Treated}_i \times \text{Center}_i$$
$$+ \sum_{t=1970, t\neq 1980}^{2010} \psi_t \times \text{Treated}_i + \sum_{t=1970, t\neq 1980}^{2010} \theta_t \times \text{Center}_i$$
$$+ \sum_{t=1970, t\neq 1980}^{2010} \lambda_t \times \text{Treated}_i \times \text{Center}_i + \delta_t + \delta_c + u_{i,t}$$

and our coefficients of interests are λ_{1970}, λ_{1990}, λ_{2000}, and λ_{2010}. We can see that in 1970, differences between treated and non treated cities were not significant (panels 4a and 4b), supporting the existence of parallel trends between treated and non treated cities before the mandates.



(a) (log) Median income

(b) % College Graduates

Figure 4: Parallel Trends

2.4.1 Main results

We start by analyzing the effect of the insurance policy mandate on income at the city center. As explained in section **??**, two complementary outcome variables are being used in this respect: (i) the probability that a census tract's income is above the median household income in the city and; (ii) the (logged) average household income in the census tract. The first two columns in Table 3 display the results of running the triple differenced specification in equation 1 for each of the two above-mentioned variables. According to our estimates, the probability that a census tract is above the median income in the city in treated cities after the mandates is 5.6 percentage points higher downtown relative to the suburbs and compared to the cities in the control group. Similarly, average income downtown grew 5.4% relative to the suburbs in treated cities as compared to the same measure in non-treated cities. Next, we switch attention to another commonly used measure of urban revival: the percentage of college graduates that locate downtown. College graduates were 3.1 p.p. more likely to locate downtown after the mandates in treated cities as compared to the same difference in non-treated cities. Therefore, the results regarding college graduates' location patterns are fully in line with the observed changes in income downtown, as expected.

Table 3: The effect of infertility insurance mandates on urban revival

	Prov. above median	(log) Avg Income	% College Graduate
	(1)	(2)	(3)
Treated × Center × Post	0.056**	0.054***	0.031***
	(0.022)	(0.018)	(0.005)
Year FE	Yes	Yes	Yes
City FE	Yes	Yes	Yes
Controls	No	No	No
City Trends	Yes	Yes	Yes
R-squared	0.086	0.780	0.256
Observations	77338	77338	77338

Notes: This table displays the impact of infertility insurance mandates on several measures of urban revival: (1) the probability that a census tract's income is above median income in the city; (2) the census tract's (log) average income; and (3) the percentage of college graduates in a census tract. This table reports only our coefficient of interest, the full specification can be found in equation 1. Standard errors in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$.

To summarize our findings, the effect of the policy on income at the city center and the college graduates' location patterns is statistically significant and sizable in magnitude. As discussed in subsection 2.4, treated and non-treated cities were on parallel trends leading up to the treatment year. Moreover, by comparing cities in states that passed stronger mandates to those in cities enacting weaker mandates, concerns about the potential endogeneity of the policy should be taken care of. Therefore, we believe our results provide strong evidence on the role of postponed parenthood on urban revival.

2.5 Discussion of the Mechanisms

In this section, we confirm that the variation in the demographic composition of the city center supports our preferred mechanism whereby the effect of the policy on urban revival could result from women delaying having kids and staying downtown rather than moving to the suburbs. Moreover, we show some results regarding housing, as housing price increases downtown are at the core of our mechanism. Lastly, we rule out the increasing importance of long-hours occupation as driving our results.

2.5.1 Changes in the demographic composition

We claim that infertility insurance mandates extended the life period in which individuals benefit the most from locating downtown, fueling the process of urban revival. Therefore, we should observe a change in the demographic composition of central neighborhoods towards slightly older couples.

In order to capture this change, we restrict our attention to individuals with ages between 20 and 44 and examine their location choices. We focus on couples in childbearing age because these are the ones for which the timing of family formation influences their residential choices. Therefore, we run again equation 1 where this time the dependent variable is the percentage of individuals in each age bin of the census tract population who are in childbearing age (20-44). Figure 5 plots the coefficients of the triple interaction term, which displays the impact of the policy on the propensity to locate downtown for each of our 4 age bins (20-24, 25-29, 30-34, and 35-44), both for males and females. That is, this figure displays the impact of ART mandates in the age distribution downtown relative to the suburbs in treated cities and compared to the same difference in non-treated cities.

Consistent with the idea that postponing childbearing allows couples to reside in the city centre until later stages of their lifetimes, we find that the policy leads to around a 2 percentage points increase in the proportion of adults aged between 20 and 30 living downtown, while in parallel the percentage of older adults goes down. Interestingly, the proportion of women postponing maternity is a bit younger than men. This is consistent with women delaying having kids until the early thirties and moving out of the city centre with their partners and kids afterwards. Since male partners tend to be a little older, the effect is delayed for men. In line with our mechanism, the proportions of men and women aged between 35 and 44 living downtown decrease by around 3 percentage points.

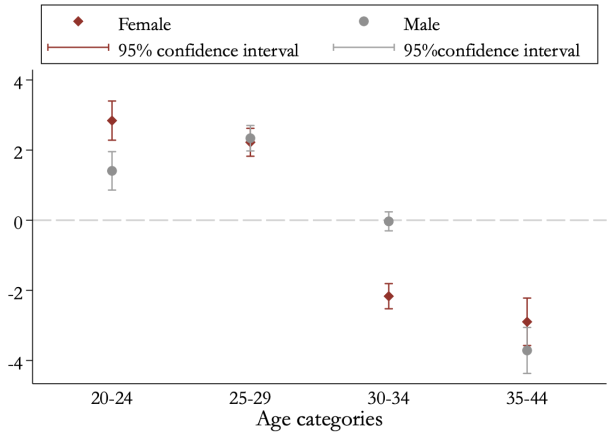


Figure 5: Age composition males vs females

Notes: This figure shows the change in the age distribution of female and male individuals in downtown neighborhoods as compared to the suburbs in treated cities vs non-treated cities. That is, it plots the coefficients of the triple difference of running equation 1 for the percentage of females or males in four different age categories.

2.5.2 Changes in the housing market

As the demographic group that has the highest valuation for living downtown expands, so does the demand for housing in these locations, which should lead to price rises and, possibly, trigger an increase in the supply of housing. In order to confirm that this was the case, we run our triple difference specification (equation 1) for several outcomes related to the housing market: (i) the (log) average value of houses, (ii) the average age of the housing stock, and (iii) the average number of units in the census tract. Our results confirm that housing value downtown relative to the suburbs increased considerably after the mandate in treated cities as compared to non treated cities. Moreover, they point towards some construction taking place downtown, as the average age of the housing stock decreases an the number of units increases.

2.5.3 The role of long-hours occupations

Recent studies have pointed to the rise in the returns to working long hours as an important driver of urban revival (Edlund et al. (2015), Su (2018)). Long-hour occupations create incentives to have a shorter commute, driving demand for downtown locations. The potential threat for our empirical strategy arises because women in long-hour occupations have a higher incentive to postpone maternity. Therefore, states with a larger fraction of employment in long-hour occupations

Table 4: The effect of infertility insurance mandates on urban revival

	Log average value	Average age	Number of units
	(1)	(2)	(3)
Treated × Center × Post	0.281***	-1.717***	186.225***
	(0.021)	(0.427)	(32.459)
Year FE	Yes	Yes	Yes
City FE	Yes	Yes	Yes
Controls	No	No	No
City Trends	Yes	Yes	Yes
R-squared	0.777	0.577	0.229
Observations	74246	74246	74246

Notes: This table displays the impact of infertility insurance mandates on: (1) the (log) average value of houses, (2) the average age of the housing stock, and (3) the average number of units in the census tract. This table reports only our coefficient of interest, the full specification can be found in equation 1. Standard errors in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$.

may have also been more likely to implement insurance mandates.

To test for this possibility, we employ the measure developed by Cortés and Pan (2019) to classify occupations into terciles according to returns to long-hours, both in 1980 and in 2010. Once we have divided occupations into high, middle and low returns to long-hours, we check whether their presence differed across treated and non-treated states. In Table 5, we report the share of male and female employment in occupations with high, medium, and low returns to working long hours by city. We show that differences in the occupational composition of treated and non-treated states in 1980 is not statistically significant. The difference is not significant regardless of whether we compute returns to working long hours in 1980 or in 2010. Therefore, we conclude that the occupational composition of states cannot explain the diverging urban revival.

2.6 Delayed childbearing and urban revival: an IV approach

So far, we have shown that differences in infertility insurance mandates across US states had a significant effect on the urban revival of downtown neighborhoods. Moreover, we have provided evidence consistent with the postponement of maternity mediating the effect of these policies on the spatial distribution of income. However, the rise in the age at first-time mother is a much more general trend that is not solely related to ART mandates. Starting in the late 70's, the age at first birth has gone from just over 21 to close to 25 years old in 2010. Over the same period, the probability that a census tract in the city center had an average income above the median income in the city went from 5% to 25%. To relate both trends in a

Table 5: Employment composition by returns to working long hours

		Share of employment					
		Returns in 1980			Returns in 2010		
		Control	Treated	Diff.	Control	Treated	Diff.
		(1)	(2)	(3)	(4)	(5)	(6)
	High Ret.	0.17 ***	0.18***	0.01	0.62***	0.62***	0.00
		(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.04)
Male employment	Middle Ret.	0.64***	0.65***	0.01	0.20***	0.23***	0.02
		(0.03)	(0.02)	(0.03)	(0.03)	(0.03)	(0.04)
	Low Ret.	0.20***	0.17***	-0.02	0.20***	0.17***	-0.02
		(0.03)	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)
	High Ret.	0.18***	0.17***	-0.00	0.39***	0.40***	0.00
		(0.03)	(0.03)	(0.05)	(0.05)	(0.04)	(0.07)
Female employment	Middle Ret.	0.42***	0.43***	0.01	0.07***	0.08***	0.00
		(0.03)	(0.02)	(0.04)	(0.02)	(0.02)	(0.03)
	Low Ret.	0.40***	0.39***	-0.01	0.40***	0.39***	-0.01
		(0.05)	(0.02)	(0.06)	(0.05)	(0.02)	(0.06)

Notes: This table reports the share of employment in occupations by terciles of the return to working long hours. Columns (1) to (3) rank occupations based on the return to working long hours in 1980 and Columns (4) to (6). Returns to working long hours are calculated as the elasticity of log weekly earnings with respect to log hours with controls using the US Census, following the specification in Goldin (2014).

causal fashion, in this section we use the mandates as an instrumental variable for the average age at first birth in the city when estimating the impact of the latter variable on urban revival. In addition, we provide some preliminary quantitative assessment of the overall effect that a delayed age at first birth could have on the relative income growth of city centers and suburbs over the sample period under consideration.

