The effect of norms on fertility and its implications for the quantity-quality trade-off in Pakistan*

Zainab Iftikhar

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Abstract

This study investigates the effect of fertility norms on the fertility of women in Pakistan and infers its consequences for the education of their children. Due to the lack of information on investment in education of children (quality) I make use of indirect inference to assess the effect of norms on quality. I first estimate an auxiliary econometric model that shows a strong positive effect of norms on fertility. Next, I develop a quantity-quality model augmented with the role of fertility norms. The structural parameters of the model are identified using the results of the empirical analysis. Simulation of the theoretical model leads to conclusion that the $\frac{2}{5}$th of the variation in the quantity between the women with highest and lowest fertility comes from difference in norms while the rest is explained by wage difference. Similarly, $\frac{1}{5}$th of the variation in quality between the two women is explained by the norms while the rest comes from difference in wage. Women with lower wages are more responsive to changes in norms in terms of changes in quantity-quality trade-off. Women's response to changes in wages is governed by norms. Higher norms mitigate the effect of economic development on both quantity and quality.

Keywords: Quantum fertility norms, Quantity-quality trade-off, Indirect inference, Zero-inflated poisson

JEL codes: C13, J13, D10, Z13.

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1 Introduction

The role of human capital in fostering economic growth and development in a country is well known. Education is an important determinant of human capital. The importance of education increases many folds in the context of developing countries like Pakistan where the challenges are rather intense. The multidimensional poverty is one of the main concerns of Pakistan with 39% of the population living under multidimensional poverty.[1] The biggest contribution to national poverty stems from education in Pakistan. Education driven poverty contributes 42.8% to the national poverty (Multidimensional Poverty in Pakistan, 2016). Despite the situation, on a national level annual public expenditure on education has remained between $2-2.6\%$ of GDP over the last many years. This is smaller than the investment made by neighbouring countries like India, Iran and Nepal which on average spend more than 3% of GDP on education (WDI, 2016). Generally, the education decisions are made during childhood by the parents. To design policies that cater to the needs of certain segments of the society, information is required on what affects the decision of a parent to invest in the education of her children. Unfortunately, this information is missing for Pakistan. There exists a big body of literature that suggests a trade-off between the quantity and quality of children. So, to gather information on how a parent chooses what to investment in education of her children (henceforth referred to as quality) it is important to first understand her fertility behaviour. Among other factors fertility decisions in Pakistan are also subject to high fertility norms of the society. Since the quantity-quality decisions are closely related, these norms affect not only fertility but has implications for the quality of children as well. The objective of this study is to explain variation in quantity-quality trade-off among women in Pakistan stemming from difference in fertility norms[2].

It is difficult to map a women's fertility to the corresponding quality of her children using the existing data for Pakistan. Hence, the direct methods cannot be used to quantify the effect of norms on quantity-quality trade-off. So, I employ indirect inference to retrieve data on quality. The idea of the strategy is to first estimate an auxiliary econometric model to get stylized facts on fertility patterns of the women. Next, the theoretical channels that predict how fertility norms affect the quantity-quality of children are developed. The information from the empirical analysis is used to identify the structural parameters of the theoretical model. The theoretical model is then simulated to infer the quality of children and evaluate the role of norms. I consider quantum norms for my analysis. Quantum norms are fertility norms related to the socially acceptable number of children including childlessness (Klusener, Neels and Kreyenfeld, 2013; Balbo, Billari and Mills, 2013). To quantify the effect of norms on fertility I estimate the econometric model of fertility using "Pakistan Household Demographic Survey" (PDHS) data from 2012-13 on married women aged 15-49. Later, I use the theoretical model

[1] Multidimensional poverty index is based on fifteen indicators. It was developed by Oxford Poverty and Human Development Initiative (OPHI) and the United Nations Development Programme in 2010.

[2] Norms and fertility norms are interchangeably used in this study

to replicate the results of the empirical analysis and generate information on corresponding quality of the children.

The first step for the empirical analysis is to find a measure of fertility norms.I conceive two types of individual specific norms based on education and on ethnicity of the women in the sample. The ethnic fertility norms capture the persistent dimension of culture that distinguishes one ethnic group from the other. Based on the 8 ethnic groups classified in PDHS I construct 8 ethnic fertility norms. For the education norms I create four education groups namely, 1; uneducated 2; with some or complete primary education 3; with some or complete secondary education 4; with tertiary education which amounts to 13 years or schooling or more. The idea behind the norms based on education is to capture the cultural innovation which may be specific to the educated segment of the society. Since in Pakistan this group forms a very small proportion of the society, the cultural development within this segment is not observable when merged with the average behaviour of the society. But there is a possibility that the cultural developments within this group may diffuse into the rest of the society as this segment expands and interacts with the rest of the society.

The norms in each group are measured as the average of the total number of children ever born to women who have completed fertility (aged 49). The identification of norms is challenging, there are several factors that make the identification of norms difficult but two key problems require more attention. Fist, to identify norms it is important to disentangle the effect of norms from economic, institutional and political factors, second norms are endogenous to fertility after all they are measured as the average number of children born to women who have completed fertility in a certain ethnic or education group. To deal with these problems utilizing the notion that norms persist over time I develop a lagged measure of norms. I construct norms using PDHS data from 1990-91. This allows me to mitigate the identification problem arising from time-specific conditions the women face and from the endogeneity between norms and fertility. This measure does not reflect the norms of the parents instead capture the effect of horizontal norms. Note that the dataset for the empirical analysis is for 2012-13 which is used for information on fertility decisions and the rest of covariates. I estimate a zero-inflated poisson (ZIP) model to quantify the effect of norms, years of schooling and other covariates on fertility. ZIP allows to more clearly see the effect of norms and other covariates on extensive margin (childlessness) of fertility. I include childlessness in the analysis to have a clearer understanding of fertility behaviour of women as the two margins of fertility may respond differently to the same factor. Besides I have more than 1300 childless women, this calls for an analytical strategy that would take care of these observations in the analysis. ZIP also allows to differentiate between permanent and opportunity driven sterility. The results of the empirical model suggest that both ethnicity and education norms significantly affect the fertility level of a woman. The effects for ethnic norms are stronger than the education norms. The empirical analysis also reveals information on the effect of time opportunity cost on fertility. Opportunity cost of rearing and bearing a child is captured by education of women, a higher level of education is associated with higher opportunity cost.

In the next part of the analysis I build the theory using the quality-quantity model developed by de la Croix and Doepke (2003), I augment the model with the role of fertility norms and allow for childlessness. The model assumes that society inflicts an asymmetric cost on women who deviate from the norms. The women who are above the norms suffer less than those who are below norms. This effect reflects a society where having no children or fewer children is costlier than having more children because of the stigma attached to childlessness and family planning. Norms affect fertility through social costs. In order to minimize the cost related to higher fertility norms women choose higher fertility. Through this mechanism the norms also regulate the level of childlessness in the society. The asymmetric effect of norms on fertility thus ensures that childlessness either completely disappear or occur for infinitely higher wages. In this way higher fertility norms may dominate the effect of opportunity cost on childlessness. The opportunity cost of children in the theoretical model is captured by wage. Higher fertility norms may prevent women with higher opportunity costs from staying childless.

