Sex and the Single Girl: The Role of Culture in Contraception Demand*

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Abstract

Historical out-of-wedlock fertility is shown to affect demand for the birth control pill in the years following its introduction in Sweden. A model of premarital sex is developed where social sanctions play a prominent role. The model has implications for how social forces influence unwed birth rates and demand for new contraceptive technologies. Using unique data on contraceptive sales we find that communities with higher out-of-wedlock birth rates at the turn of the century have higher demand for the pill six decades later, consistent with model predictions. The strong positive relationship between pill demand and historical illegitimacy is robust to controlling for contemporaneous economic, demographic, and epidemiological factors as well as historical measures and unobserved community characteristics. We find evidence that variation from the turn of the century, not contemporary differences in illegitimacy. Instrumented regressions affirm that the relationship is causal.

JEL Codes: J13, N3, O33, Z10
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*_Sex and the Single Girl_ was the title of Helen Gurley Brown's 1962 advice book translated into Swedish in 1966 and published under the title _Sexrecept för en ensam flicka_.

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1 Introduction

Social constraints on individuals' reproductive decisions were particularly strong throughout nineteenth and early twentieth-century Sweden. Low (1990) described the setting, "Nineteenth-century Sweden represents an extreme of societal constraints on people's reproduction: highly monogamous, little remarriage, essentially no divorce, and a low rate of illegitimacy." Though strong, social constraints were not uniform. Illegitimacy, marriage and fertility behavior differed dramatically across Swedish communities at the turn of the century, a fact that had been observed since the first population statistics were collected.[1] These differences were the basis of demographic divisions of Sweden into distinct demographic regions depicted in figure 1. More than historical novelty, these patterns are prescient predictors of demand for the birth control pill when introduced in Sweden more than a half century later; illegitimacy patterns from the turn of the century can account for a full quarter of the differences in demand for the pill across Sweden in the decade after it is introduced.[2][3]

In order to illustrate why historical nonmarital fertility rates may be so closely correlated with demand for new contraceptive technologies a model of demand for premarital sex and contraception is developed. Demand for pre-

[1] The most detailed review of the fertility patterns of 19th and early 20th century Sweden is provided by Gustav Sundbärg as part of his contribution to the extensive Swedish emigration investigation of 1907-1914.

[2] Including the other historical factors considered here, in addition to out-of-wedlock births, can explain over half of the differences in pill demand captured by market level fixed effects.

[3] See Chapter 8 in Low (2000) for several examples of this as well as Low and Clarke (1992) and Low (1990). Sundin and Soderlund (1977) have edited a volume with many detailed demographic studies of 19th Century Sweden. An interesting summary of general trends in fertility by Gigi Santow (1995) makes some reference to the particular case of Sweden. The most detailed review of the fertility patterns of 19th and early 20th century Sweden is provided by Gustav Sundbärg as part of his contribution to the extensive Swedish emigration investigation of 1907-1914.

marital sex is a function of social sanctions, an equilibrium outcome. The facets of culture that play a prominent role in the model are similar to the explanation for the divergent illegitimacy patterns proposed by Gustav Sundbärg (1910), the father of Swedish population statistics, who argued that inherited characteristics, persistent across generations and within communities, drove differences in nonmarital fertility; Sundbärg coined the phrase "public mood" to refer to these characteristics.[4] In keeping with Guiso, Sapienza and Zingales (2006) definition of culture as "those customary beliefs and values that ethnic, religious, and social groups transmit fairly unchanged from generation to generation," Sundbärg's extensive studies suggest that culture may play an important role in the marriage and fertility decisions of Swedes. In turn, these same forces may also explain why women's demand for new contraceptive technologies is so closely related to the out-of-wedlock birth behavior of women from their grandmother's generation and before. The model captures how past illegitimacy may reflect differences in social constraints regarding nonmarital sex, moral acceptability and customs regarding contraception, or marriage conventions that persist over time. The stylized model illustrates a role for culture in contraception demand, but the detailed empirical analysis takes into account a variety of other forces such as the role of marriage market conditions and earnings opportunities to establishes a robust positive relationship between illegitimacy behavior in the past and contraceptive demand decades later. The results are consistent with culture playing an important role in women's contraceptive decisions.

[4] See Gustav Sundbårg's *Bevolkerungsstatistik Schwedens 1750-1900* as well as his volume *Emigrationsutredningen Bilaga V: Ekonomisk-statistisk beskrifning öfver Sveriges olika landsdelar.*

Norms about sex, marriage, and reproduction are difficult to elicit. Using historical measures of illegitimacy behavior to proxy for differences in culture is similar to Fernandez and Fogli (2006, 2009), who emphasize the impact of culture as a feature of the preference environment. Culture may also operate through social constraints on contraceptive practices and the strength of institutions that enforce promises of marriage among the young, in a manner similar to Akerlof, Yellen and Katz (1996) or Greenwood and Guner (2010). Theoretical and quantitative studies have emphasized the important interaction of culture and technology with regard to contraception; this paper is the first to investigate the topic empirically.

Demand for premarital sex is modeled as a function of social sanctions, an equilibrium outcome, and the expected cost of an out-of-wedlock birth, which depends on the likelihood of a pregnancy that does not result in marriage. Demand for an improved contraceptive technology depends on these same social forces. While the strength of community institutions and social sanctions against premarital sex are not directly observable, the model suggests that out-of-wedlock births are an appropriate proxy for these forces. The model, calibrated so that both social sanctions and the expected cost of an out-of-wedlock birth have similar weight in women's decisions, shows how historical out-of-wedlock births have a positive effect on demand for a new contraceptive technology. This relationship is born out in the data.

The empirical analysis accounts for a variety of current and past economic, demographic, marriage market, and epidemiological factors, as well as supply

side constraints that may affect observed demand for the pill. Even after taking such factors into account, we show that areas where nonmarital fertility was high at the turn of the century have higher demand for the pill when it is introduced six decades later. Persistent differences in social constraints regarding premarital sex, marriage, and contraception are consistent with the nonmarital fertility behavior observed in the data. Nonmarital fertility rates are highly correlated over time.[5]

Though persistent, out-of-wedlock birth rates are not constant. We use long run time variation in unwed birth rates within communities to estimate our model in differences. This allows us to account for the presence of unobserved local characteristics. We find that in places where cultures regarding sex and marriage became more liberal, represented by an increase in the rate of out-of-wedlock birth at the turn of the century, demand for the pill increased more rapidly. We find evidence that variations from the turn of the century, rather than more recent years, drive our results. An instrumental variables strategy is employed to identify exogneous variation in the supply of men to out-of-wedlock fatherhood. Changes in agricultural prices differentially shifted the absolute and relative wages at the low end of the earnings distribution for both men and women across Sweden in the late 19th and early 20th century as documented by Schultz (1985); according to Willis (1999) these wage fluctuations should affect the supply of men to out-of wedlock fatherhood. Our model predicts that

[5] The correlation between out-of-wedlock birth rates in 1900 and 1910 is 0.95, and for the period from 1900 to 1940 the correlation is 0.71. Highly persistent out-of-wedlock birth behavior is seen for other time periods, and well documented in the historical demography literature discussed in Section 2.

these prices changes will shift the equilibrium sanctions associated with engaging in nonmarital sex, the key variable behind the mechanism we study. The instrumental variable estimates are positive and highly significant; these results presents strong evidence that the estimated relationship is causal and that out-of-wedlock births have a persistent cultural component. All of the empirical results support the hypothesis that differences in cultures are persistent and affect demand for new contraceptive technologies.

The paper proceeds with a brief review of the related literature, the Swedish institutional setting, and important historical trends. Next, we develop a model of demand for premarital sex and use it to analyze the introduction of the pill. The unique data on pill demand that we use is described in the following section. The empirical framework and the main results are then presented. The final section concludes.

2 The Institutional and Historical Setting

2.1 Related Literature and the Institutional Setting

Many studies argue that increases in women's employment and education can be attributed in large part to innovations in contraception such as the birth control pill. The empirical analysis of Goldin and Katz (2002) supports this argument. Innovations in contraception shifted in the balance of power between women and men. A theoretical analysis of this is provided by Chiappori and Orrefice (2008). Orrefice (2007) shows how the pill, and other contraceptive

innovations, altered allocations between spouses. Contraceptive innovations affected customs in local marriage markets, in particular marriage in the case of pregnancy (shotgun marriages) and the incidence of out-of-wedlock birth, as examined in Akerlof, Yellen and Katz (1996). Greenwood and Guner (2010) analyze how the contraceptive revolution changed the cost of sex and attitudes toward premarital sex. Here we reverse the question and ask how differences in culture influence the take up of a new contraceptive technology.