The choice of an IV approach in this exercise is dictated by the following reasoning. As pointed out above, downtown neighborhoods tend to be wealthier in cities in which women have their first kid at an older age. However, the direction of causality is unclear. In particular, it could be the case that as urban revival gets stronger (because central areas of the city become more attractive due to shorter commuting times or increased density of amenities), women reacted by postponing having children and moving to the suburbs, leading in this way to reverse causality. Thus, in order to estimate the causal effect of age at first birth on urban revival, we use the ART policy enactment to instrument the average age at first birth in a city, on the basis that the approval of these policies across different states is unrelated to the specific preferences of their populations about delayed fertility treatments. The identifying assumption in this empirical strategy is that the mandates affected urban revival only by affecting the age at first birth, but not directly.

Our specification requires that we run our regressions at the city level instead of using census tract as done in our previous analysis. We obtain the age of first-time mothers at the county level from the National Center for Health Statistics (NCHS) Natality Birth Data. We then construct a measure of urban revival at the city level by dividing the average income in central counties by the average income in suburban counties. Therefore, an increasing income ratio will be indicative of urban revival happening in the city.

$$\text{urban revival}_{i,t} \equiv \frac{\sum_{j \in Downtown} MeanIncome_j}{N_{downtown}} / \frac{\sum_{j \in Suburbs} MeanIncome_j}{N_{suburbs}} \tag{2}$$

Since the instrument we employ is a binary instrument, we use the Wald estimator, also known as the grouping estimator. The estimator is implemented through the following three steps. First, we regress our measure of urban revival city i at time t on the instrument and controls:

$$\begin{aligned} \text{urban revival}_{i,t} =& \alpha_0 + \alpha_1 \text{Treated}_i + \alpha_2 \text{Treated}_i \times \text{Post}_t + CitySize_i \\ & + \mu_t + \phi_{State(i)} + \delta_{State(i)} \times t + \epsilon_{i,t}, \end{aligned} \tag{3}$$

where μ and ϕ are time and state fixed effects, and δ are state trends and we also control for city size. Next, we run a similar regression for the average age of mothers at their first birth in city i at time t:

$$\begin{aligned} \text{age at first birth}_{i,t} =& \beta_0 + \beta_1 Treated_i + \beta_2 Treated_i \times Post_t + CitySize_i \\ & + \mu_t + \phi_{State(i)} + \delta_{State(i)} \times t + \nu_{i,t}, \end{aligned} \tag{4}$$

where the time, state, and state trends are denoted with the same symbols as before for comparability. Finally, we combine both estimates together to obtain the Wald estimator, which captures the effect of age at first birth on urban revival, instrumented with the insurance mandate.

$$\widehat{W} = \frac{\hat{\alpha}_2}{\hat{\beta}_2}, \qquad SE_{\widehat{W}} = \frac{\hat{\alpha}_2}{\hat{\beta}_2}\sqrt{\left(\frac{SE_{\hat{\alpha}_2}}{\hat{\alpha}_2}\right)^2 + \left(\frac{SE_{\hat{\beta}_2}}{\hat{\beta}_2}\right)^2} \tag{5}$$

The results of the first and second step are included in Table 6. We find that the policy increased the age at first birth by 0.62 years, and the ratio of downtown to suburb income goes up by 1.5 percentage points. For reference, the average ratio of downtown to suburb income in our sample is 57 percent with a standard deviation of 15 percentage points. Moreover, the average mean age at first birth is 24 years with a standard deviation of 2 years. If the exclusion restriction holds, this implies that for each year of increase in the average age at first birth, cities should expect the ratio of income downtown to income in the suburbs to increase by 2.4 percentage points.

The magnitude of the estimated effect points towards a potentially large economic significance. A back-of-the-envelope calculation tells us that the increase in the age at first birth from 23.27 in 1980 to 24.7 in 2000 could explain an increase in the income ratio of downtown to suburb of 5.8 percentage points. The average increase in the ratio from 1980 to 2000 was 3.7 percentage points. Of course, there are many other mechanisms working at the same time and we do not claim that all of the increase in age at first birth is exogenous, nor that it is the sole driver of urban revival. However, these results are suggestive of the potential central role that a delay in the age at first birth may have played in explaining urban revival.

Table 6: Causal effect of Age at 1st Birth on urban revival

	First step	
	Urban Revival	Age at 1st birth
	(1)	(2)
Treated × Post	0.015***	0.618***
	(0.0021)	(0.0255)
Observations	72737	72737
Year FE	Yes	Yes
State FE	Yes	Yes
State time trends	Yes	Yes
City Size FE	Yes	Yes
	Second step	
	Urban Revival	
	(1)	
Age at 1st birth	0.024***	
(IV: Treated × Post)	(0.0035)	

Notes: This table displays the impact of delayed maternity on urban revival using a Wald estimator. The top panel displays the results of the first step regressions while the bottom panel displays the result of the second step regression. Standard errors in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$.

3 A Model of Fertility Timing and Location Choice

In this section, we propose a model of endogenous fertility timing and location choice. The goal of the model is to quantify how much of the observed urban revival can be explained by the delay in the age at first birth and what have been the welfare consequences of this delay. The model is necessary to include general equilibrium effects of a counterfactual change in the incentives to delay childbearing as well as to draw welfare implications.

3.1 Model setup

Geography. The geography in this economy consists on a city featuring a set of locations indexed by $l = \{1, ..., N\}$. There are two types of locations: downtown (d) and suburbs (s). There is one downtown location and $N_s = N - 1$ suburb locations. The suburb locations are identical except for an idiosyncratic amenity that agents derive from living in a particular location. The suburb locations differ from the downtown location in three time-varying dimensions: amenities, δ_t, income, I_t, and supply,H_t.

We assume that there is no cost to move across locations and that amenities are local, they can only be consumed by residing in the location. Moreover, we assume that income is independent of the location of residence, this can be interpreted as there being a unique labor market for the whole city. There is free trade of the final good which is used as the numeraire. The housing supply in each location is fixed and owned by absentee landlords.

Households. The economy is inhabited by a mass of households indexed by i. Households are composed by a couple and live for three periods. The first period they are young (y), then mature (m), and finally old (o), we let $a \in \{y, m, o\}$ index age. Households also differ on their skill, z, which is permanent through their lifetime. Households choose where to live, and whether and when to have children. At period t, there is a mass $L_t(a, z)$ of households of age a and skill s in the city.

Households derive an idiosyncratic utility from residing in location l. Each period, they draw a vector of idiosyncratic preferences, $\varepsilon^i = \{\varepsilon_l^i\}_{l=1}^N$. Each element is an iid random variable following a Fréchet distribution with shape parameter β_ε. Moreover, if households choose to have children, they derive an idiosyncratic utility η^i which is also distributed as a Fréchet with shape parameter β_η. This idiosyncratic amenity is enjoyed in each of the periods in which the children is in the households.

Children. Children remain in their household for two periods. Let $k = 0$ if there are no kids present, $k = 1$ if the household had kids that period (young kids), and $k = 2$ if they had kids the previous period (old kids). Conditional on wanting children, there is a probability that the household will be successful. For simplicity, we assume that the probability is equal to one when young, $\rho_y = 1$, zero when old $\rho_o = 0$, and a number between zero and one when mature $0 < \rho_m < 1$. Amenities, $\delta_t(a, k, z, l)$, and income, $I_t(a, k, z)$, depend on the presence and age of kids, k, in addition to age, a, skill z. Amenities, but not income, also depend on the location of residence l. This flexibility on the amenities is meant to capture location-specific amenities related to kids, for example, the availability of high-quality schools or the proximity to parks. The flexibility on income can capture child penalty effects. This income penalty could be related, for example, to changing jobs in order to gain more flexible hours or a shorter commute.

Preferences. An agent i at age a with kids aged k, skill z, and living in location l at time t derives the following Stone-Geary period utility from the consumption of final output, c, and housing:

$$\begin{aligned} U_t^i(c, h; a, k, z, l) =& c^{1-\alpha}(h - \underline{h})^{\alpha} \cdot \delta_t(a, k, z, l) \cdot \varepsilon_l^i \cdot \left(\eta^i\right)^{D_{k>0}} \\ &\text{subject to: } c + p_t(l)\, h = I_t(a, k, z), \end{aligned}$$

where $D_{k>0}$ is a dummy taking value one on the period the household has kids, and $p_t(l)$ is the housing price in location l, and $\underline{h}$ is the minimum amount of housing that agents buy. Agents apply discount factor ϕ to future periods and have perfect foresight.

Timing. When couples are born, they draw an idiosyncratic preference for children η^i which stays constant for their lifetime. Each period, they first observe whether they had kids the previous period. If they do not have kids yet, they can decide whether to try to have kids that period. They then observe if they are successful in having kids. Once they have discovered their kid state this period, they draw a vector of idiosyncratic preferences for locations, ε^i and choose where to live, they consume and produce.