To estimate the structural parameters of the model I use minimum distance procedure. This procedure estimates the structural parameters of the theoretical model such that the theoretical model replicates as closely as possible the fertility behaviour predicted by econometric model. These parameters assist in generating information on quality of children across women in Pakistan. In the quantitative part of the study I simulate the model to generate information on quality and decompose the fertility difference between women with least and most number of children into contributions by norms and opportunity cost. Then, I run some counter-factual simulations to gather information on the effect of lower norms, higher wages and non-labour income on quantity-quality trade-off. The objective is to get an idea of how norms interferes with the effect of economic development on fertility. The results show that women of Punjabi ethnicity spend the most in education of their children with expenditure of highly educated women amounting to 5.51% relative to consumption expenditure in education. The uneducated Baruhi women have the highest fertility and they invest the least in the quality of their children. At most 58% of the variation in quantity is explained by wage while about 42% is explained by variation in norms. The quality varies at most by 80% due to difference in wage while the rest 20% of the variation is explained by norms. Lowering the norms increase the investment in education as well as reduces fertility in the society. Fertility behaviour in less educated women strongly responds to changes in norms. Consequently, the relative change in quality is higher at low level of wages.

Literature suggests that social norms play an important role in shaping the individual behaviours (Thomson and Goldman, 1987; Akerlof, 1997) and these norms also regulate the fertility behaviour in a society (Dasgupta and Dasgupta, 2017). However, this is the first study to the best of my knowledge in the economic literature that evaluates the effect of fertility norms on the quality of children as well as on childlessness. This study adds to the limited evidence on quality-quantity trade-off and explains why some regions with same the level of development may show different quality-quantity trade-off. The existing literature on norms and fertility abstracts from including quality as well as avoid investigating childlessness. Recently though childlessness has become an important issue even in the context of developing countries. Studies by Gobbi (2013), Aaronson et al (2014) and Baudin, de la Croix, Gobbi (2015, 2017) include childlessness in the analysis. The argument is that to have a better understanding of demographic trends in a country it is important to investigate fertility along both intensive and extensive margins. Baudin, de la Croix and Gobbi (2017) show that the determinants of the two margins may be different. They show for example that fertility decreases with the education along the intensive margin while the relationship is inverted U-shaped in case of the extensive margin of fertility. Fertility increases along the extensive margin (reduced probability of childlessness) for initial levels of education and after reaching a minimum it starts increasing with a rise in education. Understanding such responses is important from the population and development policy viewpoints. I show in this study that childlessness also responds to norms and it is important to incorporate this response as it has implication for inequality. Higher fertility norms lead to higher number of children in low-skilled women.[3] These children are also poorly educated. The same norms in the society also prevent the high waged/highly educated women from having no children despite the high opportunity cost.[4] This leads to at least one child in highly educated women who are also able to invest in the quality of their children. This leads to persistent inequality between successive cohorts. Kremer and Chen (2002) provide evidence that the fertility differentials between low-skilled and skilled women together with inter-generational persistence in education level make it difficult to reduce inequality in developing countries.

This study closely relates to the studies by Munshi and Myaux (2006), Fernández and Fogli (2006, 2009), Stichnoth and Yeter (2013), Spolaore and Wacziarg (2014) and Chabé-Ferret (2016). These studies examine the effect of cultural norms on fertility behaviour in a society. Munshi and Myaux (2006) provide evidence that high fertility choices and resistance to accept family planning in Bangladesh is strongly related to cultural norms. Fernández and Fogli (2006, 2009) show that the fertility of second generation of immigrant women in U.S. is positively affected by the culture in country of origin. They use fertility and labour force participation rates in country of origins as the proxy of culture. Stichnoth and Yeter (2013) find similar implication for fertility behaviour of migrant women in Germany. They allow migrant women from same origin to have heterogeneous norms based on the timing of migration. I also follow the idea of heterogeneous norms within a country in my analysis and assume that women from Pakistan are exposed to different fertility norms based on education and ethnicity. Melkersson and Rooth (2000) argue that individuals may be exposed to different social norms based on their

[3]Low-skilled; women with no education or education below 13 years of schooling
[4]Highly skilled; women with 16 years of schooling and above

social status. Therefore, they control for heterogeneous norms by using self reported social class of individuals as a proxy for norms while studying female fertility choices for Sweden. Chabé-Ferret (2016) provides evidence on the effect of norms observed in country of origin on the birth timing of second generation migrant women in France and U.S. Spolaore and Wacziarg (2014) look at the transfer of norms from France to surrounding Europeans countries and provide empirical evidence that in some European countries fertility rate declined due to diffusion of lower fertility norms from France. Another study by Beine, Docquier and Schiff (2013) suggests that destination country's norms may possibly diffuse into countries of origin through emigrants and affect the fertility behaviour in the source country.

However, none of the above mentioned studies look at the effect of norms on the level of childlessness. Chabé-Ferret (2016) differentiates between the extensive and intensive margins of fertility but looks at *tempo* norms. *Tempo* norms are related to the timing of childbirth (Balbo, Billari and Mills, 2013). The study shows that cultural norms have no effect on the timing of first and second birth in second generation migrant women in France and U.S. But it does not say whether the overall level of childlessness is affected by the country of origin' norms. The economic literature mainly relates childlessness to economic factors like higher opportunity cost (Gobbi, 2013; Baudin, de la Croix, Gobbi, 2015; Aaronson et al, 2014) or poverty (Baudin, de la Croix and Gobbi, 2017). While the theoretical literature is quite clear on this issue, Aaronson et al (2014) is the only study to the best of my knowledge that analyses the quality-quantity trade-off while accounting for both extensive and intensive margin of fertility. This study however is not conducted in the context of norms and mainly looks at the economic determinants of childlessness.

Lastly, I could also compare the study to that of Hazan and Zoabi (2015). Their study suggests that highly educated women in U.S. may produce more children and work longer hours due to the availability and affordability of house keeping and daycare services. In developing countries it is possible to observe highly educated women with children. It could possibly be inferred that these women have children due to the channel described by Hazan and Zoaby but it may not be the case. The women may have children due to the stigma attached to childlessness. So to better understand the underlying causes of certain fertility patterns it is important to have a comprehensive framework which relates fertility to both economic and social factors and distinguishes between the two margins of fertility.

The rest of the study is organized as follows; section 2 discusses the empirical analysis; section 3 develops the theoretical framework; section 4 explains the identification of structural parameters and the results of simulations and section 5 concludes the study.

2 Empirical Analysis

This section specifies the econometric model and data set used in the empirical analysis. The idea behind conducting an empirical analysis is to get stylized facts from data on effects of norms and wages on fertility. These facts are later used to estimate the structural parameters of the theoretical model.

2.1 Context

I use PDHS data set for year 2012-13 for Pakistan. Pakistan is a developing country where more than 95% of the population relates to Islam. Pakistan has observed very high fertility rates between 7 and 6 till the end of 1980s. It witnessed a decline in fertility rate below 6 for the first time in early 1990s (Pakistan Demographic Survey 1992). Sathar and Casterline (1998) suggest that the fertility transition in Pakistan started in 1990s. The study suggests that important demographic changes began in 90s which were motivated by large scale social and economic changes that lead to changes in reproductive behaviour in this era. Among other determinants, the study suggests that female education may be one of the sources that initiated the break from reproductive regime which characterized the country between 1960s and end of 1980s. The primary school enrollment ratio of females increased from 13% in 1960 to 30% in 1990. The primary school enrollment ratio rose to 65% in 2012.[5] This may reflect that an increase in the number of educated women in the country may have lead educated women to deviate from the prevalent higher fertility norms affecting reproductive behaviour first through opportunity cost and later reinforced by peer effect. Sathar and Casterline (1998) calls this change in fertility behaviour as the onset of fertility transition in Pakistan. Despite the economic and institutional factors reducing the fertility rate along the intensive margin (fertility rate dropped from 5.4 (PDHS, 1990) in 1990 to 3.83 in 2012 (PDHS, 2012-13)) they seem to have very little affect on childlessness. Childlessness has in fact reduced since 1990s. In 1990s 3.3% of women aged 45 and plus were childless while in 2012-13 the fraction of childless women in sample reduced to 2.7%. These figures include both naturally sterile as well as by choice infecund women (if any). Fertility norms may very well explain why this might have happened. Economic environment may have caused women to decrease fertility along intensive margin in face of increasing opportunity cost but norms may have prevented them from becoming completely childless by imposing a higher social cost of staying childless. Technological advancement may have helped avoiding natural childlessness. This is one probable reason why childlessness may have declined over time. I leave evidence to the empirical analysis.