Theoretical models of out-of-wedlock fertility fall into two camps. Akerlof, Yellen and Katz (1996) emphasize the role of local marriage market customs with regard to shotgun marriages, while Willis (1999) emphasizes the role of men's and women's absolute and relative earnings as the driving force behind trends in nonmarital fertility. Although Willis (1999) ignores the role of local institutions in his model he does argues that differences in the ability of communities to force men to share in the cost of children would raise the "supply price" of unmarried children and diminish the attractiveness of nonmarital relative to marital fatherhood, reducing the equilibrium share of children born out-of-wedlock.[6] Our model emphasizes the social constraints that influence out-of-wedlock childbearing such as the ability of communities to enforce marriage promises or income transfers between unmarried parents common in the theoretical literature. The instrumental variable approach we adopt is an application of Willis (1999) that builds on the empirical analysis of Schultz (1985).[7]

[6] The relative prices that drive the supply of men to unwed parenthood and equilibrium outcomes discussed in Willis (1999) will be discussed in relationship to the parameters of our model in Section 3.

[7] Schultz (1985) studied the importance of demand induced increases in women's agricultural wage rate as a source of a quarter of the reduction in marital fertility across Sweden

Empirical studies of the fertility transition have investigated the role of technological innovations in contraception, cultural factors, as well as changes in women's economic opportunities in explaining the decline in fertility throughout the west and in Sweden during the 19th and early 20th century. The quantitative importance of culture is echoed in the findings of Guinnane, Moehling, O'Grada's (2006) and Blau (1992) who study immigrants to the U.S. and find that home country differences in fertility have a significant effect on immigrants fertility decisions even after accounting for differences in observed characteristics.

The question we examine, the data we use, and the empirical strategy we adopt differ from previous work on culture, fertility and contraception. Our analysis closely complements recent papers on the role of culture in women's fertility and employment decisions such as Fernandez and Fogli (2006, 2009). While Fernandez and Fogli focus on observed fertility, demand for contraception is a closely related latent variable. The focus on contraception as a specific channel through which culture may influence fertility is unique.[8] Fernandez (2010) notes the dearth of studies on the interaction of culture and the economic and institutional environment with regard to contraception. Our instrumental variable results suggest that wage shocks not only affect current marriage and fertility patterns, but also have long run effects.

from 1860-1910.

[8] Fernandez and Fogli (2006 and 2009), and other papers on culture transmission such as Bisin and Verdier (2000 and 2001), emphasize the joint influence of culture as transmitted by parents (direct) and the communities in which women reside (oblique). We estimate the composite effect of both forces as proxied for by observed behavior of previous generations of women in a locality.

The institutional setting of this paper differs from Fernandez and Fogli (2006, 2009), and other studies of social norms such as Fernandez (2007) and Blau et al (2008), which analyze the behavior of second generation immigrants using measures of behavior in the parents' home country to proxy for norms. This approach addresses the challenge of separating cultural and institutional influences by looking at immigrants residing in an institutional setting unrelated to the cultural background of their parents. We avoid this challenge since the localities we study face the same legal, educational, medical, and retail drug market institutions.

The homogeneity of institutions in Sweden induced by the extensive regulatory environment is unprecedented. The assumption of uniform institutions is difficult to support in some settings, but in the context of Sweden this assumption is accurate in both the *de jure* and *de facto* sense. The laws regulating the sales of contraceptives do not differ by jurisdiction, and are set by national regulatory bodies. In addition, the medical and retail pharmaceutical sectors in Sweden are operated by public entities that are subject to uniform administration. Pharmacies offer the same assortment of contraceptive drugs, at the same prices, throughout the country. Private insurance is virtually non-existent during the period we study, so the prices set by the pharmacy monopoly reflect the cost faced by consumers.[9]

We study demand for contraceptives at the local level. Unique sales data from 70 local markets constitute the entire universe of oral contraceptive sales in

[9] This period largely predates the introduction of uniform subsidies on oral contraceptives available to all Swedish women. This universal subsidy was introduced in 1974 and discontinued in 1984.

Sweden. The period we study, 1970 through 1974, is the earliest for which data is available following the approval of oral contraceptives for use in Sweden.[10] This period predates changes in abortion access brought about by the Swedish Abortion Act of 1974. This act granted women access to abortions without the approval of a medical board or two physicians, as required during the period we study.[11] The period also predates the revision of sex education curriculum in 1975.[12,13]

Sweden's institutional setting is well suited for our analysis of how culture affects demand for the pill. The legal, medical, retail pharmaceutical, and educational institutions that played a role in the supply of the pill and related contraceptive information were all subject to uniform rules during the period we study. In this unique environment, where all of the salient institutional features are arguably constant, differences in sales of oral contraceptives are primarily driven by differences in demand.

This paper fills a void between empirical studies of the introduction of the pill in the U.S., which have largely ignored culture, theoretical contributions, such as Akerlof, Yellen and Katz (1996) and Willis (1999), and recent quantitative work by Greenwood and Guner (2010). Bailey (2006) and empirical studies which focus on the differential pattern of access to the pill across U.S. states rely

[10] In May of 1964 the Svenska medicinalstyrelsen approved the use of oral contraceptives in Sweden.

[11] Abortion data is only available at the national level. Linner (1967) describes the availability and use of abortions in Sweden.

[12] It should also be noted that advertising by pharmaceutical companies to consumers was prohibited.

[13] Since 1970, Swedish law has not distinguished between children born in and out-of-wedlock with regard to paternal inheritance rights, and changes in the marriage code that expanded the scope for civil marriages predate the periods we study.

on strong identifying assumptions; differences in legislative and legal outcomes cannot be correlated with local cultures and institutions. These assumptions preclude any evaluation of culture's role in contraception demand. We investigate empirically this largely ignored, though quantitatively important, social aspect of contraceptive demand.

2.2 A History of Contraception in Sweden

Differences in out-of-wedlock birth behavior have been a consistent feature of Swedish population statistics since the 1700s. Sundbärg (1910), attributed such differences to inherited characteristics, persistent across generations and within communities, and he proposed a division of Sweden into three demographic regions, shown in Figure 1.[14] Eli Heckscher (1949) argued that regional differences in urbanization rates led to the differential pattern of out-of-wedlock fertitlty, while Nils Wohlin (1915) argued that marital fertility patterns were the result of differences in land tenure systems.[15] According to the Swedish Population Commission, the most common form of birth control at the turn of the century was coitus interruptus, but abstinence and abortion also played a role.[16] Poor measurement was not the only reason for the lack of attention paid to the important role of contraception in explaining fertility patterns across Sweden. Wohlin regarded family planning as a sign of moral weakness and this view

[14] The figure is from Gustav Sundbårg (1910) *Emigrationsutredningen Bilaga V: Ekonomisk-statistisk beskrifning öfver Sveriges olika landsdelar.* To a lesser extent Sundbärg (1910) also included characteristics based on the incidence of suicides in his analysis. See discussion on pp. 6-8 of Sundbärg (1910). Sundbärg argued that these historical differences persisted despite the mass emigration of the late nineteenth century.

[15] Wohlin's (1915) thesis has not found support, see Gaunt (1973), and the data he based his analysis on has been shown to be flawed.

[16] See Santow (1995) and Sklar (1977).

was codified by the Swedish anticontraceptive laws of 1910. From 1911 until 1938, it was illegal to provide knowledge of contraceptive techniques or publicly sell contraceptives "intended for immoral use or to prevent the results of sexual intercourse."[17]

Efforts by others, in particular Knut Wicksell, aided in spreading information regarding contraception in the period before and after the anticontraceptive laws.[18] Wicksell was denounced as an "apostle of promiscuity" and jailed for spreading birth control propaganda. The anticontraceptive laws were ultimately abandoned in 1938.

Since the 1950s, all maternal health clinics have provided information about contraceptives and supplied diaphragms to women regardless of their marital status.[19] The Riksförbundet för Sexuell Upplysning (RFSU) kept a list of doctors known to provide contraceptives, but by the late 1960s they deemed this unnecessary as doctors were universally willing to provide contraceptive services to women. Swedish law also provided the right to women as young as 15 to receive help with birth control measures without parental knowledge. As of 1968, of those couples using some type of preventative method at their most recent intercourse, coitus interruptus and condoms were the most common methods.

The regulation of abortion has a long history in Sweden. The thirteenth century Västergötland Law forbade any form of induced abortion under threat

[17] See Myrdal (1968) and Linner (1967).

[18] Wicksell advocated for the formation of societies to promote family planning while a student in Uppsala in 1880, giving lectures and distributing pamphlets throughout the country. Wicksell was nearly expelled from Uppsala University, but he continued touring the country to lecture on family planning. See also Myrdal (1968).

[19] See Linner (1967), Chapter 5.

of severe penalty. In the seventeenth century the practice was made punishable by death. In 1864 the law was liberalized, and the maximum sentence for abortion was reduced to six years of penal servitude. The law was further liberalized in 1890 and 1921. Although abortion was not generally allowed, it had become unofficially acceptable to perform abortions in cases of clear medical, social or humanitarian necessity, as determined by a medical board that reviewed individual petitions for abortion.[20]

3 Model

Akerlof, Yellen and Katz (1996) model how customs with respect to shotgun marriages are important for explaining patterns of out-of-wedlock birth, and Willis (1999) discussed how a community's ability force fathers to bear the cost of the children they father may reduce the share of children born out-of-wedlock. Social costs and individual preferences play a role in determining the cost of fertility regulation according to Easterlin and Crimmins (1985). The data speak clearly to the importance of past illegitimacy in determining demand for the pill. We develop a model of demand for premarital sex to analyze how social constraints affect unwed births. We show how the same forces that lead to higher rates of out-of-wedlock birth also lead to increased demand for the pill.