The key timing assumption is that agents observe their location preference only after having made the decision on whether to have children. Under this assumption, fertility choices are partly driven by downtown amenities that are common to everyone. For instance, if the amenity of living downtown increases for households with children, more households may want to have children. However, the timing assumption rules out selection into delayed fertility of households that idiosyncratically enjoy living downtown more.

This assumption is reasonable to the extent that idiosyncratic preferences for location are more likely to change quickly and unexpectedly while the childbearing decisions are more permanent. In other words, at least some of the taste shocks related to location are realized only after making decisions on whether and when to have children.

3.2 Definition and characterization of equilibrium

Location choice. A household i of age a, kids aged k, skill z, and an idiosyncratic preference vector ε^i chooses the optimal location at each period in order to solve the following problem:

$$v_t^*\left(a,k,z,\varepsilon^i\right) = E\max_l \left\{x_t\left(a,k,z,l\right)\cdot\delta_t\left(a,k,z,l\right)\cdot\varepsilon_l^i\right\},$$

where $x_t\left(a,k,z,l\right) = \alpha^\alpha\left(1-\alpha\right)^{1-\alpha}\left(\frac{I_t(a,k,z)}{p_t(l)^\alpha} - p_t\left(l\right)^{1-\alpha}\underline{h}\right)$ is the observed component of the indirect utility from living in location l, which is common to all individuals of the same demographic group.

Given the assumption that ε_l^i is distributed as a Fréchet with shape parameter β_ε, we can obtain the fraction of households that will choose to live downtown in a given period:

$$\pi_t^{loc}\left(d|a,k,z\right) = \frac{x_t\left(a,k,z,d\right)^\beta\delta_t\left(a,k,z,d\right)^\beta}{x_t\left(a,k,z,d\right)^\beta\delta_t\left(a,k,z,d\right)^\beta + N_s x_t\left(a,k,z,s\right)^\beta\delta_t\left(a,k,z,s\right)^\beta}, \quad (6)$$

where N_s is the number of locations of type suburb. Since all locations in the suburbs are identical, we employ $d=1$ for the location index of the downtown location and $s\in\{2,...,N_s+1\}$ for the index of any of the suburb location.

Fertility choice. Households can choose whether to have children, and whether to have them as young, or postpone and try to have them as mature. To make this decision, household i compares the discounted present utility from the three possible outcomes, not taking into account the idiosyncratic preference. We can write the lifetime utility from having kids as young, v_{ky}^*, as mature v_{km}^*, and from no kids v_{nk}^* for a household with idiosyncratic preference for children, η^i as:

$$v_{ky,t}^*\left(z;\eta^i\right) = v_t^*\left(y,k=1,z\right)\eta^i + \phi v_{t+1}^*\left(m,k=2,z\right)\eta^i + \phi^2 v_{t+2}^*\left(o,k=0,z\right)$$
$$v_{km,t}^*\left(z;\eta^i\right) = v_t^*\left(y,k=0,z\right) + \phi v_{t+1}^*\left(m,k=1,z\right)\eta^i + \phi^2 v_{t+2}^*\left(o,k=2,z\right)\eta^i,$$
$$v_{nk,t}^*\left(z\right) = v_t^*\left(y,k=0,z\right) + \phi v_{t+1}^*\left(m,k=0,z\right) + \phi^2 v_{t+2}^*\left(o,k=0,z\right),$$

An agent with an idiosyncratic preference for children of η^i will then solve:

$$\max\left\{v^*_{ky,t}\left(z;\eta^i\right),\quad \rho_m\left(v^*_{km,t}\left(z;\eta^i\right)\right)+\left(1-\rho_m\right)v^*_{nk,t},\quad v^*_{nk,t}\right\}.$$

Since agents have perfect foresight, the fertility decision is made once when households are young. Therefore, we can define thresholds of η^i for which the young will choose each of the three lifetime paths kids young, delay kids, or no kids. Define threshold at time t, $\bar{\eta}^t_{i,j}$, such that if the idiosyncratic preference is above the threshold, the individual prefers i to j. In an equilibrium path in which a positive mass of households have kids as mature and preferences are transitive, it must be the case that:

$$\bar{\eta}^t_{km,nk}\left(z\right)<\bar{\eta}^t_{ky,nk}\left(z\right)<\bar{\eta}^t_{ky,km}\left(z\right).$$

The middle threshold is not active in an equilibrium with delay childbearing. Thus, we can summarize the choice with the following graph:

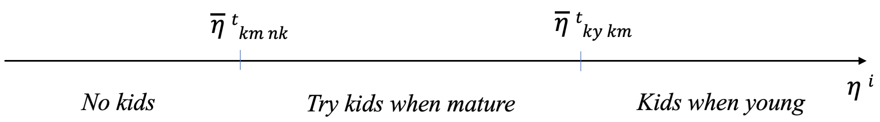


Figure 6: Fertility decision at period t

Now we can compute the fraction of households of each skill z who choose each of the three options at each time period t:

$$\begin{aligned}Prob_t\left(\text{kids young};z\right)=&1-F_\eta\left(\bar{\eta}^t_{ky,km}\left(z\right)\right),\\ Prob_t\left(\text{try kids mature};z\right)=&F_\eta\left(\bar{\eta}^t_{ky,km}\left(z\right)\right)-F\left(\bar{\eta}^t_{km,nk}\left(z\right)\right),\\ Prob_t\left(\text{no kids};z\right)=&F_\eta\left(\bar{\eta}^t_{km,nk}(z)\right),\end{aligned}\tag{7}$$

where $F_\eta(x)$ is the Fréchet distribution of the idiosyncratic preference for children and has shape parameter β_η. From, here we can obtain the fraction of households,

$\pi_t^{fert}(a,k,z)$ with each realized fertility outcome, k, age, a, and skill, z.

$$
\begin{aligned}
&\pi_t^{fert}(1,0,z) = F\left(\bar{\eta}^{t}_{ky,km}(z)\right),\\
&\pi_t^{fert}(1,1,z) = 1 - F\left(\bar{\eta}^{t}_{ky,km}(z)\right),\\
&\pi_t^{fert}(1,2,z) = 0,\\
&\pi_t^{fert}(2,0,z) = F\left(\bar{\eta}^{t-1}_{km,nk}(z)\right) + (1-\rho_m)\left(F\left(\bar{\eta}^{t-1}_{ky,km}(z)\right) - F\left(\bar{\eta}^{t-1}_{km,nk}(z)\right)\right),\\
&\pi_t^{fert}(2,1,z) = \rho_m\left(F\left(\bar{\eta}^{t-1}_{ky,km}(z)\right) - F\left(\bar{\eta}^{t-1}_{km,nk}(z)\right)\right),\\
&\pi_t^{fert}(2,2,z) = 1 - F\left(\bar{\eta}^{t-1}_{ky,km}(z)\right),\\
&\pi_t^{fert}(3,0,z) = 1 - \rho_m\left(F\left(\bar{\eta}^{t-2}_{ky,km}(z)\right) - F\left(\bar{\eta}^{t-2}_{km,nk}(z)\right)\right),\\
&\pi_t^{fert}(3,1,z) = 0,\\
&\pi_t^{fert}(3,2,z) = \rho_m\left(F\left(\bar{\eta}^{t-2}_{ky,km}(z)\right) - F\left(\bar{\eta}^{t-2}_{km,nk}(z)\right)\right).
\end{aligned}
$$

Housing market. Housing supply, $H_{l,t}$, varies exogeneously in each location. All the suburb locations will have an identical housing supply, and may differ from the housing supply in the downtown location. The housing price is such that the housing market will clear in each location, l. Namely,

$$
H_{l,t} = \sum_{a,k,z}\left(\frac{\alpha\left(I_t(a,k,z) - p_t(l)\underline{h}\right)}{p_t(l)} + \underline{h}\right)\pi_t^{loc}(l|a,k,z)\,\pi_t^{fert}(a,k,z)\,L_t(a,z). \quad (8)
$$

Equilibrium path to steady state Given a sequence of (i) demographic composition $\{L_t(a,z)\}_{t=0}^{\infty}$, (ii) amenities $\{\delta_t(a,k,z,l)\}_{t=0}^{\infty}$, (iii) income $\{I_t(a,k,z)\}_{t=0}^{\infty}$, and (iv) housing stock $\{H_{t,l}\}_{t=0}^{\infty}$ such that they are all constant from a period $T<\infty$ on, an equilibrium path to steady state is a sequence of housing prices $\{p_{t,l}\}_{t=0}^{\infty}$ such that:

1. Agents correctly predict future income, amenities, and housing prices.
2. Households optimally choose location (Eq. 6).
3. Fertility choices are optimal (Eq. 7).
4. Housing markets clear every period (Eq. 8).

Since Equation 8 has a unique solution every period, an equilibrium path to steady states exists and is unique.

4 Model Quantification

4.1 Data and Definitions

The quantification of the model employs census individual-level data for the years 1980, 1990, and 2000, and American Community Survey (ACS) multiyear 2008-2012 for 2010. The geographic unit in the census data vary in each year. We employ the smallest unit available in each year, that is Public Use Microdata Areas (PUMAs). We select only couples in our data and treat each household as an individual agent in the model. Households are assigned to groups according to their age, skill, fertility choices, and location.

Age. The age of a household is assigned based solely on the age of the female. Households between the ages of 20 and 30 are classified as young, between 30 and 40 as mature, and above 40 as old. This classification is meant to capture three distinct fertility phases. Regarding fertility choices, we consider three fertility states: no kids, young kids if the household had them in the current age bin, or old kids if the household had them when in the previous age bin.