Education in Pakistan is not completely subsidized and a large part of education expenses are paid by the parents. There are several types of education systems running parallel in

[5] http://www.unicef.org/infobycountry/pakistan_pakistan_statistics.html.

the country.[6] The main distinction is based on ownership (private or public) of school, and medium of instruction (English or Urdu [7]) at school. Public and Urdu medium schools are cheaper compared to the private and English schools and quality of education provided in private schools is considered superior to that provided at public schools. Private schools charge different fees based on their claim to quality of education they provide. They work more like brands and the richer a parent is the more expensive brand in terms of schooling her child wears. While the elite class of the country is almost always sending their children to privately owned expensive schools there is now an increasing trend in the middle class to send their children to a reasonably good private schools in terms of quality of education. One out of three students in Pakistan goes to private schools (Nguyen and Raju, 2014). The parents can choose a school according to their financial circumstances. Poor of the country on the other hand are most likely to either send their children to cheap (in terms of expenditure) public schools or not send them to schools at all. Being a developing country with an overall high fertility rate and with different systems of education to choose from, makes the quality-quantity trade-off easy to observe and makes Pakistan suitable case for my analysis.

2.2 Data

The fertility in the empirical part is presented by the number of children ever born (NCEB) to a woman. The unit of analysis for empirical part of the study is woman. I shall analyze a sample of married women aged 15-49. The sample has women from four major provinces of Pakistan namely 1) Punjab (Pun); 2) Sindh (Si); 3) Khyber Pakhtoonkhwa (KPK); 4) Balochistan (Bal). I use information on the years on schooling as a proxy for wage. The more educated are assumed to correspond to a higher wage group and less educated to a lower wage group. 59% of the women in sample have not received any formal education at all. The non-labour income is measured by ownership of assets. Only 16% women own assets either independently or jointly with the spouse. The last and most important factor characterising a woman is the level of fertility norm she is exposed to. The most important task here is to construct norms for women in the sample.

There are several factors one needs to keep in mind while thinking about the norms but first and most important of all, there is no perfect way of constructing norms. I shall construct norms bearing in mind three hypotheses proposed by Manski(2000) while explaining similar behaviour among individual. These are

"1) endogenous interactions, wherein the propensity of an agent to behave in some way varies with the behavior of the group; 2) contextual interactions, wherein the propensity of an agent to behave in

[6] I do not consider Madrasa-education system (Islamic seminaries providing religious education) in this analysis

[7] Urdu is the national language of the country

some way varies with exogenous characteristics of the group members; 3) correlated effects, wherein agents in the same group tend to behave similarly because they have similar individual characteristics or face similar institutional environments", Manski (2000).

It is difficult to disentangle these effects but to capture endogenous interactions and contextual effects I construct norms based on education and ethnicity. An individual can be exposed to different norms based on several different factors. I argue that norms may vary not only based on ethnicity but also with variation in the type of networks of individuals. For example a woman belonging to an ethnic group may be exposed to very high fertility norm in her ethnic group but if she is educated she may observes a lower fertility norm among her peers. This individual would then be affected by more than one norm. These different norms may very well be affecting her fertility decision in opposite directions. The fertility norm of the ethnic group might push her fertility upwards while the norm from her peers may be affecting her fertility choice downwards. This individual is not only exposed to different and opposing norms but also her exposure to norms is different from another women who has the same the ethnicity but is uneducated and observes a higher fertility norm both in her ethnic group and among her peers. So, I define two types of norms for my empirical analysis namely 1) Ethnic Norms based on the ethnicity of the woman 2) Education Norms based on the education group of the woman.[8] Norms based on ethnicity would carry the influence of cultural, lingual and ethnic characteristics that are transferred from one generation to another and characterize the people in that group. Education norms are important in capturing the transition in norms. Educated women form a small proportion of the society in Pakistan. If this segment of society is not analyzed separately we may miss the cultural innovation and development that may be locked into a small segment of society but may diffuse via education networks across the rest of the society. So, the overall norms N_i could be expressed as a function of two norms $N_i = f(N_{Li}, N_{Ei})$ where N_{Li} are individual specific ethnic norms while N_{Ei} represent individual specific education norms. I use subscript L for ethnic norms so it is not mistaken for education. Note that the effect of education norm should not be confused with the effect of own education of a woman on her fertility. Her own education level would affect her fertility decision due to the time opportunity cost she has to pay for a child but the education norm would affect her fertility decision through what Manski (2000) calls endogenous interactions and contextual effects.

To measure norms I regress the fertility of ever-married women aged 15-49 on age dummies using Ordinary Least Square. Using the result of this regression I predict fertility for each woman at age 49[9]. I then create four education groups based on level of schooling namely 1) No education; 2) some or completed primary; 3)some or completed secondary; 4)higher

[8]It is possible to construct norms based on social networks, access to media and contraceptives etc but I believe that education is the most important factor which also affects the afore mentioned factors. So I base norms on education

[9]Poisson regression gives the same results but OLS makes the estimation of fertility at age 49 computationally easier compared to poisson model.

education. For each education group I compute average fertility for women at age 49 weighted by sampling probability. Thus, I get four types of norms based on education group. These education groups are formed on the national level rather than regional or district level in order to avoid correlated effects. Forming the groups across another dimension along with education, for example region, would lead to two problems first it may lead to very few observations in an education group belonging to a certain region and hence result in Manski's reflection problem. Secondly, taking norms in an education group that belong to same region may also lead the norm to capture the correlated effects as the women in these groups would be very homogeneous not only in terms of education but also in terms of exposure to same labour markets, similar environments and institutions etc. This means that the behaviour of females in a group with same education and from same region may vary with the behaviour of the group not because of their social interactions but because they are lets say exposed to same labour markets and same economic and political institutes. Creating norms nationwide across different education groups with no regard to region would minimize this probability to some extent and give variation in terms of exposure of females in same education group to different economic, political and physical environments.

For ethnic norms there are seven main groups defined in PDHS and an eighth group is defined as "others" and include all minority ethnic groups without clearly identifying them. So, I have 8 ethnic groups and I compute average fertility women at age 49 weighted by sampling probability as ethnic norm for each ethnicity. This gives me a total of 8 ethnic and 4 education norms with 32 possible combinations of norms.

One may still think that these norms could be capturing other correlated effects like education or labour market situations etc. To mitigate the identification problem further employing the notion put forward by Fernández and Fogli (2009) that norms persist over time I use data from PDHS 1990-91 to construct the norms described above. This means that the values for these norms would at least not reflect the labour markets, education situations or any other time-specific characteristics of the region for individual under study. Therefore, these are more likely to capture the norms' effect on fertility and quality choices of females as economic conditions captured by these norms are no longer relevant for individuals in 2012-13. The data available for 1990-91 unfortunately does not have information from the capital Islamabad and Gilgit Baltistan. Only in 2012-13 wave these two regions were included in the PDHS. That is why I exclude these two regions from my analysis. Both education and ethnic norms are weighted by there sampling probabilities to represent underlying population. Table 1 shows the distribution of norms across different ethnicities and education groups in the sample of 2012-13. The minimum value of education norm is 4.66 which corresponds to the skilled group depicting a lower fertility norm for more educated females.[10] Ethnicity norm ranges between 6.62 and 7.54.