Out-of-wedlock births per woman in community j is a function of the share of women in locality j that engage in out-of-wedlock sex, n_j, and the probability

[20] Linner (1967) provides a review of the history of abortion laws in Sweden.

that someone engaging in premarital sex in locality j would incur an out-of-wedlock birth, p_j

$$owb_j = n_j p_j.$$

The share of women that choose to engage in sex outside of marriage will be determined in equilibrium, given the probability p_j. The probability p_j will be taken as given by women in our model. This probability may be a function of local marriage market conditions such as the proportions of men and women in a locality and the wage structure that, in total, determine the supply of men to marriage and out-of-wedlock fatherhood, as well as local constraints on the contracts that can be enforced between couples. The contraceptive knowledge and technologies available in community j are also captured by p_j. Women in community j choose whether to engage in sex outside of wedlock in order to maximize their utility, which reflects both the utility they receive if they do not engage in sex, V, as well as the joy they receive from engaging in nonmarital sex, β_i, where this taste parameter varies across women.[21] Women also take into account the costs of having out-of-wedlock sex. These costs include both a social sanction, γ_j, as well as the relative cost of an out-of-wedlock birth, C, that will happen with probability, p_j.[22] The probability of an unwed birth is

[21] For simplicity we assume β_i shares a common distribution across communities, and that V is a constant. These assumptions could be relaxed without changing the general conclusions of the model. Persistent heterogeneity across communities in the relative utility derived from abstinence may be another way culture affects both out-of-wedlock birth rates and demand for the pill.

[22] The cost of an out-of-wedlock birth is both an economic and social outcome. Persistent heterogeneity in this cost across communities, just as with the relative utility derived from abstinence, may be another way culture affects both out-of-wedlock birth rates and demand for the pill. With sufficiently long data on pill demand it may be possible to distinguish between fixed differences in the value of abstaining, V, over different communities and the dynamic evolution of the social sanction term, γ_j, but this is beyond the scope of the current paper.

both a social and economic outcome. It varies by community depending on the ability of social institutions to enforce promises of marriage, the level of support from fathers of children born outside of marriage that a community can require, as well as the efficacy of contraceptives available in the community. The utility of engaging (or not) in premarital sex is given by

$$U_{i,j} = \begin{cases} V & \text{abstain} \\ \beta_i - \gamma_j - p_j C & \text{premarital sex} \end{cases}$$

Each community will have a critical threshold, β_j^{sex}, where women with larger benefits from premarital sex will choose to engage in sex and women whose benefit is less than this threshold will choose to abstain. This threshold value, β_j^{sex}, is increasing in both the social sanction and the expected out-of-wedlock birth cost,

$$\beta_j^{sex} = V + \gamma_j + p_j C.$$

We assume that β_i is distributed according to the cumulative distribution function $\Phi(\cdot)$. We can compute the fraction of those that engage in premarital sex in each community as

$$n_j = 1 - \Phi(V + \gamma_j + p_j C).$$

The social sanction associated with engaging in out-of-wedlock sex is higher if fewer women in your community have sex outside of marriage. If no one engages in premarital sex in the community this cost may be large, $\lim_{n_j \to 0} \gamma(n_j) = \infty$, but the more women that choose to engage in out-of-wedlock sex the smaller the associated social sanction of doing the same, $\frac{\partial \gamma_j}{\partial n_j} < 0$. The share of women

that engage in sex outside of marriage may not be easily observable, so the social sanction function we assume is a function of unwed births. We assume a particular form for the social sanction function that satisfies these conditions

$$\gamma_j = -\ln(n_j p_j)$$

The equilibrium share of the population engaging in out-of-wedlock sex, n_j, is characterized by the following equation

$$n_j = 1 - \Phi(V - \ln(n_j p_j) + p_j C).$$

The more costly an out-of-wedlock birth, larger C, the smaller the share of women engaging in out-of-wedlock sex and the larger the social sanction associated with having out-of-wedlock sex in equilibrium. Increases in the likelihood of an unwed birth, increasing p_j, has the direct effect of reducing the share of women who engage in sex outside of marriage as well as indirect effects that operate through increasing the social sanction function against nonmarital sex.

Changes in the cost of nonmarital sex brought about by changes in p_j have an ambiguous effect on the out-of-wedlock birth rate.[23] The direct effect of an increase in p_j is to raise out-of-wedlock births for a given share of the population engaging in out-of-wedlock sex, while the indirect effect works in the opposite direction, reducing the fraction of the population that engages in nonmarital sex,

$$\frac{\partial owb_j}{\partial p_j} = \frac{\partial p_j n_j}{\partial p_j} = n_j + p_j \frac{\partial n_j}{\partial p_j}.$$

[23] Increases in the cost of incurring an out-of-wedlock birth, C, have an unambiguous negative effect on the out-of-wedlock birth rate.

For examples calibrated such that both the social sanction and the expected cost of an out-of-wedlock birth have similar weight in the decision problem the woman faces we find that $\frac{\partial owb_j}{\partial p_j}$ is weakly positive.[24] The assumption that the first order effect of increasing the likelihood of an unwed birth dominates the total response implies the following condition:

$$\frac{\partial n_j}{\partial p_j} > -\frac{n_j}{p_j}.$$

A positive relationship between the probability of an unwed birth and the unwed birth rate is desirable in the sense that it conforms to the predictions of Willis (1999) and his analysis of men's demand for out-of-wedlock fatherhood. The supply of men to out-of-wedlock fatherhood is captured by p_j in our model. In Willis (1999) the forces that induce men to prefer unwed parenthood to marriage, such as increases in women's wages, will also lead to higher rates of out-of-wedlock childbearing. The results of our model, where an outward shift in the supply curve for out-of-wedlock fatherhood corresponds with an increase in p_j, are consistent with Willis (1999) when the total effect of an increase in p_j is positive. This assumption regarding the total effect of changes in p_j on total out of wedlock births when combined with the functional form assumption for γ implies that equilibrium social sanctions against engaging in sex outside of marriage are decreasing in p_j.

What happens when the pill is introduced? The probability of a costly out-of-wedlock birth is p_p when using the pill, and this comes at cost c_p. In the short run, we assume the social sanction is fixed. Each woman compares abstaining

[24] $\Phi(\cdot)$ is assumed to be the Normal cdf in these computations.

to the utility she would obtain using the technology that is least costly to women in her community. She compares using the existing technology, with associated probabiltiy p_j, to the birth control pill with the probability of out-of-wedlock birth p_p and cost c_p. Women will use the pill if the net benefit of using the new technology exceeds the cost,

$$c_p < (p_j - p_p) C$$

and the value of using the pill and engaging in out-of-wedlock sex exceeds the value of abstinence,

$$V < \beta_i - \gamma_j - p_p C - c_p.$$

This will lead to another critical threshold in each community, β_j^{pill}, that will partially determine the choice to adopt the pill if $\beta_i > \beta_j^{pill}$, where

$$\beta_j^{pill} = V + \gamma_j + p_p C + c_p.$$

Demand for the pill will depend on two conditions. The first is determined by the social sanction of engaging in nonmarital sex. The second is a function of local customs such as the ability to enforce promises of marriage in case of pregnancy and support or the ability of men to shift the cost of children to their unmarried partners, p_j,

$$n_{pill} = \underbrace{\left[1 - \Phi\left(V + \gamma_j + p_p C + c_p\right)\right]}_{\text{Social Sanction}} \times \underbrace{1\left[\text{if } c_p < (p_j - p_p) C\right]}_{\text{Local Customs}}.$$

The first condition describes demand for the pill, or the share of women whom would engage in nonmarital sex using the pill as a function of the social sanction, γ_j. If social sanctions are large, few women engage in nonmarital sex, and

demand for the pill will be low. The social sanction reflects past behavior, in particular the share of women who engaged in nonmarital sex in past periods.[25] The second condition captures the effect of local customs that prevent out-of-wedlock birth. If local customs are ineffective at preventing unwed births, reflected by a large p_j, women will choose to adopt the pill as a means to prevent costly out-of-wedlock births.

Two forces can lead to higher out-of-wedlock birth rates. Small sanctions on engaging in nonmarital sex tend to raise the rate of out-of-wedlock birth, all else equal. Poor customs for preventing out-of-wedlock births is the other force. Past out-of-wedlock birth rates proxy for both of these forces.[26]

We can use the structure of this model to understand what forces drive demand for a new contraceptive technology. We find that social sanctions and local customs affect demand for this new technology just as they influenced out-of-wedlock birth rates. It is not out-of-wedlock birth rates *per se* that cause increased demand for the pill, but differences in the social sanction incurred by engaging in nonmarital sex, or the ability of local institutions to enforce promises of marriage in the case of pregnancy. This model illustrates how local customs and social sanctions influence both past behavior and demand for modern contraceptives when they are introduced.