Location. Household's location is classified as downtown or suburbs depending on the geographic unit where the couple live according to the following procedure. First, we establish the point location of a city center as in Lee and Lin (2018). [6] Second, we employ the distance of each census tract to this point city center, as provided by Lee and Lin (2018). Third, we classify as downtown all census tracts which are closest to the center and include 10 percent of the population in the year 2000. Fourth, we follow Couture and Handbury (2017) and classify a PUMA as downtown if at least 50% of the PUMA's population belongs to census tracts classified as downtown and we classify it as suburbs if less than 10% of the population lives in the downtown area. Finally, we select only cities for which we can accurately identify the downtown in all of our sample years (1990-2010). Following Couture and Handbury (2017), we consider that we can identify the center in cities for which, at least 50% of the population in the center lives in a PUMA (or county group) that is classified as downtown.[7] Table **??** includes the cities that are included in this sample.

[6] Lee and Lin (2018) use the procedure developed in Fee et al. (2013) by which they identify the CBD of 268 MSAs using 1982 Census of Retail Trade for the central city of the MSA. For the remaining 117 MSAs, the center is found by geocoding the MSA's central city found using ArcGIS's 10.0 North American Geocoding Service.

[7] We use slightly more generous thresholds than in Couture and Handbury (2017). They use 60% thresholds while we employ 50%. We made this decision in order to have the largest possible sample of cities. Our goal was to have more power in the estimation.

Skill, income, and the child penalty. In our model, household income varies with the skill of the households as well as with the presence of children. Therefore, one of the challenges when quantifying the model is to correctly estimate the effect of children on income. If households who are more productive are more likely to have kids, we would quantify the wrong income effect of having kids. This is problematic because when we perform the counterfactual we would like to predict how the income of individuals changes causally with fertility.

We proceed in two steps. First, we assign households a skill based on their income. We divide households into 10 income bins within age bins. Second, we estimate the child penalty of having young children in the household which we allow to vary by skill level. Third, we subtract the estimated child penalty from the income of households with young children.

In order to estimate the child penalty, we compare how the gap between men and women within the same household varies with the presence of young kids. We limit attention to young couples in order to avoid comparing households across age groups, as well as selection into delayed childbearing. In other words, we use men within the household as a control group for the effect on women's income. The assumption is that children do not impact men's earnings and that selection into fertility based on income is similar for men and women. If this is the case, comparing the gender difference in households with and without children will not suffer from a selection bias and will correctly reflect the impact of children on women's earnings. However, the estimate would still be biased if couples with a higher earnings gap are more likely to have children. Figure 7 plots the estimated child penalty by skill and year.

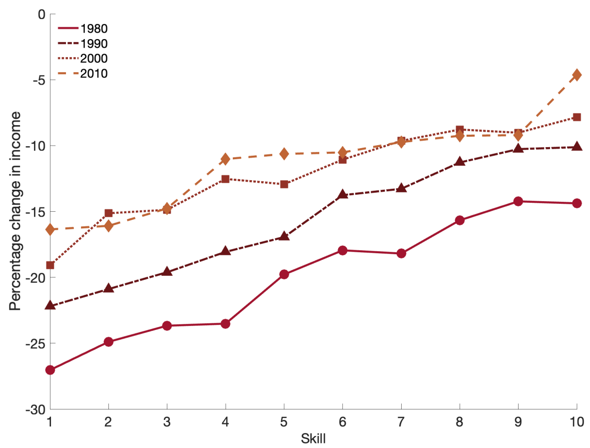


Figure 7: Child Penalty

Our approach is inspired by the estimation in Kleven et al. (2019) but we are limited by the lack of a panel dimension. However, the resulting estimates are similar in magnitude. They find that the long-term child penalty in the U.S is around 35% of women's income. Our estimates capture the effect on household's income for a 10 year period. We cannot use the estimates in Kleven et al. (2019) because we need across-skill variation.

4.2 Estimation

Calibrated parameters There is a set of parameters that we quantify externally following the literature. First, the utility parameters, that is, the Stone-Geary weight for housing and housing requirement, and the discount factor. Second, the probability of pregnancy success conditional on deciding to have children for mature couples. Finally, we calibrate the Fréchet shape for the idiosyncratic taste for location. The values of these parameters are included in table 7

Table 7: Externally quantified parameters

Parameter	Definition	Value	Source
α	Stone-Geary weight for housing	0.224	Eeckhout, et al. (2014)
$\underline{h}$	Stone-Geary housing requirement	\$1,440/year	Eeckhout, et al. (2014)
ϕ	Discount Factor	0.96	4% annual int. rate
ρ_m^a	Actual prob. have kids when mature	0.80	Rothman et al. (2013)
β	Fréchet parameter idiosyncratic taste for location	3	Couture et al. (2019)

Notes: This table includes the value of the parameters of the model that are estimated externally.

Estimation of downtown amenities. The only parameters left to estimate are the amenities for each age, kid's age, skill, and location, $\delta_t(a, k, z, l)$. First, we normalize the suburbs amenity for couples with no kids: $\delta_t(a, k = 0, z, s) = 1$. For a given β, the fraction of each group that lives in the city center allows us to estimate the difference in amenities between the center and the suburbs. Recall the probability of choosing center is:

$$\pi_t^{loc}(d|a,k,z) = \frac{x_t(a,k,z,d)^\beta \cdot \delta_t(a,k,z,d)^\beta}{x_t(a,k,z,d)^\beta \cdot \delta_t(a,k,z,d)^\beta + N_s x_t(a,k,z,s)^\beta \cdot \delta_t(a,k,z,s)^\beta}$$

Let $\Delta_l(a, k, z)$ denote the amenity ratio of downtown relative to the suburbs:

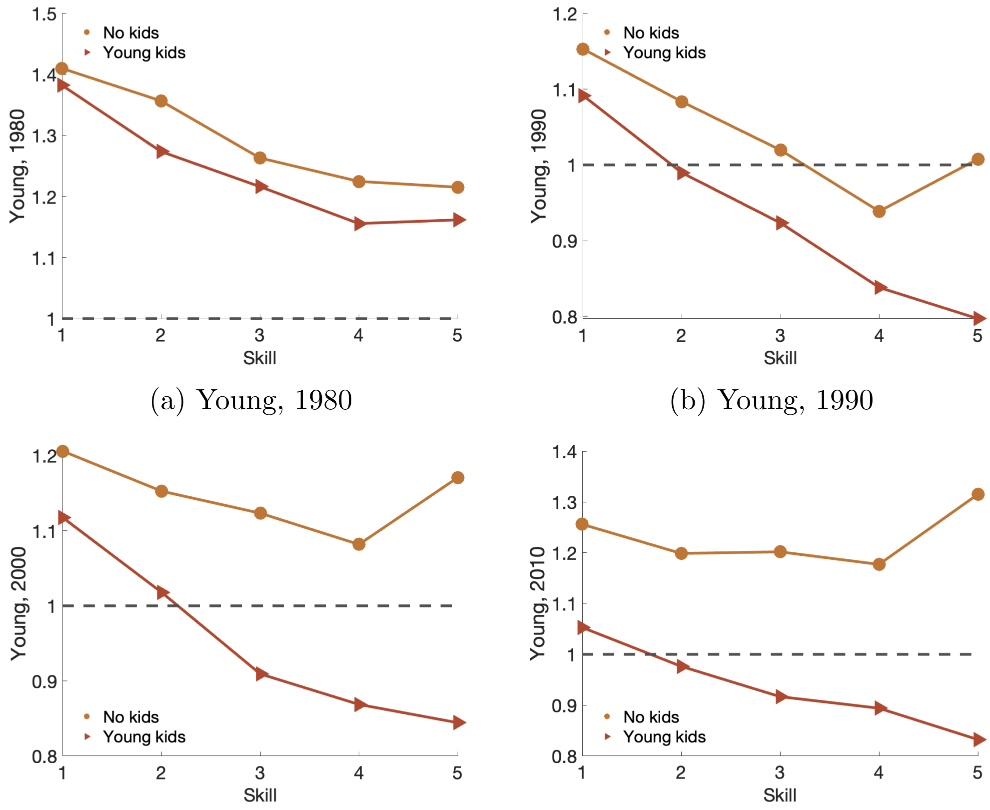
$$\Delta_l(a,k,z) \equiv \frac{\delta(a,k,z,d)}{\delta(a,k,z,s)}, \quad \forall a,k,z.$$

After some algebra, we have that the amenity downtown relative to the suburbs can be expressed as a function of the fraction of each group that chooses to live downtown, $\pi_d(a, k, z)$, which is observed in the data, the scale parameter of the distribution of taste for location, β_l, and the number of suburban locations, N_s.

$$\Delta_l (a, k, z) = \left(\frac{\pi_t^{loc} (d|a, k, z)}{\pi_t^{loc} (s|a, k, z)} \right)^{1/\beta} \cdot \frac{x (a, k, z, s)}{x (a, k, z, d)}$$

The most relevant amenities for our purposes are the estimated amenities of living downtown as compared to living in the suburbs (Δ_l) for young and mature individuals depending on whether they have children or not. Figures 8 and 9 display precisely these estimates for young and mature households respectively as function of their skill level and from 1980 to 2010, while Table 11 in the Appendix contains all estimates.

We can see that the estimated amenities are larger for individuals with no kids regardless of household's age or skill level in *all years*. That is, individuals with no kids had already a high valuation of downtown locations in 1980.