[10] skilled group; 13 years of schooling and above

Ethnicity	Value	Percentage of sample
Punjabi	6.62	19.71
Others	6.63	6.70
Urdu	6.72	15.46
Baluchi	6.78	4.94
Sindhi	6.94	12.14
Pashtu	7.05	25.10
Saraiki	7.18	10.88
Baruhi	7.54	5.07
Education by years	**Value**	**Percentage of sample**
None	6.94	58.90
1-5 years of schooling	6.70	13.60
6-12 years of schooling	6.09	21.89
13 and more years of schooling	4.66	5.60

Table 1: Norms across ethnic and education groups

I have a sample of 10,884 observations from PDHS 2012-13 and the summary statistics of the main variables used in the analysis are given in table 2. The sample consists of married women only and does not include widows, divorced or separated women. As mentioned before the sample has women of age between 15 to 49. The reason of including women of all ages is to have a reasonably good number of observations to quantify certain effects. For example, it may be noticed that women with tertiary education only gives about 609 observations when women of all ages are included. This number would reduce drastically if the sample consists of only the women with completed fertility. This would make is difficult to identify the effect of education on fertility. Similarly, the observations in certain ethnic groups may reduce as well making a meaningful analysis rather difficult. Dependent variable for the analysis is the number of children ever born (NCEB) to a woman. The minimum is 0 while the maximum is 19. Baruhi ethnic group clearly has a much bigger mean NCEB than other ethnicities which also corresponds to the higher norms observed in this ethnic group. Remember that the stats in table 2 are for women between age 15 to 49 while are norms are constructed for women at age 49 to capture norms based on completed fertility.

2.3 Econometric Model

The most commonly used estimation technique involving count data is Poisson regression model (PRM). PRM seems appropriate for empirical analysis of fertility behaviour but if we observe too many zero values taken by dependant variable (the number of children ever born in this analysis) then PRM turns out to be a poor fit as it under predicts the zeros in the data (see Long and Freese, 2001 for details). I have about 1335 zero observations in the data set. The zeros in data could be either structural or sampling zeros. In the context of fertility structural zero would be permanent sterility and sampling zero refers to opportunity driven childlessness

Variable	Mean	Sd	Min	Max
NCEB total	3.7	2.76	0	19
NCEB Urdu	3.14	2.42	0	14
NCEB Punjabi	3.54	2.54	0	16
NCEB Sindhi	3.86	2.99	0	16
NCEB Pashtui	3.79	2.73	0	19
NCEB Baluchi	3.84	2.81	0	14
NCEB Baruhi	4.88	3.31	0	14
NCEB Saraiki	3.84	2.87	0	14
NCEB Others	3.59	2.75	0	13
Years of Schooling	3.50	4.82	0	16
Education %age sample				
	No education	Some or complete primary	Some or complete secondary	Higher
	58.90	13.60	21.89	5.60
Region %age sample				
	Punjab	Sindh	KPK	Balochistan
	32.97	25.71	23.94	17.38
Wealth index%age sample				
Poorest	Poor	Middle	Rich	Richest
18.37	19.04	19.14	19.55	23.90

Table 2: Descriptive Statistics

or childlessness due to young age etc as the sample contain women aged 15-49. It is not possible to deduce which zeros are structural because some young women in specific might appear childless but this might be one possible outcome and as age increases this zero may disappear for some women. On the other hand in some women it may represent structural zero and fertility may stay zero as these women reach the age of completed fertility. PRM also puts a very strong restriction on data as it does not allow for over dispersion. I shall employ the Zero-inflated Poisson regression model (ZIP) introduced by Lambert (1992) which allows to predict probabilities for both sampling and structural zeros. It not only assists to overcome the under-prediction of zeros but also allows for over-dispersion as it changes the mean structure and uses two distinct process to generate zeros (for details see Long and Freese, 2001). It means unlike PRM, ZIP does not require $\overline{n} = \sigma$. Where $\overline{n}$ is the mean value of fertility in the sample and σ is the variance. ZIP assumes that there are two latent groups one that is a always zero A and other that is not always zero B. $A = 1$ if n_i is always zero and zero otherwise. First, it predicts the membership in each group. It runs a logit/probit to determine the probability of an observation in the structural zero group. It then estimates the probability of each count including zero in not always zero group. In the last step it combines the probabilities from the previous two steps to predict the overall probability of a zero and non-zero count. I shall estimate the parameters of following ZIP model:

Logit for always zero group

$$\psi_i \equiv Pr[A_i = 1|Z_i] = \frac{e^{Z_i\gamma}}{1 + e^{Z_i\gamma}} \tag{1}$$

Poisson for sampling zero and positive count

$$E[n_i|X_i, Z, Ai = 0] = e^{X_i\beta}(1 - \psi_i) \tag{2}$$

The overall probability of a zero is then computed as follows

$$Pr[n_i = 0|X_i, Z_i] = [\psi_i x1] + [(1 - \psi_i)xPr(n_i = 0|Xi, Ai = 0)] \tag{3}$$

For the always zero group one has to specify variable that predicts the membership in always zero group. ZIP then runs a logit to determine the membership in always zero group. I choose age, square of age, ethnic norms, education norms and own education to predict membership in always zero group. These are called the inflate covariates and are presented by vector Z_i. These variables could be the same or different from the control variables of may be zero group (Long and Freese, 2001).

Where n_i is the number of children ever born to a woman i and β is the vector of estimated parameters and $\epsilon = 2.71828$ is the mathematical constant. X_i is the vector of the covariates. It includes both age and square of years of age to capture the non-linear relationship between fertility and age. There are about 34% women in the sample who have a different number of pregnancies compared to children ever born. To control for fertility differences due to stillbirths or terminated pregnancies I use a categorical variable which takes the value of 0 if there has been no still-birth or terminated pregnancy experience and 1 otherwise. It is expected that women who experienced stillbirths or terminated pregnancies would have higher number of children ever born compared to those with no such experiences. For the effect of education I use information on years of schooling. For non-labour income there is no information available on the value of non-labour income. So, I make use of information on assets in possession of a woman. This is information on property that a women may own alone or with the spouse. Since information on its value is not available I use categorical variable which is 1 in case of positive assets and zero otherwise. I use the wealth index to capture the effect of living standards. Wealth index in DHS reflects in general the living conditions of respondent, for example access to type of water, possession of durable like bicycle, car etc, access to media and similar things. I also use region fixed effects. I follow Fernández and Fogli (2009) and Chabé-Ferret (2016) in my approach by controlling for additional variables. They recommend to control for variables which may have explanatory power in predicting the fertility behaviour of a woman since other variables would capture any effect that is not caused by norms and prevent the norms estimates from being upward biased.

2.4 Results

The results of estimation are presented in Table 3. The coefficients in first column are coefficients of ZIP converted into percentage changes in expected count for not always zero group and percentage odds of always zero group, the latter group represents permanent sterility. The second column gives results in terms of expected log count. The third column shows the standard error w.r.t column two. The reference group is a married poorest female who lives in Balochistan, owns no assets and has no stillbirth or a terminated pregnancy.