[25] The economy does not move to a new stationary equilibrium immediately in response to the introduction of pill, but social sanctions will adjust over time to the existence of the pill.

[26] Differences in relative tastes for sex and the cost of children, two factors that may be largely influenced by local social circumstances, can also be allowed to vary without changing the underlying conclusions of the model. To the extent that the cost of children may be determined by other factors, features of the local economy for example, we will control for both past and current economic conditions to address this. See Section 5.2.1 for further details.

4 Data Description

We aim to explain the striking differences in demand for oral contraception in Sweden from 1970-1974. We account for differences in current demographic and economic conditions, characteristics of the local marriage market, differences in certain non-pecuniary costs of obtaining the pill, as well as demand shocks in the form of venereal disease (VD) prevalence. In addition to extensive contemporaneous controls, we also account for alternative historical factors related to the role of religion and women's education attainment. Table 1 presents summary statistics for the variables used in this analysis.[27] The following sections discuss pill demand per woman and out-of-wedlock birth rates, the main variables considered in this analysis.

4.1 Demand for the Pill

The dependent variable throughout our analysis is the sale of oral contraceptives per woman aged 16-40. Since different communities face the same supply curve, we interpret differences in quantities sold as differences in demand for the pill.[28] We have data on all oral contraceptive sales in Sweden for 70 local markets from 1970 onward. These data are compiled from the quarterly *Swedish Drug Market* publication from Läkemedelstatistik, AB.[29] Average expenditures per woman were 9.6 SEK per year.[30] This corresponds to approximately a month

[27] The values reported in Table 1 are unweighted averages and the table note describes variables in greater detail.

[28] Non pecuniary costs, such as access to pharmacies, may have differed across markets, but we will account for this in our empirical specification.

[29] These 70 markets account for the total universe of oral contraceptive sales in Sweden.

[30] The average expenditure roughly corresponds to the cost of two movie tickets, or three bottles of wine.

of the most popular variety of the pill. A year of birth control pills would cost less than one percent of the average woman's income at the time.

Figure 2 maps out how demand for the pill varies across the 70 markets in our study. There is no clear pattern in pill demand. Areas of relatively high and low demand are found in the North and the South, and in densely and sparsely populated areas. While urban centers such as Stockholm and Malmö are among the areas with the highest pill demand, Gothenburg (GBG), the second largest city, is not.[31]

The total sales data we use to quantify pill demand is unique to this paper. Previous studies have relied on retrospective surveys to determine which types of contraception women had used at different points in time. These surveys are useful in eliciting information on the birth control methods women have used, but they present an incomplete picture of demand for the pill. Our measure of pill demand captures both the extensive margin of pill demand, more and more women opt to try the pill, as well as the intensive margin, women continue to take the pill.

4.2 Out-of-Wedlock Births

Our main explanatory variable is the out-of-wedlock birth rate in 1910. We use measures per total births, as well as per woman. Figure 3 maps out-of-wedlock birth rates per woman in 1910.

There have been significant increases over recent centuries in out-of-wedlock

[31] See Figure 2.

birth. The out-of-wedlock birth rate more than doubled during the nineteenth century. By 1910 this rapid increase had plateaued. Demographers have attributed the rise out-of-wedlock births to three factors. First, a series of land reforms, begun in the eighteenth century, disrupted rural communities making it difficult to monitor and enforce norms related to sex and marriage among the young. Second, the growth of resource extraction industries such as forestry and pulp processing in the middle north of Sweden led to a large migration of single men to these areas. The greater mobility of single men made it difficult for communities to enforce norms of marriage in the case of pregnancy. Finally, women were also more mobile, moving to cities and regions that offered employment in industries such as textiles, and as a result women were also less subject to the control of family and community.[32,33] The differential influence of these factors can be seen in Figure 3. The region around Stockholm exhibits relatively high out-of-wedlock birth rates, consistent with the large role land reform played in the area. Out-of-wedlock birth in the middle northern regions are high. This is where lumber and extraction industries attracted male laborers, and offered few opportunities for women. Urban areas offered more employment opportunities for women and had generally higher rates of out-of-wedlock birth.

[32] See Sklar (1977).

[33] DeMoor and Van Zanden (2010) argue that high levels of out-of-wedlock births are indicative of low levels of mutual trust in a community.

5 Empirical Specifications and Results

We consider two empirical models of culture that are closely related and yield similar results. The model in levels posits that culture is a fixed characteristic. This hypothesis fits well with the highly persistent nature of unwed birth rates. The second model posits that culture may also have a slowly evolving component, so that in the long run cultures may erode or be reinforced. The second model is estimated in differences using long run time variation within communities to estimate the effect of changes in out-of-wedlock birth rates at the turn of the century on growth in pill demand. Although these two empirical models use very different sources of variation to identify the effect of culture on contraception demand, both models come to similar conclusions regarding the strong positive relationship between past nonmarital fertility and demand for the pill. The instrumental variable estimator results identify how exogenous shocks to out-of-wedlock birth rates have a long run impact on pill demand, hence providing strong evidence that the estimated relationship is causal and that out-of-wedlock births have a persistent cultural component.

5.1 A Model in Levels

We examine whether there is a persistent component of historical out-of-wedlock birth behavior that influences demand for the pill. Culture as a persistent characteristic is consistent with previous studies such as Guiso, Sapienza, and Zingales (2006). This hypothesis is consistent with the highly persistent nature of nonmarital fertility in Sweden.

The results reported here are estimated by pooled ordinary least squares (OLS) and the between estimator. All of the models we consider share a common linear specification. $Pill_{jt}$ represents demand for the pill per fecund female in locality j at time t. X_{jt} contains contemporaneous factors that vary over locality and time. OWB_j captures past out-of-wedlock birth behavior for locality j, an outcome that reflects differences in cultures that have persisted over time. The model we estimate is

$$Pill_{jt} = X_{jt}\beta + OWB_j\alpha + \eta_t + \varepsilon_{jt}.$$

The full set of time fixed effects are captured by η_t, and ε_{jt} represents unobservables in community j at time t.[34] We relate demand for the pill from 1970 through 1974 to the out-of-wedlock birth rate in 1910.

Out-of-wedlock births are measured at the market level. In order to be conservative with regard to the effect of clustering on standard errors our results are clustered by county. This allows for arbitrary correlation at the market level, within county, in the unobservables.[35] Clustering at the more disaggregated market level, as would be appropriate, produces somewhat smaller standard errors on the out-of-wedlock birth coefficient. Results are weighted by the population of fecund females in a market, unless otherwise noted.[36] Weighting does

[34] We consider specifications with time fixed effects to capture aggregate trends in demand for the pill, but omitting these fixed effects has little impact on the estimated coefficient on culture. Similarly, estimating the model for each year instead of by pooled OLS yields similar estimates with regard to the influences of out-of-wedlock births.

[35] There are 70 markets and 24 counties in Sweden. While some markets and counties correspond one to one, the island of Gotland is one example of this, there are roughly three markets per county, and a maximum of four markets in any one county.

[36] Weighting is appropriate for two reasons. First, it allows us to interpret α as an effect for the average woman instead of for the average market. Alternatively, weighting addresses

not alter our findings. We discuss the sensitivity of our results to alternative weighting schemes and a battery of robustness checks in Section 5.2.1.

5.2 Out-of-Wedlock Births and Pill Demand

Localities with higher rates of out-of-wedlock births in 1910 have higher demand for the pill six decades later. Table 2 presents results for several models that include alternative sets of contemporaneous controls. The specification in column 1 includes out-of-wedlock births as a share of all births and year fixed effects. The coefficient on the out-of-wedlock birth rate is 0.11 and significant at the one percent level. Detailed employment and income controls for both men and women are included in column 2 and the coefficient on out-of-wedlock births increases to 0.16, remaining significant at the one percent level. Employment and income controls include the share of women between 16-64 that work, the average income of these women, the average income of men in the same age group, and source incomes emphasized in the historical literature to control for the prevalence of agriculture and forestry.[37]

We account for the influence of local demographic and marriage market characteristics in column 3. Measures of the population density, the average age of single and married fecund women, the share of fecund women that are married, and the sex ratio are included. The unwed birth coefficient increases

the heteroskedasticity present when covariates like income are computed over localities that vary in population size.

[37] In alternative specifications, not reported here, we have also controlled for other moments of the income distribution including median income measures and ratios of the 70th to the 30th percentiles of the income distribution, but the coefficient on unwed births in unchanged. Similarly, including business income and other specific sources of income does not change the results with regard to the importance of historical out-of-wedlock births.

to 0.21, now significant at the tenth of a percent level.[38] Column 4 includes the number of pharmacies normalized by the geographic area to control for differences in the non-pecuniary costs of obtaining the pill. Demand for the pill is lower in areas where pharmacies are more dispersed. Pharmacy density has the expected positive and significant coefficient. In areas where there are more pharmacies in close proximity demand for the pill is greater. Column 4 also includes a measure of the fraction of the population that has a VD per 1000 of the population aged 15-40 lagged one year to capture the prevalence of VD in the locality.[39] An increase in the prevalence of VD has a negative effect on demand for the pill, as would be expected if individuals shift into other forms of contraception, such as condoms. The coefficient on the unwed birth rate remains positive and highly significant in this specification.