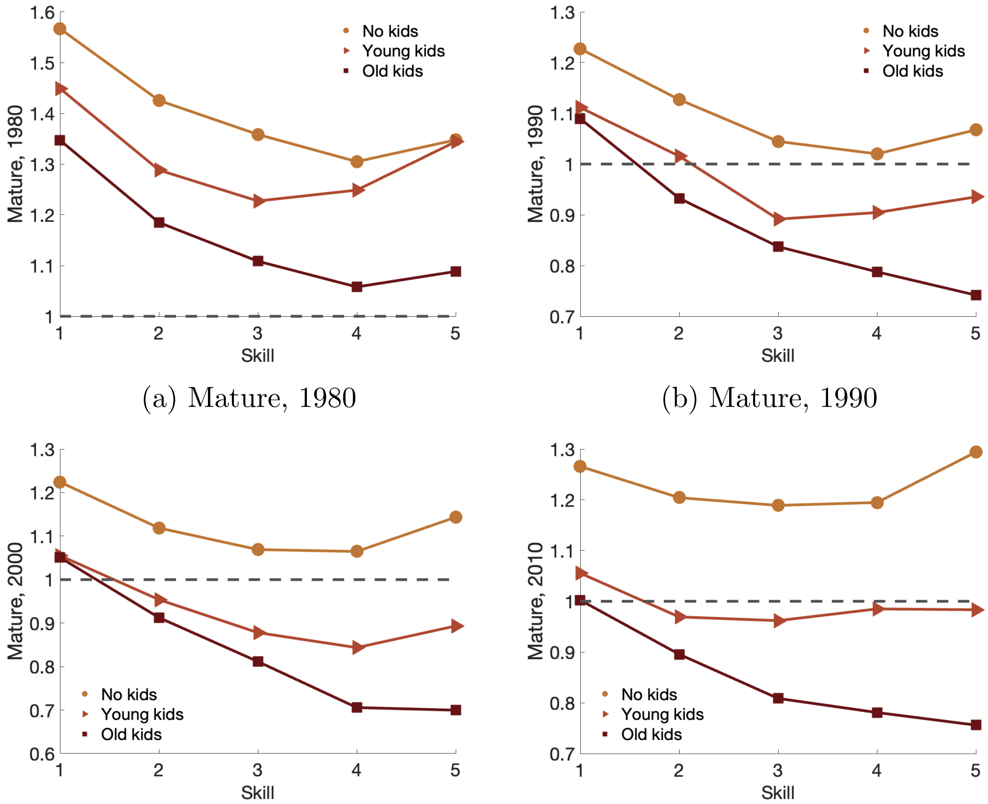


(a) Young, 1980 (b) Young, 1990

(c) Young, 2000 (d) Young, 2010

Figure 8: Estimated downtown amenities (relative to the suburbs) for young households

Notes: These graphs display the estimated amenity of living downtown as compared to living in the suburbs (Δ_l) for *young* households depending on their skill level. Each panel depicts these estimates for each available year.



(a) Mature, 1980

(b) Mature, 1990

(c) Mature, 2000

(d) Mature, 2010

Figure 9: Estimated downtown amenities (relative to the suburbs) for mature households

Notes: These graphs display the estimated amenity of living downtown as compared to living in the suburbs (Δ_l) for *mature* households depending on their skill level. Each panel depicts these estimates for each available year.

Estimation of children amenities. From the previous step, we can only compare the amenity of living downtown versus the suburbs for each demographic group but we cannot compare the amenity of, for example, living downtown with and without children. We estimate next the amenity of having children using the observed fraction of people of a given skill that have kids as young.

The estimation of children amenities depends on the price expectations of individuals up two periods ahead. For the years 1980 and 1990 we simply employ the observed housing prices, income and location amenities up to 2010. Starting in 2000 we need to mane an assumption on how households predict the future. We assume that income and amenities stay constant at their values in 2010. Housing prices take a few periods to arrive at a steady state. The path of housing prices affect household's fertility decisions and thus impact the estimation of children's amenities.

To estimate the equilibrium path of housing prices and amenities jointly we implement an iterative algorithm. We first assume that prices will be constant at the 2010 level. Given this price expectations, we obtain an estimate for amenities of having children based on households fertility choices. These estimated amenities will imply a new housing price path equilibrium. Given the new guess for housing price expectations, we re-estimate amenities in order to match the fertility choices in the data. We continue iterating over amenities and housing prices until the fertility outcomes match those in the data, the housing price path clears the market every period, and agents form expectations about the future using the correct housing prices.

Given a guess for the housing price equilibrium path, amenities are estimated as follows.[8]

Step 1. First, link fertility outcomes to the thresholds through β_η.

$$\begin{aligned}
\pi_t^{fert}(1,0,z) &= F_\eta\left(\bar{\eta}_{ky,km}^t(z)\right),\\
\pi_t^{fert}(2,1,z) &= \rho_m\left(F_\eta\left(\bar{\eta}_{ky,km}^{t-1}(z)\right) - F_\eta\left(\bar{\eta}_{km,nk}^{t-1}(z)\right)\right),\\
\pi_t^{fert}(2,2,z) &= 1 - F_\eta\left(\bar{\eta}_{ky,km}^{t-1}(z)\right),
\end{aligned}$$

Using the Fréchet distribution properties:

$$\begin{aligned}
\ln\left(-\ln(\pi_t^{fert}(1,0,z))\right) &= -\beta_\eta \ln \bar{\eta}_{ky,km}^t(z),\\
\ln\left(-\ln\left[1-\pi_t^{fert}(2,2,z) - \frac{1}{\rho_m}\pi_t^{fert}(2,1,z)\right]\right) &= -\beta_\eta \ln \bar{\eta}_{km,nk}^{t-1}(z)
\end{aligned}$$

Step 2. Find an expression of the thresholds as a function of the amenities and substitute the thresholds in the above equations. (Calculations below)

$$\begin{aligned}
\bar{\eta}_{km,nk}^t &= \frac{\tilde{\Phi}_{m,0,z} + \phi\tilde{\Phi}_{o,0,z}}{\tilde{\Phi}_{m,1,z} + \phi\tilde{\Phi}_{o,2,z}}\frac{1}{\delta(km,z,s)}\\
\bar{\eta}_{ky,km}^t &= \frac{\rho\left(\phi\tilde{\Phi}_{m,0,z} + \phi^2\tilde{\Phi}_{o,0,z}\right) - \left(\tilde{\Phi}_{y,0,z} + \phi\tilde{\Phi}_{m,0,z}\right)}{\rho\delta(km,z,s)\left(\phi\tilde{\Phi}_{m,1,z} + \phi^2\tilde{\Phi}_{o,2,z}\right) - \delta(ky,z,s)\left(\tilde{\Phi}_{y,1,z} + \phi\tilde{\Phi}_{m,2,z}\right)},
\end{aligned}$$

where we have assumed that:

$$\begin{aligned}
\delta(y,1,z,s) = \delta(m,2,z,s) &\equiv \delta(ky,z,s)\\
\delta(m,1,z,s) = \delta(o,2,z,s) &\equiv \delta(km,z,s)
\end{aligned}$$

[8] A more detailed description of how amenities are estimated can be found in the Appendix.

and where $\tilde{\Phi}_{a,k,z} \equiv \left(x\left(a,k,z,c\right)^{\beta_\varepsilon} \left(\Delta_l(a,k,z)\right)^{\beta_\varepsilon} + N_s x\left(a,k,z,s\right)^{\beta_\varepsilon} \right)^{1/\beta_\varepsilon} \Gamma\left(1-\frac{1}{\beta_\varepsilon}\right)$ can be treated as data since it is a combination of the calibrated parameters β_ε and N_s, the previous estimation step, $\Delta_l(a,k,z)$, and the income and housing price data $x(a,k,z,l) = \Gamma \frac{I(a,k,z)}{p_l^\alpha}$, and Γ is the Gamma function: $\Gamma\left(n\right) = \left(n-1\right)!$.

Step 3. Get the amenity of mature by running the following regression. We have to assume that the amenity is uncorrelated with the observable incentives.

$$\ln\left(-\ln\left[1-\pi_t^{fert}\left(2,2,z\right) - \frac{\pi_t^{fert}\left(2,1,z\right)}{\rho_m}\right]\right) = -\beta_\eta \ln\left(\frac{\tilde{\Phi}_{m,0,z}+\phi\tilde{\Phi}_{o,0,z}}{\tilde{\Phi}_{m,1,z}+\phi\tilde{\Phi}_{o,2,z}}\right) + \beta_\eta \ln\delta\left(km,z,s\right)$$

In essence, we regress a logarithmic transformation of the probability that an individual chose to not have children on the log of the ratio of the incentives of not having children relative to having children mature. The residuals can then be interpreted as the amenity of having children mature. The coefficient β_η captures how the probability of not wanting children responds to the incentives of not have children. The identification assumption is that the amenity of having children mature in not correlated with the economic incentives. The amenity parameter will thus capture everything is that is not correlated with this economic incentives.

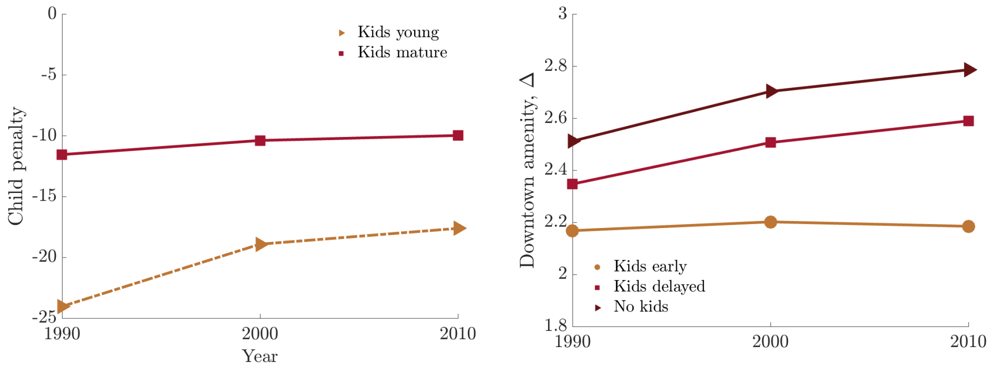
Finally, once we have β_η, we find $\delta_{km,s}(z)$ and $\delta_{ky,s}(z)$ that perfectly replicate the observed fertility outcomes in the population.