Percentage change in expected count for those not always 0			
Variable	Percentage coefficient	Expected log count coefficient	S.E
Years of schooling	-1.8^a	-0.018	0.004
Education Norm	15.5^a	0.144	0.031
Ethnicity Norm	24.1^a	0.216	0.034
Age in years	27.7^a	0.245	0.007
Square of Age in years	-0.3^a	-0.003	0.000
Assets	-0.8	-0.008	0.016
Stillbirth/Miscarriage/Abortion	2.5^b	0.025	0.011
Pun	-1.2	-0.012	0.029
Si	-1.7	-0.017	0.027
KPK	-5.7^b	-0.056	0.027
Poorer	-3.2^c	-0.032	0.018
Middle	-3.9^b	-0.040	0.020
Richer	$-9.7\ ^a$	-0.102	0.023
Richest	-16.8^a	-0.184	0.027
Small city	-1.8	-0.018	0.023
Countryside	$-5.2\ ^b$	-0.054	0.024
Constant	-5.9^a	—	0.349
Percentage change in odds of always 0			
Education Norm	-23.0	-0.262	1.259
Ethnicity Norm	23.2	0.208	0.307
Age in years	-32.5^a	-0.393	0.081
Square of Age in years	0.5^a	0.005	0.001
Years of schooling	-9.5	-0.010	0.109

Note: The sample has 10,884 married women of which 1335 have zero children. For region fixed effects, wealth effects, assets effects and experience of a terminated pregnancy/still birth, dummy variables are used. The errors are robust and clustered over primary sampling unit. The reference category is poorest married woman from Balochistan living in a big city and has experienced no terminated pregnancy/stillbirth. (a: Significant at 99 percent confidence interval ,b: Significant at 95 percent confidence interval , c: Significant at 90 percent confidence interval)

Table 3: Effect of norms on fertility

Results fecund group

First I look at the effect of norms on fertility of not always zero group (from now onwards referred to as fecund group). Increasing the education norm by one unit would increase the fertility of the woman by 15.5% in fecund group. Although personal education has a significant negative effect on fertility, a significant positive effect of education norms shows that own years of schooling may be affecting the fertility of a woman downwards but if the fertility in her education group is rising it would put an upward pressure on her fertility. As observed in the data the high skilled group has a lower norm so the fertility of high skilled declines for two reasons; one due to own education thus high opportunity cost of child-rearing, second due to decline in fertility norm of high skilled. Similarly, the ethnic norms also has a positive relation with fertility. It suggest that if the fertility norm in a specific ethnic group increases by one child the woman from that ethnicity is expected to increase her fertility by a little more than 24.1%. So it appears that the ethnic norms are more strongly affecting the fertility decision of the women compared to the education norm. Both results are significant. A positive effect of both the norms on the fertility decisions of a woman reflects the well studied hypothesis that human behaviour is affected by social interactions and in turn affects the economic outcome (Manski, 2000; Guiso et al, 2006; Munshi and Myaux, 2005; Spolaore and Wacziarg, 2014). Fertility norm is a common example in this literature. A higher fertility norm would lead to higher fertility despite the fact that it leads to inefficient economic output, and it may be widespread (Guiso, et al, 2006).

The effect of own education on fertility is negative and an additional year of schooling decreases the fertility by 1.8%. The negative effect of education complies with the literature that suggests that education reduces fertility as educated parent bears a higher opportunity cost of child rearing(Barro and Becker, 1989; Livi-Baci, 1997; Kremer and Chen, 2002; de la Croix and Delavallade, 2018). The effect of assets which reflects the non-labour income here is insignificant. Experience of stillbirth increases the fertility by 2.5%. It is intuitive as women who experience still births or have children who die at an early age would have a higher NCEB in order to have a desired number of living children and they would attempt to reproduce more than the women with no such experiences. The region fixed effects are significant only for KPK and it has a lower fertility compared to the reference woman in Balochistan. Coefficient for wealth index dummies are significantly different from zero only for richer and richest women. Poorer and middle class woman's fertility does not differ significantly from poorest woman. A higher wealth index would not only mean better living standard but also better access to technology and probably more awareness about fertility control methods etc which may be why the richer and richest have lower fertilities compared to others. The effect of age is significant and positive. While the square of age has a negative relation with fertility.

Results permanently sterile group

The results for always zero group (permanently sterile group) in the lower part of table 3 gives the percentage chances of permanent sterility for a woman based on age, age square, education, ethnicity norms and education norms. Age is the only significant factor affecting permanent sterility.

Childlessness

Combining the results for fecund and permanently sterile group gives the total probability of being childless. It appears that norms have a significant impact on fertility not only along intensive margin but along extensive margin as well. Norms increase fertility along extensive margin by affecting opportunity driven childlessness. The results shows that norms play an important role in preventing childlessness in a sample with higher fertility norms.

Using the probabilities from count model and always zero group I generate the overall probability of childlessness for women exposed to different norms and with different years of schooling. The results are shown in the table 9 and 10 in appendix A. It can be observed in table 9 that exposure to higher norms decreases probability of childlessness. For the effect of education on childlessness my results are similar to those found by Baudin, de la Croix and Gobbi (2017) for developing countries. The probability of childlessness decreases for increases in education at initial level reaching a minimum of 0.118 at six years of education and it starts increasing for education 8 years and more. Hence, the fertility increases along extensive margin for initial levels of education while it starts decreasing after 12 years of education. It may be noticed however that the probabilities of childlessness are very low in general even for high level of education once again pointing towards the role of norms. To compare the performance of PRM with ZIP in predicting zeros accurately I plot probability of predicting zeros for the two models in figure 1. The left panel shows the results of PRM while the right panel shows the results of ZIP. The graphs plot the probability (y-axis) against the number of children(x-axis) from zero to 14. The blue lines are observed proportion while red lines show the proportion predicted by PRM or ZIP. It can be noted that PRM clearly under-predicts zeros.

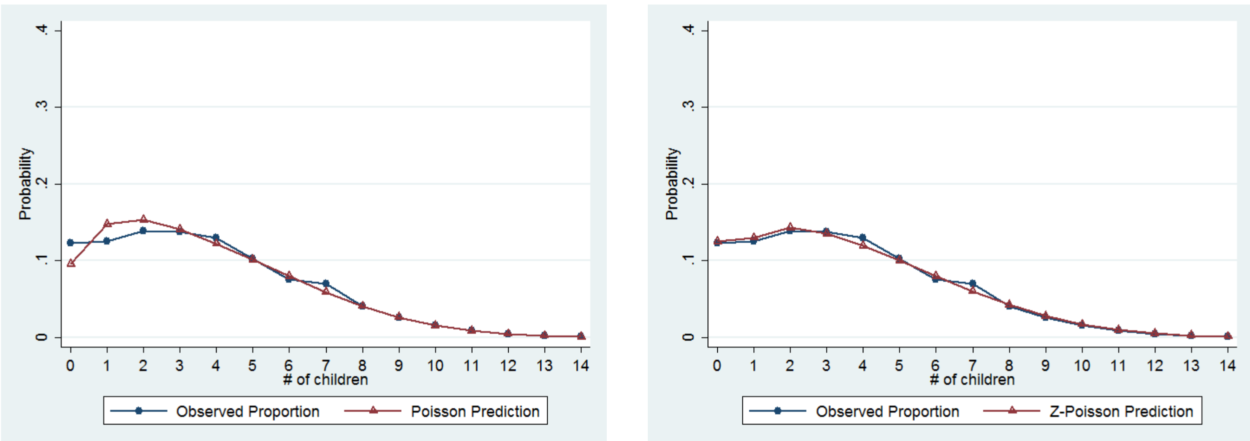

Figure 1: Zip better predicts zeros

2.5 Robustness

In this section I discuss the robustness tests. The results for all robustness checks are given in appendix B. One of the concern regarding the results in the preceding section could be that I use data on all women including those who have not yet completed fertility so the results might not be truly representative of the fertility behaviour of women with completed fertility. For this I do a robustness check running ZIP for women aged 40-49. Table 11 in appendix B contains these results.The results are robust for intensive margin although the estimates change in magnitude.

In an additional robustness check I control for education of spouse and age as fertility of the woman may not only respond to her own education but also to the education of her partner. In this regression I also control for age at marriage. The results are robust to the age and education of spouse. The education of spouse has a negative effect on the fertility of women which may reflect the fact that men may also bear some opportunity cost of raising the children. The smaller coefficient shows that this cost is smaller compared to that borne by mothers. The coefficients related to the age of spouse are also significant reflecting that fertility of women is also affected by the age of the spouse.