The results reported in Table 2 are consistent with persistent social constraints affecting contraception decisions. The point estimate in the last specification suggest that a one standard deviation increase in the rate of out-of-wedlock birth would result in an increase of 0.42 standard deviation in demand for the pill. The mechanism through which this effect is transmitted is the persistent culture regarding sex, marriage, and contraception to which women are exposed. The elasticity of pill demand to the out-of-wedlock birth rate is 0.24.

[38] Alternative specifications that take into account migration, using the share of the population that is foreign born, as well as differences local schooling systems, such as the share of high school students enrolled in programs that qualify them to attend university have similar results with repect to the importance of out-of-wedlock birth rates. Similarly accounting for additional characteristics of married women in the locality, such as the share with two or more children, does not affect the coefficient on unwed births.

[39] VD includes the diagnosis of one or more of the following: congenital or acquired syphilis, gonorrhea, or cancroid.

5.2.1 Robustness Checks

The results presented in Table 2 are robust to alternative assumptions regarding the behavior of residuals, the estimator used, and the measure of unwed birth. A sensitivity analysis is presented in Table 3.

Alternative Measures of Out-of-Wedlock Birth Rates The results in Table 2 measure out-of-wedlock births as a share of all births in 1910. These results are not sensitive to using alternative measures of nonmarital fertility. We first turn our attention to the top panel of Table 3. The first column of the top panel is identical to the last column of Table 2. The specification used in column 3 is identical to that in column 1, but the measure of unwed birth is computed per 1000 women instead of per 100 births. The coefficient is positive and significant regardless of which measure we use and the elasticity is similar to the per birth measure.

The model in section 3 argued that preferences for abstinence, the likelihood of nonmarital fertility, and the costs of children born outside of wedlock had a social component. Some of these factors may also be driven by economic or environmental factors such as local marriage market conditions and urbanization rates. To address this we adopt a two-step estimation procedure. We regress out-of-wedlock birth rates on the sex ratio, women's wage rate in levels as well as relative to men's wages, and the urbanization rate from 1910. These are the variables emphasized in the theoretical model of Willis (1999) and the historical accounts of Hecksher (1949). We use the residual from this regression as our

measure of the unwed birth rate. This approach partials out that component of out-of-wedlock birth rates in 1910 that are driven by economic and marriage market factors.

Results from the second stage regression are reported in columns 2 and 4 for unwed births per total births and per 1000 females.[40] The point estimates are similar to the results reported in Table 2. Although differences in economic and marriage market conditions influenced illegitimacy rates in 1910, the results in Table 3 show that these factors are not driving the strong relationship between illegitimacy at the turn of the century and subsequent demand for the pill.

The Between Estimator In the lower panel of Table 3 we estimate the same four specifications using the between estimator, in effect regressing the averages from each market. We identify the results using cross-sectional variation alone. The coefficients on the out-of-wedlock birth rates are unchanged and remain highly significant when using the between estimator for all four specifications. The coefficient estimates on the per birth measures in column 1 and 2 range from 0.18 to 0.19 using the between estimator or pooled OLS. Coefficient estimates on unwed birth per woman range from 0.36 to 0.38. The estimated relationship between out-of-wedlock birth and demand for the pill is not sensitive to the estimator used.

[40] Results from the first stage suggest that urbanization has a positive and highly significant effect on out-of-wedlock births, regardless of how they are measured, while the sex ratio is a significant determinant of out-of-wedlock birth per women.

Alternative Time Periods The results reported in Tables 2 and 3 are robust to measures of unwed birth from other time periods. Using the average rate of out-of-wedlock birth from 1900-1909 results in a positive and significant estimate of α and an elasticity estimate of 0.24. The average rate of out-of-wedlock birth from 1936-1940 yields a positive and significant point estimate and an implied elasticity of 0.21.

Clustering at the Market Level Standard errors for both unwed birth measures are only slightly reduced when clustering at the market level. Standard errors drop from 0.05 to 0.04 and from 0.11 to 0.10 for per birth and per woman measures respectively. The reduction in the standard errors is modest and suggests that results regarding the influence of past out-of-wedlock births on pill demand are not particularly sensitive to clustering at the county versus the market level.

Unweighted Estimates Unweighted results are generally larger and more highly significant than the population weighed results reported in Tables 2 and 3. This is consistent with social constraints and the cultures that influence women's contraceptive decisions being stronger in smaller communities. The effect of weighting suggests that the strong relationship between culture measures and demand for the pill are not driven by relatively high demand for the pill in large cities where unwed births were more common.

5.2.2 Alternative Historical Factors

Out-of-wedlock births remain an important determinant of demand for the pill even after controlling for historical factors pertaining to religious environment, education attainment, and development. The prevalence of dissenting religious denominations and the share of the community that supported prohibition have a significant influence on pill demand. Table 4 shows how accounting for these factors does not change our results regarding the importance of past out-of-wedlock births. All specifications in Table 4 control for the full set of contemporaneous factors from Table 2.

Wages, Sex Ratios and Urbanization in 1910 Differences in out-of-wedlock birth rates may reflect differences in women's economic opportunities both in absolute terms and relative to men, as argued by Willis (1999) or by urbanization rates as argued by Heckscher (1949). These differences may have a persistent component that could influence demand for the pill. We include the urban to rural population ratio, the ratio of women to men in the population, and women's wages both relative to men and in levels all from 1910 in the first column of Table 4 to address this. None of the measures are significant and they have little effect on the coefficient on the out-of-wedlock birth rate.[41] This exercise differs from the two-step approach presented in Table 3 since the effect of the other historical measures are not restricted to work only through past out-of-wedlock birth behavior.

[41] All specifications include the full set of contemporaneous controls from Table 2.

Out-of-Wedlock Births in 1961 One may argue that out-of-wedlock births, and demand for oral contraceptives, may be purely driven by contemporaneous economic factors, but we have omitted some current economic variable that is correlated with the economic conditions that existed in 1910 and captured in the historical out-of-wedlock birth rate. If this were the case, including recent measures of nonmarital fertility would control for this missing economic factor. We include recent out-of-wedlock birth behavior from 1961, to proxy for omitted current economic conditions that may drive pill demand.[42]

The second column of Table 4 reports results from a specification that includes all contemporaneous controls as well as out-of-wedlock birth behavior from 1961. The coefficient on the out-of-wedlock birth rate in 1961 is not significant, but the coefficient on the out-of-wedlock birth rate from 1910 remains significant. Accounting for omitted contemporaneous economic factors by including recent out-of-wedlock birth rates does not mute the estimated impact of unwed births in 1910.[43]

These results indicate that out-of-wedlock birth rates in 1910 capture an important cultural influence. Unwed births in 1910 are highly correlated with unwed births in 1961; they have a correlation coefficient of 0.59. Yet, the variation that is important in explaining pill demand is specific to 1910. As discussed in the historical literature, out-of-wedlock births at the turn of the century carried

[42] We have taken care to select a period that strictly predates the legalization of the pill for contraceptive use in Sweden, but the results reported here are similar if we use data from the later period.

[43] This exercise is meant to illustrate how historical unwed births remain a significant predictor of pill demand even after we control for current measures, not to test whether the coefficient estimates on current unwed birth rates differ from historical measures. We cannot reject that the coefficients on current and past unwed birth rates are equal.

a strong social penalty. As attitudes toward cohabitation became more liberal, out-of-wedlock birth became more common, and no longer reflected community norms regarding single motherhood as they once had. The changing social context of marriage must be considered as one reason for the insignificance of recent nonmarital fertility behavior on pill demand.[44] The common occurrence of cohabitating households with children and the social acceptance of cohabitation as an alternative to marriage make recent measures of nonmarital fertility less reflective of local norms regarding promiscuity.

Using variation in out-of-wedlock births specific to the turn of the century is important to examining our hypothesis. The results reported in column 2 affirm our argument that norms from the past matter. The identification of the coefficient on past nonmarital fertility comes from variation that is specific to the early twentieth century.[45]

Women's Education Norms regarding education may influence women's demand for the pill. We use the share of women with a high school degree in 1930 to proxy for local norms about female human capital investment that may drive demand for the pill.[46] Column 3 evaluates how differences in women's past education behavior affects pill demand. High school attainment in 1930 reflects the education environment faced by the mothers of the fecund females we study.

[44] Cohabitation was uncommon at the turn of the century, and generally regarded as inferior as reflected by the derogatory reference to such arrangements as "Polish marriages." I thank Torben Traenas for this insight. Such arrangements were also referred to as "Stockholm marriages."

[45] We discuss this at greater length in section 5.3.

[46] We also account for local differences in women's literacy in these same communities. The literacy (småskolan) education corresponds to less than an elementary education.