5 Counterfactual Delay in Childbearing

In this section, we perform a series of counterfactual exercises to quantify how much of the observed urban revival can be generated by changes in fertility and fertility timing. The first step is to identify the forces in the model that lead to delayed childbearing. There are three forces in the model that lead to changes in fertility: economic incentives, downtown amenities, and tastes over parenthood. We explore each of them in turn.

Child penalty and delay premium An important reason why households delay childbearing is due to income incentives. Delaying children can help alleviate the child penalty. Figure 10a plots the lifetime child penalty of households that are born in each decade, depending on whether they have children early or late in life. Having children later is associates with a smaller (closer to zero) child penalty. Thus, generating an incentive for households to delay. However, notice that this incentive does not seem to have gotten larger with time and thus is unlikely to explain the increased delay in childbearing.

Downtown amenities Another reason to delay childbearing is the effect of children on downtown amenities. Once a household has children their valuation of downtown amenities changes. Figure 10b plots the lifetime downtown amenity that households being born in each decade would get if they decided to live downtown depending on whether they do not have children, have children early, or late in life. Downtown has become more attractive with time but only for households having no children or having children late in life. This may have been an important reason for the increased delay. It is also possible that part of this change was due to the endogenous reaction of downtown amenities due to changes in fertility composition.



(a) Delay premium (b) Downtown amenities

Taste for delayed parenthood The third reason why household may delay childbearing is because they may enjoy a different utility from having children early relative to later. In the model, we have allowed that households derive a different utility from having children early $\kappa_y(z)$, and late $\kappa_m(z)$. This parameter captures all the unobserved components of utility that are common across households. It captures the difference between unobserved benefits and costs. Figure 11 plots the relative estimated taste for children as mature relative to young, $\kappa_m(z)/\kappa_y(z)$.

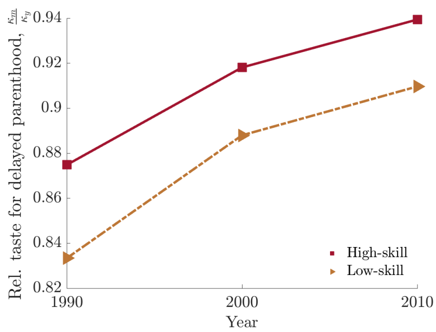


Figure 11: Preference for delayed childbearing

The relative preference takes values lower than 1, indicating than in general households tend to prefer to have children when young. However, this preference has changed, becoming more favorable to having children later in life. The relative preference for having children mature increased from 1980 to 2010. This increase can be related both to decrease benefits as increased costs. For instance, it could capture the opportunity cost of time in having children, medical improvements, better information on the possible risks of delaying maternity, and ways to reduce them, as well as social norms and stigma associated to having kids as mature.

5.1 The effect on urban revival of preferences towards delayed parenthood

The main counterfactual exercise sets the taste for having children constant at 1990 and compute the counterfactual urban revival. Our preferred measure for urban revival is the difference in income growth between downtown and the suburbs in the following way,

$$\frac{I_t\,(\text{downtown}) - I_{t-1}\,(\text{downtown})}{I_{t-1}\,(\text{downtown})} - \frac{I_t\,(\text{suburbs}) - I_{t-1}\,(\text{suburbs})}{I_{t-1}\,(\text{suburbs})},$$

where $I_t(l)$ denotes the average income in location l at time t.

Figure 12 shows the main result of this counterfactual scenario. This figure displays income growth differences between downtown and the suburbs each period in the data and in the counterfactual scenario in which the incentives to postpone childbearing are lower. As expected, income growth downtown relative to the suburbs would have been lower in the absence of increased amenity incentives to postpone maternity. The increase in delay incentives can explain 1 percentage points of the difference in income growth rates from 2000 to 2010 between downtown and suburb. These represent 20.6 percent of the total difference in income growth rates.

In order to understand how these differences arise, we need to (i) assess the impact of a change in the incentives to postpone maternity on fertility choices; (ii) study how household location choices change with parenthood; and (iii) show how the impact of the counterfactual varies along the skill distribution.

Changes in fertility choices Figure 13 displays the fraction of individuals that have children as young (panel (a)) and as mature (panel(b)) both in the data and in the counterfactual. We can see that in the counterfactual the fraction of young couples that have children increases while the fraction of mature couples that have children that period decreases. This means that keeping the taste for children as in 1990 induces couples to have children earlier. Furthermore, given that delayed childbearing has been more common in recent times, the effect of the counterfactual is the largest in 2010.

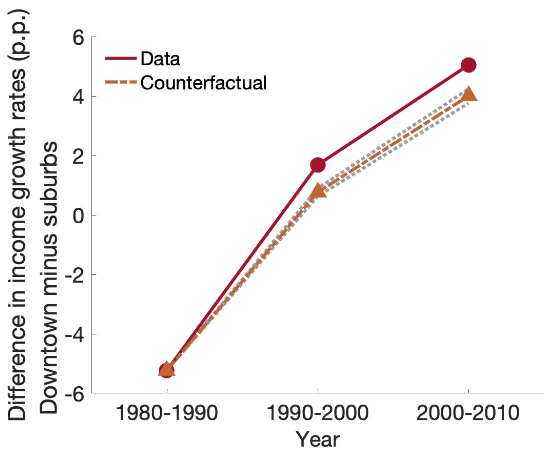
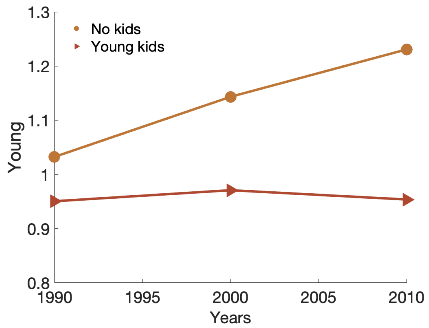


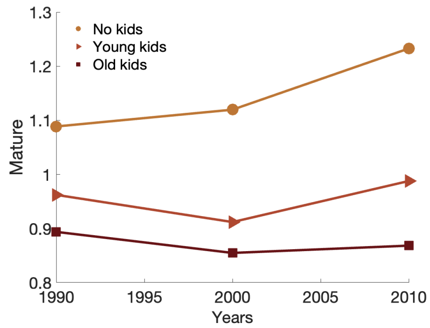
Figure 12: Income growth differences in downtown and the suburbs

Notes: This figure shows the difference in income growth between the downtown and the suburbs in the data and in the counterfactual exercise from period to period. The grey lines represent the 95% confidence interval on the β_η parameter.

Location choices by parenthood In Figure 15, we show that couples without children derive a higher amenity from living downtown than couples with children. The graph displays the downtown amenity premium for couples with and without children. The differences have been widening over time, both for young and mature people, which may be the result of amenities downtown and in the suburbs catering towards couples without and with children, respectively.



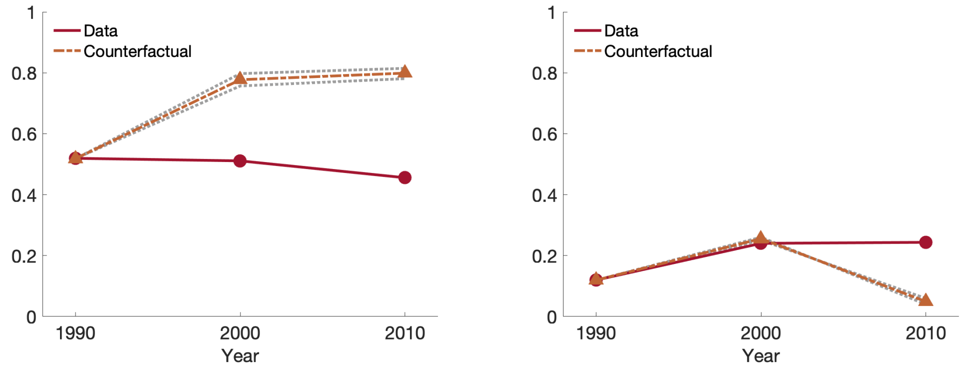
(a) Young



(b) Mature

Figure 15: Downtown premium, Δ_d

Notes: This figure shows the difference in the fraction of households that locate downtown for a given each group depending on whether the household has children or not. This difference is calculated as the probability of locating downtown for couples of a given age group that do not have children minus the probability of locating downtown for couples of the same age group that do have children. We calculate this probabilities using the data.

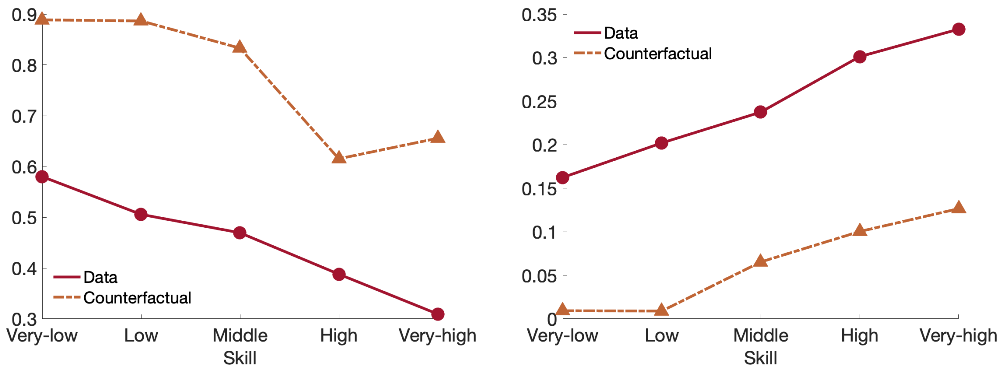


(a) Young households (b) Mature households

Figure 13: Fraction of households with young kids

Notes: These graphs show the fraction of young (panel (a)) and mature (panel(b)) couples that have children that period in the data and in the counterfactual scenario from 1980 to 2010.