In the last robustness check I attempt to take care of the endogeneity problem between education and fertility. Students in Pakistan usually complete their Bachelor's degree between age 19 and 20. This amounts to 14 years of schooling. As I defined highly educated women those with at least 13 years of education, to check the robustness to education I run the same regression on a sample of women who gave birth to the first child at the age 20 or above. The results are presented in appendix B in table 13. The result for not always zero group are robust although for always zero group ethnicity norm is not robust.

3 Theoretical Framework

I build on the quantity-quality model developed by de la Croix and Doepke (2003). I consider an economy populated with heterogeneous individuals characterized by the wage (w_i), non-labour income (R_i) and fertility norms (N_i). Wage depends on the level of education of the individual. Individuals maximizes utility by choosing level of consumption (c_i), number of children (n_i) and the quality (e_i). The quality of children is determined by investment in education of children. Education has a fixed positive cost p per unit. It is a partial equilibrium analysis where w_i, R_i, p are exogenous. The utility function of an individual is given as follow

$$U_i = \log c_i + \theta \log[(n_i - \pi N_i) + a_1] + \lambda \log[e_i + a_2] \tag{4}$$

N_i represents the fertility norms of individual i. The parameter π represents the intensity of effect of norms. As I constructed two norms in the empirical analysis so I define the overall norm N_i here as a linear combination of two norms $\pi N_i = \pi_L N_{Li} + \pi_E N_{Ei}$. N_L is the ethnicity norms while N_E represents the education norm. π_L and π_E is the intensity of effect of norms associated with ethnicity and education norm respectively. a_1 and a_2 are auxiliary parameters added to the model to incorporate opportunity childlessness with restrictions $a_1 \geq \frac{1}{\phi}$ and $a_2 = 1$. These restrictions are added to the model to avoid log of negative and zero values. $\theta > 0$ and $\lambda > 0$ are the preference parameter for quantity and quality of children respectively.

At first glance this specification may appear like *Keeping up with the Joneses* utility function where utility depends on a reference point. In these models the agents compete to match their consumption to that of an aspirational group. However, in the specification in eq(4) the agents do not compete to reach at least a minimum level of fertility. Instead they may choose to have fewer children than the reference point πN_i or may even choose childlessness. The addition of a_1 ensures that agents can make such choices and still have positive utility. So, πN_i is not the reference point agents compete with, it is rather a cost that the society levies on all agents to ensure they choose higher fertility to maximize utility. This formulation allows to capture the fact that societies that prefer higher fertility inflict an asymmetric cost on individuals above and below norms. It reflects a society which stigmatizes childlessness or use of contraceptions for small family size. Spolaore and Wacziarg (2014) also assume asymmetric effect of norms on utility of individuals. If the society more readily accepts higher fertility then the individual with higher fertility would lose less for deviating from norms than those with lower fertility for given π. As $\frac{\partial U_i}{\partial n_i} > 0$, a higher number of children yields higher utility.

The asymmetric effect of norm is an important feature of this model. Assuming symmetric effect implies that individual at the same distance above or below the norm will pay same cost of deviation. This may lead to an overestimation of childlessness or underestimation of fertility along intensive margin in a society which exhibits higher fertility norms. It should be noticed that individuals with higher fertility may not necessarily be better off than those with lower fertility as they lose in terms of investing less in quality of children.The budget constraint of the individual is represented as follow

$$c_i = w_i(1 - \phi n_i) - e_i p + R_i \tag{5}$$

The other set of restrictions are given as follow

$$0 \leq n_i \leq \frac{1}{\phi} \tag{6}$$
$$e_i \geq 0 \tag{7}$$

$\frac{1}{\phi}$ is the biological maximum of the individual. It is referred to as full specialization throughout the article. ϕ cannot exceed 1 as this is the total amount of time available to the individual to allocate between work and child bearing/rearing.

The utility maximization problem of the individual is given as follow

$$\max_{n_i, e_i, c_i} U_i[n_i, e_i, c_i] \quad \text{s.t.} \quad (5) \quad (6) \quad (7)$$

The utility maximization gives the following result

Proposition. *There exist thresholds w_1, w_2, w_3, w_4, w_5 and $\overline{R}$ Such that if*

1. *$Max[w_1, w_2] \leq w_i \leq w_3$ then $\frac{1}{\phi} > n_i \geq 0$, $e_i \geq 0$ (Interior regime)*
2. *$w_5 \leq w_i \leq Min[w_4, w_2]$ and $R_i \leq \overline{R}$ then $\frac{1}{\phi} \geq n_i > 0$, $e_i = 0$ (No quality)*
3. *$w_i \geq Min[w_3, w_4]$ then $n_i = 0$ and $e_i = 0$ (Childlessness)*
4. *$w_i \leq w_5$ and $R_i \leq \overline{R}$ then $n_i = \frac{1}{\phi}$ and $e_i = 0$ (Full specialization without quality)*
5. *$R_i \geq \overline{R}$ and $w_i \leq w_1$ then $n_i = \frac{1}{\phi}$ and $e_i \geq 0$ (Full specialization with quality)*

Proof: See Appendix C.

Given the parameters of the model $\{\theta, \lambda, \phi, \pi, a_1, a_2\}$ and $\{w_i, R_i, N_i\}$ of women the thresholds in proposition are defined as follows

$$w_1 = \frac{a_2 p + R_i \theta}{(1+\lambda)(1 + a_1\phi - \pi N_i \phi)}$$

$$w_2 = \frac{a_2 p + a_2 p\theta - R_i \lambda}{\lambda(1 + a_1\phi - \pi N_i \phi)}$$

$$w_3 = -\frac{a_2 p\theta + R_i \theta}{\theta - (1+\lambda)(a_1\phi - \pi N_i \phi)}$$

$$w_4 = -\frac{R_i\theta}{\theta - a_1\phi + \pi N_i\phi}$$

$$w_5 = \frac{R_i\theta}{1 + a_1\phi - \pi N_i\phi}$$

$$\overline{R} = \frac{pa_2}{\lambda}$$

Note that these critical wages are defined in terms of N_i and R_i so they will vary for individuals with different non-labour incomes and exposure to different norms in values. So it is not possible to rank them in a systematic order. w_1 is the minimum wage required to ensure no full specialization. w_2 is the minimum wage for providing education to children. w_3 and w_4 are the wage limits for opportunity driven childlessness. w_5 is the minimum wage below which agent fully specializes in fertility and does not supply labour. $\overline{R}$ is the limit on non-labour income above which parent could educate children even without supplying labour. Figure 2 shows the different fertility regimes in wage and non-labour income space. One can observe that as soon as the wage is above the maximum of w_2, w_1 individual will move from full specialization to interior regime even if the non-labour income is above $\overline{R}$. Similarly, in case the wage is above $w3$ individual will move to opportunity cost driven childlessness even when above $\overline{R}$. We look at each case in detail in following sections.[11]