The women whose high school attainment we measure are no longer fecund and do not drive demand for the pill directly, but the culture that shaped their education decisions may continue to influence future generations of women. The coefficient on high school attainment is positive, but not significant. Although education norms may be an important factor in women's demand for the pill, accounting for such factors does not change our conclusions about the importance of past out-of-wedlock birth rates.[47]

Religion The vast majority of Swedes are members of the Church of Sweden (Svenska Kyrkan), but several other Protestant denominations have been prevalent in certain communities.[48] We account for the influence of religious minorities in column 4 by including a measure of the local population that was a member of a Pentecostal Church in 1930. The coefficient estimate on the Pentecostal share is negative and significant at the tenth of a percent level suggesting that the more prevalent the Pentecostal church was in a locality the lower was demand for the pill. Accounting for differences in the religious make-up of a community does not change the coefficient on the out-of-wedlock birth rate. Pentecostals were the only group among the three largest dissenting denominations that had a significant marginal effect, though all three had little impact

[47] Alternative specifications that include measures of women's literacy rates have similar results where the coefficient on literacy is positive but not significant, and the coefficient on unwed births is unchanged.

[48] In 1930 the largest religious minority in Sweden was the Swedish Mission Church, which claimed 2.4 percent of the population as members. The next largest religious minorities were the Baptists and Pentecostals with 1.3 and 0.7 percent of the population respectively. It should be noted that some members of dissenting religions were also members of the Church of Sweden.

on the unwed birth coefficient.[49]

Prohibition Support In order to capture differences in religious culture within communities where over 90 percent of the population was part of the Church of Sweden we construct an alternative proxy based on the results of a national referendum to ban alcohol sales in 1922. The temperance movement in Sweden was closely allied with the Church, so stronger support for the ban corresponds with more religious communities. Individuals may have had little choice with regard to their membership in the Church of Sweden, but the share of the population that supported the alcohol ban provides measure of those sharing similar views to those espoused by the Church. In the last column of Table 4 we account for the share of the population that supported the 1922 referendum to ban alcohol sales.

Voter support for prohibition in 1922 has a significant negative effect on pill demand. This is consistent with the conjecture that more religious communities have more conservative attitudes towards sex that are persistent, and in turn shape demand for contraception. The coefficient on the out-of-wedlock birth rate remains highly significant and similar to the baseline estimate. This complements and validates our findings, highlighting the significance of one specific channel through which norms may be transmitted, that is via religious institutions and the transmission of religious beliefs.

[49] Alternative specifications that take into account the share of the local population that are members of significantly smaller denominations, such as the Catholic Church, do not change our conclusions regarding the importance of local norms as proxied for by out-of-wedlock birth behavior in 1910.

5.2.3 Instrumental Variable (IV) Estimator

Result for the baseline specification estimated using the IV/2SLS estimator are presented in Table 5. The IV approach follows the analysis of Swedish fertilty in Schultz (1985). Schultz argued that diffusion of improved technology in the dairy industry and changes in the terms of trade for Swedish agricultural products led to a striking increase in demand for female labor relative to men in the agricultural sector, which accounted for the majority of employment in Sweden during the 19th and early 20th century. According to the theory of demand for out-of-wedlock fatherhood presented by Willis (1999) this increase in women's wages induced by increased demand for women's labor in the production of butter should induce some men to prefer out-of-wedlock fatherhood to marriage. In the context of our model this would imply an increase in the probability of an out-of-wedlock birth occurring, p_j, in turn increasing unwed births and reducing social sanction, γ_j.

Table 5 presents results for several specificatons where out-of-wedlock births from 1910 are instrumented for using butter prices from 1909 and 1910. The identifying assumption is that butter prices at the turn of the century have no effect on demand for the pill six decades later, other than through the effect on out-of-wedlock births. All specification include the full set of contemporaneous controls from Table 2. First stage regressions results are not reported in Table 5, but the Kleibergen-Paap statistics reject underidentification and weak instruments in all specifications. The coefficient estimate in column 1 is positive, highly significant and twice as large as the coefficient in the baseline

specification. The larger coefficient may reflect how shifting butter prices and in turn wages for women resulted in shifts on the margin into unwed parenthood that have a larger effect on pill demand in the long run than the average unwed birth. Attenuation bias may also play a role in the larger coefficient using the IV estimator. The second column reports results for a specification where unwed births are measured per 1000 women in 1910 and again the results are positive, significant, and generally twice as large as comparable results reported in Table 3. The fourth specification uses unwed births per 100 births measured in 1900 and instruments for these birth rates using butter prices from 1899 and 1900. The results are similar those reported in column 1, and unchanged when we include butter prices from 1910 as an additional regressor as reported in column 4. The inclusion of 1910 butter prices is important to support our identification assumption. We could be worried that butter prices at the turn of the century capture permanent differences across regions, which may in turn affect demand for the pill. However, by controlling for butter prices in 1910 we account for these permanent differences across communities. It is reassuring that the results are robust to such challenges.

The IV estimation results provide evidence that the estimated relationship is causal, and that exogenous changes in the probability of an unwed birth and in turn the observed out-of-wedlock birth rate have a persistent effect on demand for contraception six and seven decades later. Our model suggests that increases in the probability of an unwed birth, that is a larger p_j brought about by an increase in demand for women's labor in community j, will induce a decline in

the equilibrium social sanction associated with nonmarital sex, that is a smaller γ_j. Both forces are associated with higher levels of unwed birth and in turn higher demad for the pill when it is introduced. The IV results are consistent with the model and they are robust to including butter prices from later periods in our specification to account for any effects relative prices may have had on industry structure that may not be captured in the current income controls.

5.3 A Model in Differences

Here we relax the assumption that culture is constant. We estimate how long run changes in cultures at the turn of the century, reflected in changes in the nonmarital fertility rate, affect growth in demand for the pill. We show how communities which became more liberal with regard to their tolerance of nonmarital fertility at the turn of the century have more rapid adoption of the pill decades later. This model of slowly evolving cultural is consistent with Guiso, Sapienza and Zingales (2006) definition of cultural traits as well as Putnam's (2000) study of trust in the U.S. Studies of the transmission of cultural traits such as trust, as in Algan and Cahuc (2010), have emphasized how trust changes over decades. Our model does not emphasize a specific role for trust but instead manifestations of trust related to marriage and parental support agreements, though it should be mentioned that economic historians have argued that low levels of out-of-wedlock birth are indicators of a high degree of mutual trust in a community.[50]

[50] See DeMoor and VanZanden (2010) for a discussion of this literature.

Levels and changes in unwed birth behavior at the turn of the century are closely related. The rise in illegitimacy during the first decades of the last century was not uniform. Communities with low illegitimacy rates in 1900 also have low rates of illegitimacy in later years. A regression of the change in the out-of-wedlock birth rate from 1900-1910 on the 1900 illegitimacy rate yields a positive and significant coefficient, suggesting that a community with a 10 point higher rate of unwed birth would experience an increase in the illegitimacy rate of roughly one percentage point more over the decade. Results are similar when comparing changes from 1900 to 1940. The data suggests that illegitimacy evolved in a nonlinear fashion, increasing more rapidly in communities with already high levels of illegitimacy. This differential pattern of growth in illegitimacy rates at the turn of the century motivates our estimation of a model in differences.

Estimating a model in differences identifies the effect of culture from changes in unwed birth rates. This approach allows us to address concerns that omitted fixed characteristics, unrelated to culture, may drive past out-of-wedlock birth and subsequent demand for the pill. Using variation across time within communities uses a very different source of variation than the model in levels. Even after differencing out the fixed component of unwed birth behavior, which may be driven in large part by culture, the changes in unwed birth rates across communities at the turn of the century are still significant determinants of growth in demand for the pill.

Consider an extended version of our model in levels that allows for market

level fixed characteristics, μ_j,

$$Pill_{jt} = X_{jt}\beta + OWB_{jt}\alpha + \eta_t + \mu_j + \varepsilon_{jt}.$$

These fixed characteristics could include constant differences in the public mood, as discussed by Sundbärg (1910), or other characteristics that may be fixed over time and possibly correlated with initial levels of nonmarital fertility. We could explicitly control for the regional differences discussed by Sundbärg by including fixed effects for the three regions he outlined. Doing so results in larger, yet still highly significant, point estimates of the coefficient on nonmarital fertility at the turn of the century.[51] Controlling for these regional differences, and identifying α from within region variation in unwed birth rates and pill demand suggests local variation in culture within demographic regions is important.

A more flexible approach differences out the fixed effect for each market and estimates a model in differences. We estimate the following model

$$\Delta Pill_{jt} = \Delta X_{jt}\beta + \Delta OWB_{jt}\alpha + \Delta\eta_t + \Delta\varepsilon_{jt},$$

where Δ is the time difference operator. We identify the effect of culture off of changes in the unwed birth rate, in this case from 1900-1910, unaffected by the fixed characteristic μ_j. Changes in pill use over ten year intervals are equivalent to levels in the terminal period since initial period pill sales were zero.[52] Using longer horizon differences to identify how changes in culture affect

[51] In the baseline specification, which corresponds to the results reported in column 4 of Table 2, including fixed effects that correspond to Sundbärg's three demographic regions results in an estimated α of 0.20 (0.08), as compared to 0.18 (0.05). Larger point estimates for α are found in other specifications as well when demographic region fixed effects are included.