Heterogeneity by skill Incentives to delay maternity are greater among high-skilled women (Adda et al., 2017), therefore, we expect that high-skilled households respond more strongly to an increase in the risk from postponing childbearing. In Figure 17, we plot the fraction of individuals that have children as young (panel(a)) and as mature (panel(b)) for different skill levels both in the data and in the counterfactual scenario. For ease of exposition, we restrict our attention to the year 2010, but the picture is similar in other years.[9] We can see that the counterfactual results in a lower fraction of households postponing childbearing and that this fraction increases with skill.



(a) Young (b) Mature

Figure 17: Changes in fertility choices by skill in 2010

Notes: These graphs show the fraction of young (panel (a)) and mature (panel(b)) couples that have children that period for different skill levels in the data and in the counterfactual scenario for the year 2010.

[9] Figures **??** and **??** in the Appendix shows the same picture for other years.

Therefore, we have shown in this section that (1) an increase in the risk of postponing childbearing results in an increase in the fraction of households that have children when they are young; (2) this increase is larger for high-skilled households that for less skilled households; and (3) households with children are less likely to locate downtown than those without children. Overall, this means that high-skilled households that would have postponed the arrival of children and stayed in the center if the perceived probability of having a successful pregnancy had remained high, now have children when they are young and move to the suburbs. As a result, income growth downtown relative to the suburbs slows down as compared to what has been observed in the data.

6 Conclusions

In the US, forming a family and having kids is associated with couples moving to the suburbs, where housing is larger and schools are better. However, more and more, young couples are choosing to postpone both fertility and the move to the suburbs. This has been made possible by medical advances in infertility treatments that allow couples to delay childbirth into the 30s without much risk. As couples stay downtown longer, precisely at a time when their incomes are growing fast, they increase the demand for amenities such as bars, movie theaters, and restaurants. This paper provides causal evidence of the importance of delaying fertility on urban revival by exploiting state-level variation in the enactment of policies that essentially decreased the cost of delaying maternity. We find that these policies had a direct and statistically significant effect on the income growth of downtown vs. the suburbs which took place in parallel with a demographic change in the city center consistent with postponing the arrival of children and suburban life. In addition, we provide some evidence of some characteristics that may lead to the high cost of remaining downtown after having children: housing sizes and school quality.

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A Appendix

Heterogeneity in infertility insurance mandates

Table 8 lists all states that have enacted mandates affecting the insurance of ART procedures over the five decades covering our census samples (1970-2010) and summarises their main features.

Table 8: States with mandated infertility insurance

State	**Date enacted**	**Mandate to cover**	**Mandate to offer**	**IVF coverage**
Arkansas	1987	X		X
California	1989		X	
Connecticut	1989	X		X
Hawaii	1987	X		X
Illinois	1991	X		X
Louisiana	2001	X		
Maryland	1985	X		X
Massachusetts	1987	X		X
Montana	1987	X		
New Jersey	2001	X		X
New York	1990	X		
Ohio	1991	X		X
Rhode Island	1989	X		X
Texas	1987		X	X
West Virginia	1977	X		

Notes: This table summarizes the main features of acts mandating infertility insurance in all states that ever passed a mandate of this type.

Impact of infertility insurance mandates on gentrification

Table 9 shows that our results are robust to the inclusion of several control variables: (log) income of the city, the share of jobs within 3 miles distance from the neighborhood, (log) population of the city, and the share of college graduates in the city.

Table 9: The effect of infertility insurance mandates on gentrification

	Prov. above median	(log) Avg Income	% College Graduate
	(1)	(2)	(3)
Center	-0.520***	-0.563***	-0.002
	(0.014)	(0.011)	(0.003)
Treated × Center × Post	0.054**	0.055***	0.037***
	(0.024)	(0.019)	(0.006)
(log) City Pop.	-0.019	0.014	0.020***
	(0.021)	(0.017)	(0.005)
% College Graduates in City	-0.085	0.082	0.919***
	(0.267)	(0.214)	(0.063)
(log) City Median Income	-0.066**	0.854***	0.105***
	(0.028)	(0.022)	(0.006)
Year FE	Yes	Yes	Yes
City FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes
City Trends	No	No	No
R-squared	0.081	0.778	0.252
Observations	74246	74246	74246

Notes: This table displays the impact of infertility insurance mandates on several measures of gentrification: (1) the probability that a census tract's income is above median income in the city; (2) the census tract's (log) median income; and (3) the percentage of college graduates in a census tract. This table reports only selected coefficients, the full specification can be found in equation 1. Standard errors in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$.

Table 10 shows that our results are robust in the absence of city trends.

Table 10: The effect of infertility insurance mandates on gentrification

	Prov. above median	(log) Avg Income	% College Graduate
	(1)	(2)	(3)
Center	-0.520***	-0.570***	-0.001
	(0.014)	(0.011)	(0.003)
Treated × Center × Post	0.054**	0.046**	0.039***
	(0.024)	(0.019)	(0.006)
Year FE	Yes	Yes	Yes
City FE	Yes	Yes	Yes
Controls	No	No	No
City Trends	No	No	No
R-squared	0.081	0.773	0.245
Observations	74246	74246	74246

Notes: This table displays the impact of infertility insurance mandates on several measures of gentrification: (1) the probability that a census tract's income is above median income in the city; (2) the census tract's (log) median income; and (3) the percentage of college graduates in a census tract. This table reports only selected coefficients, the full specification can be found in equation 1 except for the fact that city trends have not been included. Standard errors in parentheses. $*p < 0.10, **p < 0.05, ***p < 0.01$.

A.1 Estimation of amenities

In this section we describe in detail the procedure for estimating amenities given a guess for the housing price equilibrium path. The first step is to back out the thresholds $\bar{\varepsilon}_{ky,km}$ and $\bar{\varepsilon}_{km,nk}$ from the observed fertility timing choices.

Recall that the fraction of people that have kids as young π_{ky}, as mature, π_{km}, and that do not to have kids π_{nk}, are given by:

$$\pi_{ky}(z) = 1 - F(\bar{\varepsilon}_{ky,km}(z)),$$
$$\pi_{km}(z) = \rho_m(F(\bar{\varepsilon}_{ky,km}(z)) - F(\bar{\varepsilon}_{km,nk}(z))),$$
$$\pi_{nk}(z) = F(\bar{\varepsilon}_{km,nk}(z)) + (1-\rho_m)(F(\bar{\varepsilon}_{ky,km}(z)) - F(\bar{\varepsilon}_{km,nk}(z))),$$

where F is the distribution of idiosyncratic preferences for children and it is assumed to be a Gumbel distribution with scale parameter β_k Thus, there are two thresholds and two equations.[10] Given the observed choices $\pi_{ky}(z)$, $\pi_{km}(z)$, and $\pi_{nk}(z)$ and probability of having a successful pregnancy as mature, ρ_m, it is straightforward to back out the thresholds $\bar{\varepsilon}_{ky,km}(z)$, and $\bar{\varepsilon}_{km,nk}(z)$, as a function of skill, z, from these system of equations.

[10]Notice that one equation is colinear, since $1 = \pi_{ky} + \pi_{km} + \pi_{nk}$

Next, we write the amenities to be estimated as a function of the thresholds. Recall the thresholds are given by:

$$\begin{aligned}
\bar{\varepsilon}_{ky,km}(z) =& \frac{\rho_m v^*_{km}(z) + (1-\rho_m) v^*_n(z) - v^*_{ky}(z)}{1-\phi\rho_m}, \\
\bar{\varepsilon}_{ky,nk}(z) =& v^*_{nk}(z) - v^*_{ky}(z), \\
\bar{\varepsilon}_{km,nk}(z) =& \frac{v^*_{nk}(z) - v^*_{km}(z)}{\phi},
\end{aligned}$$

where,

$$\begin{aligned}
v^*_{ky}(z) &= v^*(y, k=1, z; p_{l,t}) + \phi v^*(m, k=2, z; p_{l,t+1}) + \phi^2 v^*(o, k=0, z; p_{l,t+2}) \\
v^*_{km}(z) &= v^*(y, k=0, z; p_{l,t}) + \phi v^*(m, k=1, z, p_{l,t+1}) + \phi^2 v^*(o, k=2, z p_{l,t+2}) \\
v^*_{nk}(z) &= v^*(y, k=0, z; p_{l,t}) + \phi v^*(m, k=0, z; p_{l,t+1}) + \phi^2 v^*(o, k=0, z p_{l,t+2})
\end{aligned}$$

The first step is to characterize the expected period utility, $v^*(y,k,z)$ for a given age, age of kids, and skill before the agents know their location idiosyncratic taste. The distributional assumption on the idiosyncratic preference for location implies that the optimal utility $v^*(a,k,z)$ is distributed Gumbel with parameters $\mu = \Phi_{a,k,z}$ and β_l. From the properties of the Gumbel we know the expectation is $\mu + \beta_l\gamma = \Phi_{a,k,z} + \beta\gamma$, where $\gamma \approx 0.58$ is the Euler-Mascheroni constant. Therefore, we can write:

$$\begin{aligned}
v^*(a,k,z;p_l) &= E_{\varepsilon_l} \max_l \left\{ v(a,l,k;p_l) + \varepsilon^i_l \right\} \\
&= \beta_l \log\left(\sum_l \exp\left\{ \frac{x(a,k,z,l;p_l) + \delta(a,k,z,l)}{\beta_l} \right\} \right) + \beta_l\gamma \\
&= \delta(a,k,z,s) + \tilde{\Phi}_{a,k,z} + \beta_l\gamma
\end{aligned}$$

where $\tilde{\Phi}_{a,k,z} = \beta_l \log\left(\exp\left\{ \frac{1}{\beta_l}\left(x(a,k,z,d;p_l) + \Delta_l(a,k,z)\right)\right\} + N_s \exp\left\{\frac{1}{\beta_l}\left(x(a,k,z,s;p_l)\right)\right\}\right)$ can be treated as data at this point since it is a combination of the calibrated parameters β_l and N_s, the previous estimation step, $\Delta_l(a,k,z)$, and the income and housing price data $x(a,k,z,l;p_l) = \Gamma\frac{I(a,k,z,l)}{p_l^\alpha}$.