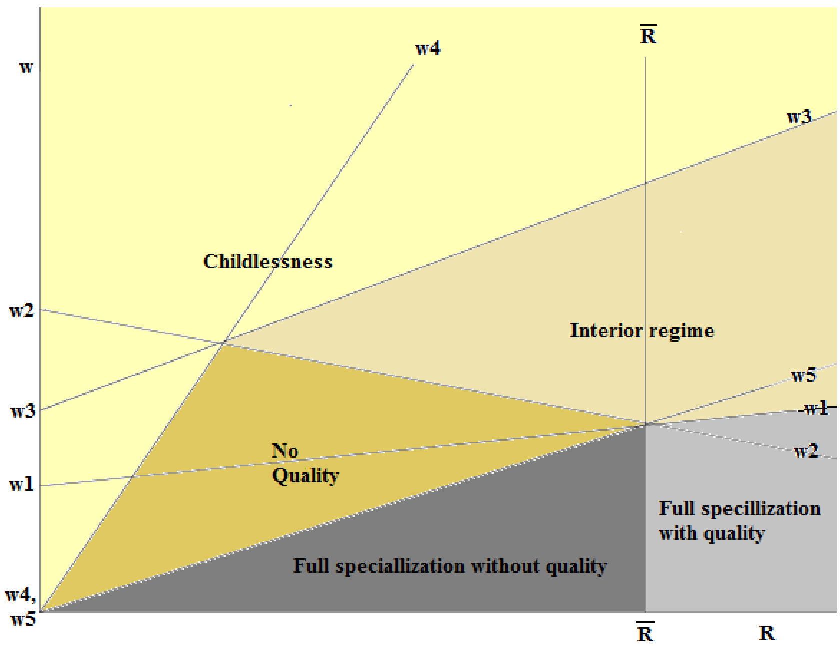

Figure 2: Fertility regimes in wage and non-labour income space

[11] See appendix C for proofs of all regimes.

3.1 Interior regime

When $\frac{1}{\phi} > n_i, e_i \geq 0$ then individuals are in interior regimes and quantity-quality can be defined as follows

$$n^* \equiv n_i = \frac{\theta(a_2 p + R_i + w_i) - w_i(1+\lambda)(a_1 - \pi N_i)\phi}{w_i(1+\theta+\lambda)\phi} \tag{8}$$

$$e^* \equiv e_i = \frac{-a_2 p(1+\theta) + \lambda(R_i + w_i + w_i(a_1 - \pi N_i)\phi)}{p(1+\theta+\lambda)} \tag{9}$$

Eq (7) shows the optimal value of n_i has a non-linear relationship with w_i. It reflects the fact that initially as wage increases the opportunity cost of having a child increases leading to lower fertility along the intensive margin. But if the wage is very high so that its income effect dominates the opportunity cost effect then fertility increases in wage. This later effect was explored by Hazan and Zoabi (2015) in women with very high wages. Fertility is increasing in non-labour income while the norms N_i also have a positive effect on fertility reflected by the following results

$$\frac{\partial n_i}{\partial N_i} = \frac{(1+\lambda)\pi}{(1+\theta+\lambda)} > 0 \quad \frac{\partial n_i}{\partial R_i} = \frac{\theta}{w_i(1+\theta+\lambda)\phi} > 0 \tag{10}$$

Results in eq (9) show that the quality of children reduces as the norm of parent increases. There is positive relationship between quality of children and wage of parent. Non-labour income also has a positive effect on quality. The individuals in this regime are indifferent to childlessness at wage equal to w_3.

$$\frac{\partial e_i}{\partial N_i} = -\frac{w\lambda\pi\phi}{p(1+\theta+\lambda)} < 0 \quad \frac{\partial e_i}{\partial R_i} = \frac{\lambda}{p(1+\theta+\lambda)} > 0 \quad \frac{\partial e_i}{\partial w_i} = \frac{\lambda(1+(a1-\pi N_i))\phi)}{p(1+\theta+\lambda)} > 0 \tag{11}$$

3.2 No quality

When $\frac{1}{\phi} > n_i, e_i = 0$ then n_i is defined as follow

$$n^\star \equiv n_i = \frac{R_i\theta + w_i\theta - a_1 w_i\phi + \pi N_i w_i \phi}{\phi(1+\theta)w_i} \tag{12}$$

In this regime individuals have positive number of children but they do not fully specialize if wage is above w_5. At wage w_5 they are indifferent between full specialization and producing children below maximum number possible. In this regime if the wage is below w_2 they cannot educate their children either. In this regime individuals cannot be childless as long as wage is below w_4, at w_4 the individuals in this regime are indifferent between staying childless and producing children. Remember that the individuals in interior regimes decide to stay childless above w_3. The As it is clear from (12) that in this regime as well the wage has a non-linear effect on fertility. It means the fertility may initially decrease with wage and then start increasing if the wage goes up by a large amount. While the following result suggest that fertility is positively affected by both norms and non-labour income in this regime.

$$\frac{\partial n_i}{\partial N_i} = \frac{\pi}{1+\theta} > 0 \quad \frac{\partial n_i}{\partial R_i} = \frac{\theta}{w_i(1+\theta)\phi} > 0 \tag{13}$$

3.3 Childlessness

In case of opportunity driven childlessness we have both $e_i, n_i = 0$. In this regime the value of wage should be high enough to ensure a higher opportunity cost of having children and the individuals decide to have no children. So as soon as the wage is above $Min[w_3, w_4]$ the optimal fertility level for the agent is zero. Note that the individuals in interior regime choose childlessness above w_3 while those in no quality regime choose childlessness when wage is above w_4. Since the critical wage is defined in terms of N_i and R_i, it is possible that the non labour income or/and norms are so high that it is not possible to have opportunity driven childlessness despite $a_1 > \frac{1}{\phi}$. Therefore, $a_1 > \frac{1}{\phi}$ is a necessary but not sufficient condition for the opportunity driven childlessness regime.

3.4 Full Specialization without quality

In this regime producing the maximum number of children ($\frac{1}{\phi}$) biologically possible becomes the optimal decision for the individual. In this regime R_i must be below $\overline{R}$ otherwise wage will not matter for investment in education of children. This regime is similar to no education regime as there is no investment in education of children. The difference is that in no education regime $n_i < \frac{1}{\phi}$.

3.5 Full specialization with quality

In this regime the agents may have very low wage but their non-labour income R_i could be sufficiently high so as to ensure positive investment in education of children. For individuals with very high level of non-labour income the no education regime vanishes. The education in this regime is independent of wage and is given as follows

$$e_i^{\bullet} = -\frac{a_2 p - R_i \lambda}{p + p\lambda} \tag{14}$$

It can be observed that the investment in quality is not only independent of wages but it is also independent of norms. This is rather a simplified assumption as in case the price of education was dependant on wage (highly waged women choosing expensive private schools compared to low-waged women choosing public schools with lower cost) then the quality in this regime would also depend on wage. Education in this regime clearly increases as non-labour income increases.

3.6 Graphical representation of the regimes

Figure 3 shows the graphical representation of regimes discussed in preceding sections. The left panel on figure 3 shows a positive relationship between wages and quality for fixed values of norms and non-labour income. The flat part of the curve on the bottom shows no quality. The increasing part of the graph shows the education in interior regime. The right panel shows the negative relationship between fertility and wages. The upper flat part corresponds to regime with no investment in education of children and $n_i = \frac{1}{\phi}$. The part of the graph lying on the horizontal axis shows the opportunity driven childlessness. The rest of the curve shows interior and no quality regimes. Remember that when fertility becomes zero the curve for e_i becomes irrelevant, intuitively it is not possible to invest in quality of children when there is no child.