[52] The results reported in Table 5 exclude the 1964-1974 difference since pill sales from the last half of 1964 are not observed.

the growth of demand for the pill uses a very different source of variation than the model in levels, and the long horizon over which we calculate our differences is critical, as year to year differences in unwed births would likely be dominated by measurement error and short run variations unrelated to the slow moving cultural component.

Our results are similar estimating models in differences or levels. Coefficient estimates on changes in the out-of-wedlock birth rate are positive and significant, where we use the pooled OLS estimator, as reported in columns one and two of Table 6. Controlling for other trends, such as changes in total birth rates, local marriage market conditions, and urbanization from 1900 to 1910 improves model fit but does not alter the positive and significant coefficient estimate on changes in nonmarital fertility. Results are similar when using the between estimator, as seen in columns three and four. Variation in the growth of out-of-wedlock birth rates explains six percent of the variation in the fixed component of pill demand growth.

Even after controlling for the fixed component of culture in Swedish communities, we find that changes unwed birth rates from the turn of the century have a positive and significant effect on pill demand. These results support the conclusion that omitted fixed characteristics unrelated to culture cannot explain our findings regarding pill demand and historical illegitimacy. The strong positive effect of historical nonmarital fertility on pill demand is robust to whether we estimate our empirical model in levels or differences.

6 Conclusion

We model how differences in social constraints determine out-of-wedlock birth behavior. The driving forces in our model are differences in the ability of communities to enforce promises of marriage or the efficacy of contraceptive knowledge, and social sanctions against premarital sex. These same social forces are shown to drive demand for new contraceptive technologies. The predictions of the model are born out in the data. Communities with higher out-of-wedlock birth rates in the past are shown to have higher demand for the pill when it is introduced.

Out-of-wedlock births have differed persistently across Swedish localities, a fact noted long ago by Swedish statisticians, but establishing the robust positive relationship between historical out-of-wedlock birth behavior and contemporary demand for contraceptives is a unique contribution of this study. We estimate models that control for contemporaneous economic, demographic, and epidemiological factors as well as historical conditions. All specifications point to a positive and significant relationship between past illegitimacy in a community and demand for the pill when it is introduced. Instrumental variable estimates that use shocks to the demand for women's labor that would shift the probability of unwed biths and in turn social sanctions associated with nonmarital sex support the argument that the effect of unwed birth rates in the past on demand for a new contraceptive technology is causal. Furthermore, we find evidence that it is variation from the turn of the century that drives our result. This fits well with the historical literature that has documented strong social

pressures to avoid out-of-wedlock births at this time in Sweden.

We account for the presence of unobserved local characteristic by estimating our model in differences over time within communities. We find that in places where cultural attitudes toward sex and marriage became more liberal at the turn of the century, represented by an increase in the rate of nonmarital fertility, demand for the pill increased faster. All of the empirical approaches employed here support our hypothesis that the social forces which constrain the occurrence of unwed births and impose sanctions on sexual behavior are persistent, and these forces affect demand for the pill.

While theory has emphasized the important interaction of culture and technology with regard to contraception, our paper is the first to address this empirically. Culture has a significant and multifaceted influence on the adoption of a new contraceptive technology. Past out-of-wedlock birth rates explain a quarter of the market level variation in pill demand. Quantitatively, this is as important as the religious characteristics of a community or the status of women.[53]

Our findings point to the importance of accounting for cultural factors when analyzing contraception and fertility through the inclusion of relevant historical variables. We have shown how out-of-wedlock birth rates, a measure of behavior that we argue is largely influenced by social forces, vary systematically across communities and are persistent over time. Culture may work through many channels: differences in what Sundbärg (1910) called the "public mood", the

[53] A regression of the market level pill demand fixed effects on out-of-wedlock birth rates in 1910 has an $R^2 = 0.25$ as compared with 0.31 for religious factors and 0.27 for women's literacy/education attainment.

capacity of communities to enforce promises of marriage in the case of pregnancy, norms, beliefs, and other features of preferences. Our findings are consistent with all of these interpretations and together make a convincing case that culture matters for contraceptive decisions.

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Table 1: Summary Statistics

	Mean	Std. Dev.	Min	Max
Pill Demand	9.61	1.70	3.64	14.86
1910 Historical Factors				
Out-of-Wedlock Births (per 100 Births)	12.34	4.01	6.11	27.90
Out-of-Wedlock Births (per 1000 Women)	6.02	2.01	2.81	12.94
Urban to Rural Ratio (x100)	24.97	31.68	0	183
Female to Male Sex Ratio (x100)	103	3.68	95	114
Female to Male Wage Ratio (x100)	60.1	4.08	50	69
Woman's Wage (Öre per Day)	161.5	19.9	125	225
1930 Historical Factors				
Women's HS Attainment	0.35	0.23	0.16	1.35
Pentecostal Church Percent	0.76	0.38	0.17	2.02
Prohibition Support in 1922	0.56	0.19	0.19	0.82
1970-1974 Contemporaneous Factors				
Men's Mean Labor Income	256.4	38.1	170.4	384.6
Women's Mean Labor Income	214.9	63.18	122.7	357.2
Women's LFP Rate	0.62	0.04	0.53	0.73
Agriculture Income	4.2	2.4	0.3	14.5
Business Income	9.0	1.5	5.9	13.7
Value of Forestry	0.7	0.4	0.0	1.7
Population Density	5.2	11.8	0.1	83.4
Single Women's Mean Age	21.7	0.47	20.8	23.4
Married Women's Mean Age	31.1	0.52	29.9	32.7
Male to Female Sex Ratio (x100)	93.1	2.8	87.8	101.0
Share of Women Single	0.55	0.08	0.36	0.66
Pharmacy Density	3.16	3.66	0.19	19.9
Venereal Disease	0.05	0.09	0.01	0.92

Note: Pill demand, out-of-wedlock births, sex ratios, urban share, and age are measured at the market level, other variables are measured at the county level. Pill demand is per woman aged 16-40 in current SEK. The male to female wage ratio is based on agricultural day rates from Bagge et al (1935). High School attainment is the share of women over 15 with a high school degree in 1930. Pentecostal is the percent of the population classified as members in 1930. Prohibition support is the share of votes cast in favor of the 1922 ban on alcohol. Mean incomes are for those aged 16-64 in 100s SEK. Women's income is for working women. Population density variables are per square km for those16-40. The sex ratio is the ratio of women to men aged 16-40. Pharmacy density is per 1000 square kilometers. Venereal disease is the number of cases per 1000 of the population aged 16-40.

Table 2: Pill Demand and Out-of-Wedlock Births

	(1)	(2)	(3)	(4)
Out-of-Wedlock Births 1910	0.11**	0.16**	0.21***	0.18***
	(0.03)	(0.05)	(0.05)	(0.05)
Share of Women Working		8.04	9.53**	5.22
		(5.05)	(3.22)	(3.29)
Mean Labor Income Working Women		-0.01	0.06*	0.03
		(0.02)	(0.02)	(0.02)
Mean Male Labor Income		-0.01	-0.03	-0.03
		(0.02)	(0.02)	(0.02)
Mean Farm Income		0.09	0.21	0.18
		(0.14)	(0.14)	(0.15)
Forestry Value		-1.74	0.40	0.67
		(0.91)	(0.49)	(0.54)
Population Density			0.12*	0.07
			(0.05)	(0.05)
Pop Density Squared			-0.19**	-0.17**
			(0.07)	(0.06)
Single Women's Average Age			0.04	0.60
			(0.47)	(0.47)
Married Women's Average Age			-0.26	-0.33
			(0.61)	(0.56)
Sex Ratio			0.11	0.10
			(0.08)	(0.08)
Share of Women Married			-2.48	-2.33
			(2.42)	(2.30)
Pharmacy Density				0.28**
				(0.09)
Lagged VD Cases				-2.60
				(1.42)
Constant	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
Weighed by Fecund Population	Yes	Yes	Yes	Yes
R-squared	0.27	0.43	0.62	0.65
N	350	350	350	350

Note: Pill demand per woman 16-40 is the dependent variable. Standard errors clustered by county are reported in brackets. Out-of-wedlock births are measured per 100 births in 1910. Income measures are computed for those aged 16-64. Population density variables are per square km for those aged 16-40 and population density squared is divided by 100. Age, share variables are computed for the population of women 16-40. Sex ratio is 100 times the ratio of women to men aged 16-40. Pharmacy density is per 1000 square kilometers. Venereal disease is per 1000 of those 16-40.
* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table 3: Pill Demand and Out-of-Wedlock Births
Alternative Measures and Estimators

	(1)	(2)	(3)	(4)
Pooled OLS Estimator				
Out-of-Wedlock Births 1910	0.18***	0.19***	0.36**	0.41***
	(0.05)	(0.04)	(0.11)	(0.09)
Clusters	24	24	24	24
R-squared	0.65	0.65	0.64	0.65
N	350	350	350	350
Between Estimator				
Out-of-Wedlock Births 1910	0.19***	0.18***	0.36**	0.38***
	(0.05)	(0.05)	(0.11)	(0.10)
Groups	70	70	70	70
R-squared	0.60	0.58	0.58	0.58
N	350	350	350	350