Now we can re-write the expected utility of each fertility timing choice as:

$$\begin{aligned}
v^*_{ky}(z) &= \delta(y,1,z,s) + \tilde{\Phi}_{y,1,z} + \phi\left(\delta(m,2,z,s) + \tilde{\Phi}_{m,2,z}\right) + \phi^2\left(\delta(o,0,z,s) + \tilde{\Phi}_{o,0,z}\right) + \Psi, \\
v^*_{km}(z) &= \delta(y,0,z,s) + \tilde{\Phi}_{y,0,z} + \phi\left(\delta(m,1,z,s) + \tilde{\Phi}_{m,1,z}\right) + \phi^2\left(\delta(o,2,z,s) + \tilde{\Phi}_{o,2,z}\right) + \Psi, \\
v^*_{nk}(z) &= \delta(y,0,z,s) + \tilde{\Phi}_{y,0,z} + \phi\left(\delta(m,0,z,s) + \tilde{\Phi}_{m,0,z}\right) + \phi^2\left(\delta(o,0,z,s) + \tilde{\Phi}_{o,0,z}\right) + \Psi,
\end{aligned}$$

where $\Psi = (1 + \phi + \phi^2)\, \beta\gamma$.

Now, we can substitute them into the equation for the thresholds. First, we employ the threshold of indifference between having no kids and having kids as mature $\bar{\varepsilon}_{km,nk}$:

$$
\begin{aligned}
\bar{\varepsilon}_{km,nk}(z) =& \frac{1}{\phi}\left(v^*_{nk}(z) - v^*_{km}(z)\right) \\
=& \delta(m,0,z,s) - \delta(m,1,z,s) + \tilde{\Phi}_{m,0,z} - \tilde{\Phi}_{m,1,z} \\
&+ \phi\left(\delta(o,0,z,s) - \delta(o,2,z,s) + \tilde{\Phi}_{o,0,z} - \tilde{\Phi}_{o,2,z}\right)
\end{aligned}
$$

If we normalize utility to the amenity from living in the suburbs for individuals without children, that is, $\delta(a,0,z,s) = 0$,[11] for each age and skill group, then:

$$
\begin{aligned}
\bar{\varepsilon}_{km,nk}(z) =& \frac{1}{\phi}\left(v^*_{nk}(z) - v^*_{km}(z)\right) \\
=& \tilde{\Phi}_{m,0,z} - \tilde{\Phi}_{m,1,z} + \phi\left(\tilde{\Phi}_{o,0,z} - \tilde{\Phi}_{o,2,z}\right) - \delta(m,1,z,s) - \phi\delta(o,2,z,s).
\end{aligned}
$$

Let $\delta^{LT}_k(m,z,s) = \delta(m,1,z,s) + \phi\delta(o,2,z,s)$ denote the lifetime utility of having kids in the suburbs when mature.

$$
\delta^{LT}_k(m,z,s) = \tilde{\Phi}_{m,0,z} - \tilde{\Phi}_{m,1,z} + \phi\left(\tilde{\Phi}_{o,0,z} - \tilde{\Phi}_{o,2,z}\right) - \bar{\varepsilon}_{km,nk}(z).
$$

Therefore, the threshold of indifference between having no kids and having kids as mature allows us to estimate the lifetime utility of having kids in the suburbs, relative to no having kids in the suburbs, which we normalized to zero for every age and skill group.

Next, from the threshold of indifference between having kids as young and having kids as mature:

$$
\begin{aligned}
(1 - \phi\rho_m)\,\bar{\varepsilon}_{ky,km}(z) =& \rho_m v^*_{km}(z) + (1-\rho_m)\, v^*_{nk}(z) - v^*_{ky}(z) \\
=& \phi\rho_m \delta^{LT}_k(m,z,s) - \delta^{LT}_k(y,z,s) + \tilde{\Phi}_{y,0,z} - \tilde{\Phi}_{y,1,z} \\
&+ \phi\left(\rho_m\left(\tilde{\Phi}_{m,1,z}\right) + (1-\rho_m)\,\tilde{\Phi}_{m,0,z} - \tilde{\Phi}_{m,2,z}\right) \\
&+ \phi^2\rho_m\left(\tilde{\Phi}_{o,2,z} - \tilde{\Phi}_{o,0,z}\right)
\end{aligned}
$$

where $\delta^{LT}_k(y,z,s) = \delta(y,1,z,s) + \phi\delta(m,2,z,s)$.

[11] This assumption is necessary because it is not possible to compare utility for different age and skill groups.

Let's define operator $\Delta_{k,k'}\tilde{\Phi}_{a,z} = \tilde{\Phi}_{a,k,z} - \tilde{\Phi}_{a,k',z}$ to re-write the expression as:

$$\begin{aligned}(1-\phi\rho_m)\,\bar{\varepsilon}_{ky,km}(z) = \phi\rho_m\delta_k^{LT}(m,z,s) - \delta_k^{LT}(y,z,s) - \Delta_{1,0}\tilde{\Phi}_{y,z} \\ + \phi\left(\rho_m\Delta_{1,0}\tilde{\Phi}_{m,z} - \Delta_{2,0}\tilde{\Phi}_{m,z}\right) + \phi^2\rho_m\left(\Delta_{2,0}\tilde{\Phi}_{o,z}\right)\end{aligned}$$

Then we can solve for the lifetime utility of having children as young in the suburbs relative to the lifetime utility of not having kids and living in the suburbs:

First, let's use the operator to re-write the expresion for the lifetime utility of having kids in the suburbs as mature:

$$\bar{\varepsilon}_{km,nk} = \Delta_{0,1}\tilde{\Phi}_m + \phi\Delta_{0,2}\tilde{\Phi}_o - \delta_k^{LT}(m,s)\,,$$

and use this to re-write the lifetime utility of having kids as young in the suburbs relative to living in the suburbs with no kids:

$$\delta_k^{LT}(y,s,z) = \Delta_{0,1}\tilde{\Phi}_{y,z} + \phi\Delta_{0,2}\tilde{\Phi}_{m,z} - \phi\rho_m\bar{\varepsilon}_{km,nk}(z) - (1-\phi\rho_m)\,\bar{\varepsilon}_{ky,km}(z)\,.$$

Estimated amenities

Table 11 presents the estimates of the amenities of living downtown relative to living in the suburbs from 1980 to 2000.

Table 11: Amenity at center relative to suburbs, $\Delta_l\left(a, k, s\right)$

	1980						
	No kids			Young kids		Old kids	
	Young	Mature	Old	Young	Mature	Mature	Old
Very low skill	0.1316	0.2308	-0.0102	-0.0321	0.1436	-0.0075	0.0532
Low skill	0.1781	0.1312	-0.0019	0.0314	-0.1068	-0.0461	0.0532
Middle skill	0.0498	0.1507	-0.0647	-0.0353	-0.0562	-0.1604	-0.0088
High skill	0.1083	0.1143	-0.1209	-0.0562	0.0072	-0.1792	-0.0605
Very high skill	0.0172	0.0815	-0.1359	-0.0909	-0.0147	-0.2030	-0.0946

	1990						
	No kids			Young kids		Old kids	
	Young	Mature	Old	Young	Mature	Mature	Old
Very low skill	0.2143	0.2513	-0.0255	0.0741	0.1864	0.0328	0.0823
Low skill	0.2337	0.2547	0.0071	0.0975	0.0750	0.0564	0.0813
Middle skill	0.1598	0.2083	-0.0787	-0.0236	0.0056	0.0180	-0.0095
High skill	0.0894	0.2188	-0.1411	-0.0623	-0.0087	-0.0747	-0.0692
Very high skill	0.1860	0.2595	-0.0874	-0.1255	0.0459	-0.1365	-0.0645

	2000						
	No kids			Young kids		Old kids	
	Young	Mature	Old	Young	Mature	Mature	Old
Very low skill	0.3377	0.3073	0.1982	0.2362	0.1810	0.1273	0.1357
Low skill	0.1100	0.1543	0.0811	0.0829	-0.1911	0.0538	-0.1205
Middle skill	0.1038	0.1726	-0.0281	-0.0025	-0.1674	-0.0367	-0.1803
High skill	0.2766	0.2519	-0.0637	-0.0630	-0.0839	-0.1662	-0.1918
Very high skill	0.1094	0.1840	0.1148	-0.2172	-0.1402	-0.2033	-0.0781

	2010						
	Young	Mature	Old	Young	Mature	Mature	Old
Very low skill	0.3579	0.2744	0.3307	0.1811	0.1860	0.0971	0.0102
Low skill	-0.0687	0.0003	0.2782	-0.1720	-0.5331	-0.1880	-0.6817
Middle skill	0.0032	-0.0291	0.0735	-0.1913	-0.5771	-0.2183	-0.4668
High skill	0.0278	0.0639	0.0214	-0.2164	-0.3879	-0.2075	-0.3282
Very high skill	0.0676	0.1993	0.3008	-0.4493	-0.1743	-0.4848	-0.3090