Note: Pill demand per woman 16-40 is the dependent variable. Unwed births are measured per 100 births in column 1, and per 1000 of the female populationin columns 3. Columns 2 defines unwed births as the residual from a regression of out-of-wedlock births per 100 births in 1910 on urbanization rates, sex ratios, the ratio of women's to men's wages, and women's wage level from 1910. Columns 4 defines unwed births using a similar two step procedure using unwed births per woman. All regressions include the full set of contemporaneous controls described in Table 2. The pooled OLS regressions reported in the top panel are weighted by the fecund female population.
* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table 4: Out-of-Wedlock Births in 1910 and Pill Demand: Alternative Factors

	(1)	(2)	(3)	(4)	(5)
Out-of-Wedlock Births 1910	0.18**	0.19*	0.17***	0.17***	0.16***
	(0.05)	(0.07)	(0.07)	(0.04)	(0.04)
Historical Controls					
Urban to Rural Ratio 1910	-0.27				
	(0.80)				
Female to Male Population Ratio 1910	0.02				
	(0.09)				
Female to Male Wage Ratio 1910	7.43				
	(5.25)				
Female Wage 1910	-0.02				
	(0.01)				
Out-of-Wedlock Births 1961		-0.01			
		(0.07)			
Women's HS Education 1930			0.22		
			(0.19)		
Pentecostal Share 1930				-0.16***	
				(0.03)	
Prohibition Support 1922					-5.87***
					(0.84)
R-squared	0.67	0.65	0.66	0.69	0.71
Clusters	24	24	24	24	24
N	350	350	350	350	350

Note: Pill demand per woman 16-40 is the dependent variable. Standard errors clustered by county are reported in brackets. All specifications include the full set of contemporaneous controls as in Table 2 in addition to year fixed effects. Out-of-wedlock births are measured per 100 births. Wage data from 1910 corresponds to the agricultural wages from Bagge(1935). Pentecostal Share is the share of the population that is a member of a Pentecostal Church. Prohibition Support refers to the share of voters whom supported the 1922 referendum on the ban of alcohol sales. Women's HS refers to the share of women with a HS education. Unwed births are per total births. Pooled OLS regressions are weighted by the female population aged 16-40.
* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table 5: Pill Demand and Out-of-Wedlock Births
Instrumental Variable Estimator

	(1)	(2)	(3)	(4)
		Pooled OLS Estimator		
Out-of-Wedlock Births 1910	0.45**	0.95*		
	(0.14)	(0.37)		
Out-of-Wedlock Births 1900			0.34***	0.41***
			(0.08)	(0.08)
Butter Prices 1910				-0.01
				(0.02)
Clusters	24	24	24	24
R-squared	0.502	0.484	0.665	0.660
N	350	350	350	350

Note: Pill demand per woman 16-40 is the dependent variable. Unwed births are measured per 100 births in column 1, and per 1000 of the female population in column 2. Both specifications use butter prices in 1909 and 1910 to instrument for unwed births. Columns 3 and 4 instruments for unwed births per 100 births in 1900 using butter prices in 1899 and 1900 as instruments and butter prices from 1910 as a additional control in column 4. All regressions include the full set of contemporaneous controls described in Table 2. The results are weighted by the fecund female population.
* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Table 6: Pill Demand and Out-of-Wedlock Births: A Model in Differences
Alternative Models and Estimators

	(1)	(2)	(3)	(4)
Change in Out-of-Wedlock Births 1900-1910	0.39*	0.37*	0.31*	0.34**
	(0.16)	(0.14)	(0.13)	(0.12)
Change in the Sex Ratio 1900-1910		0.06		0.01
		(0.06)		(0.06)
Change in the Urbanization Rate 1900-1910		0.56		1.51
		(1.88)		(1.73)
Change in the Birth Rate 1900-1910		2.99***		2.30***
		(0.77)		(0.56)
Pooled OLS	Yes	Yes		
Between Estimator			Yes	Yes
R-Squared	0.181	0.359	0.079	0.284
N	280	280	280	280

Note: Pill demand per woman aged 16-40 is the dependent variable.
Levels and 10 year changes in pill demand are identical since lagged demand is zero prior to 1964 due to legal restrictions on sales of the pill. Since the pill was approved for use during 1964, and sales for 1964 are not observed we omit the 1974-1964 difference.
Unwed births are measured as a share of total births.
* $p<0.05$, ** $p<0.01$, *** $p<0.001$

Figure 1: Gustav Sundbärg's Map of Sweden's Three Demographic Areas (1910)

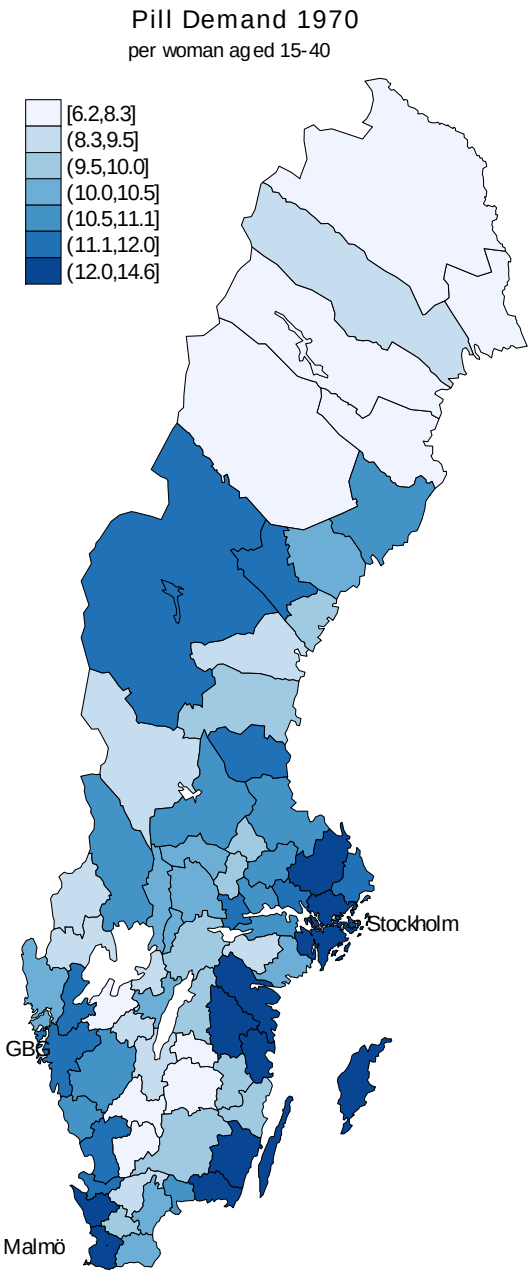

Figure 2: Pill Demand per Woman, 1970

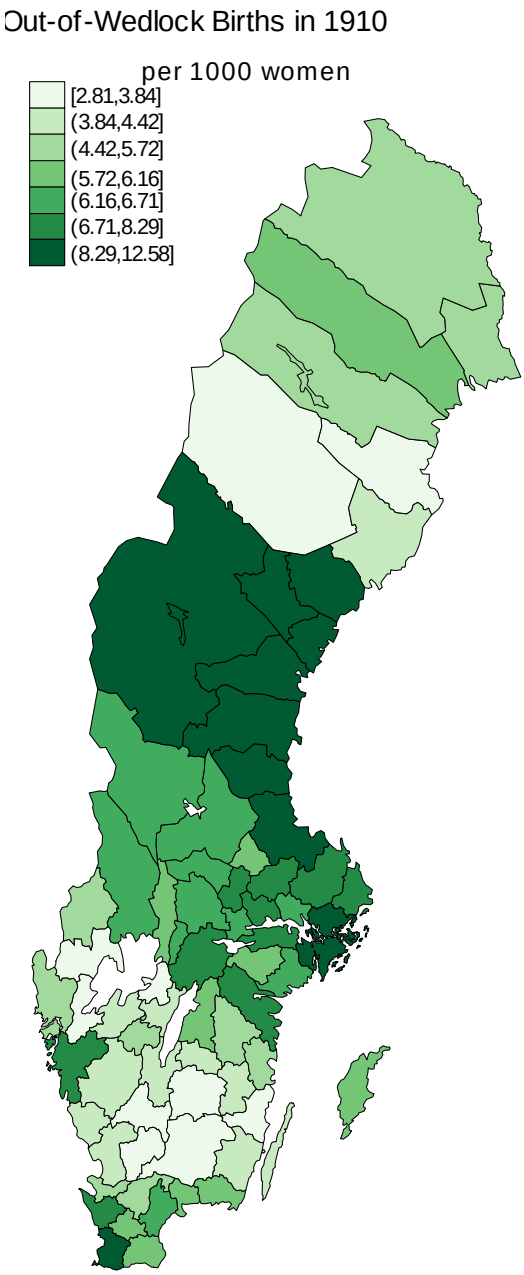

Figure 3: Out-of-Wedlock Births in 1910