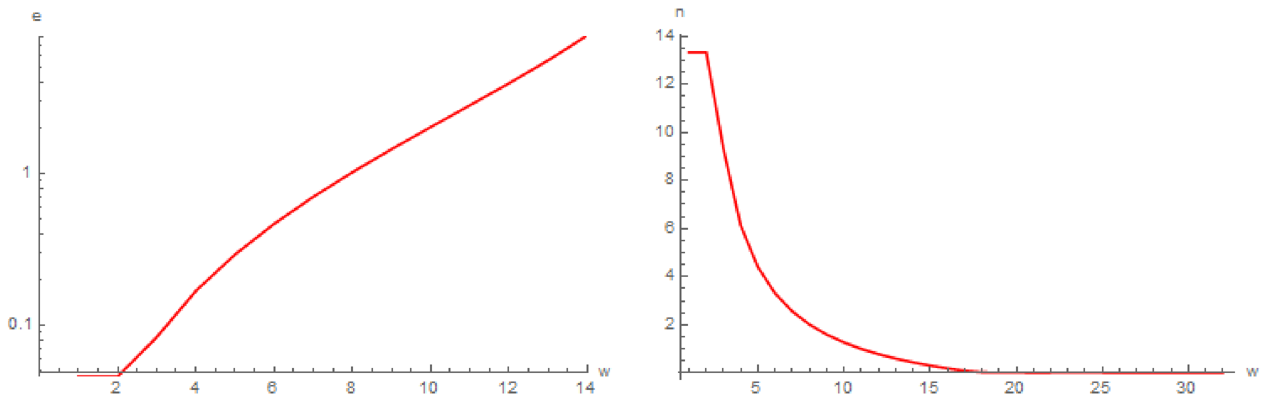

Figure 3: Different regimes of quality vs quantity of children

Effect of norms on childlessness

Figure 4 shows the effect of exposure to higher norms on quantity and quality. In both the panels the red lines show the initial levels while blue lines show the decisions when shocked by higher norms. In the left panel the curve for investment in quality of children moves rightwards as the fertility norms are changed to higher level. It reflects that societies with higher fertility norms would have lower quality of children. It is clear from the right panel of the figure that higher fertility norms increase the fertility and shifts the fertility curve upwards. It is quite possible to have societies where fertility norms are so high that it is impossible to have opportunity driven childlessness. When society reacts strongly to those childless individuals have a stronger incentive to avoid childlessness in order to avoid high costs. In this scenario the regime for childlessness would disappear.

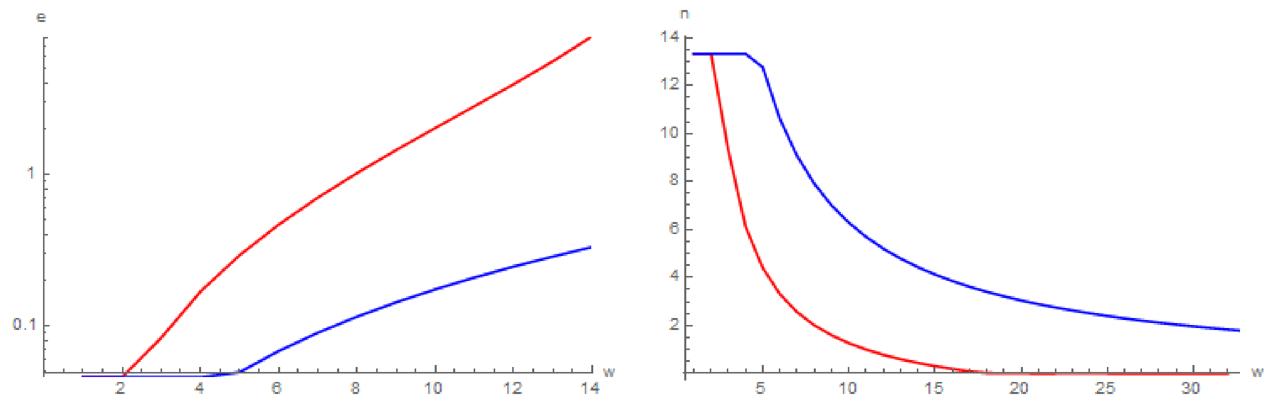

Figure 4: Effect of high fertility norms on quantity-quality

4 Quantitative analysis

4.1 Identification of structural parameters

To identify the structural parameters of the theoretical model I set the values of some parameters a priori. The auxiliary parameters a_1 and a_2 are set at $\frac{1}{\phi}$ and 1 respectively. I fix $\phi = 0.05$ which gives a maximum number of biologically possible children equal to 20. Since there is no information on the wages, I estimate the mincerian rate of return to map education into wages.

There are nine deep parameters namely; $\theta, \lambda, \pi_L, \pi_E, R, p, \varrho_1, \varrho_2, \varrho_3$ to identify. $\varrho_1, \varrho_2, \varrho_3$ give the estimated mincerian rates of return to primary, secondary and tertiary schooling respectively. The mincer rate of return for uneducated women is set at 0. The non-labour income could vary across women and that is why it is individual specific in section 3. But due to lack of information to extract individual specific values I shall estimate an average value of R. I use minimum distance estimation procedure for the identification of these parameters. I minimize the distance between 49 empirical moments and the moments generated by the theoretical model. To compute the empirical moments I use the results of empirical model to generate fertility values for women who have completed fertility (at age 49) for $4 * 8 = 32$ combinations of norms. Then using the same method I compute the fertility at age 49 for women with 0 to 16 years of schooling. This gives me 17 empirical moments based on opportunity cost. So, in total I have 49 empirical moments. The objective function estimates the structural parameters so as to minimize the distance between 49 moments described above and corresponding moments generated by the theoretical model. In addition I put a constraint that the weighted average spending on education by fertile women must equal the spending on education by government in Pakistan. This constraint does not include sterile women. This is because the theoretical model does not capture permanent sterility. The average education spending is weighted by the share of each type of women in the sample. I have 59% women with no education at all while a little below 5% have more than 13 years of education. I use information on aggregate public expenditure on education in Pakistan. Approximately a 2.5% of GDP was spent on education in Pakistan in year 2013. This will assists in extracting better information on investment in education of children by women. The objective function to minimize is as follows.

$$\min_{\theta,\lambda,\pi_1,\pi_2,\varrho_1,\varrho_2,\varrho_3,p,R} \left\{ \sum_{N=1}^{32} [{n_N}^* - {n_N}']^2 + \sum_{E=0}^{16} [{n_E}^* - {n_E}']^2 \right\} \quad \text{s.t} \quad E^* = (1-\chi)E' \tag{15}$$

Where ${n_N}^*$ are the fertility values generated by empirical model for 32 values of norms and ${n_N}'$ are the corresponding fertility values generated by the theoretical model. Similarly, ${n_E}^*$ and ${n_E}'$ are the fertility values generated by empirical model and theoretical model respectively for the 17 values of wages. E^* represents the expenditure made by government on education as a percentage of GDP while E' is the weighted average expenditure made by women belonging to different education/wage groups as implied by the model. χ is the proportion of permanently sterile women as estimated by the empirical model. It has a value of 0.032. Table 4 shows all the parameters of the theoretical model. Figure 5 shows how the fit of structural model to the data. The empirical moments generated for years of schooling assist in capturing the effect of opportunity cost on fertility while the empirical moments generated for norms assist in capturing the effect of norms on fertility. It is rather easy to see that these moments are meaningful in identifying $\theta, \pi_L, \pi_E, \varrho_i$. Now to understand how minimum distance procedure identifies λ, p, R imagine the role of λ in affecting fertility of women. When λ increases the quality will increase while quantity shall decrease. The minimum distance procedure shall estimate θ in order to simulate moments that are as close as possible to empirical moments. In order to achieve this the λ must be adjusted accordingly. If λ is too big fertility will be small and the moments generated by the model will be farther away from empirical moments. In a

Parameter	Value	
a_1	20	fixed a priori
a_2	1	fixed a priori
ϕ	0.05	chosen to match the moments
p	0.47	estimated to match the moments
θ	0.62	estimated to match the moments
λ	0.32	estimated to match the moments
π_L	0.54	estimated to match the moments
π_E	0.45	estimated to match the moments
R	0.82	estimated to match the moments
ϱ_1	0.006	estimated to match the moments
ϱ_2	0.003	estimated to match the moments
ϱ_3	0.037	estimated to match the moments

Table 4: Estimated and a priori fixed parameters

similar fashion the values of p and R shall be adjusted.

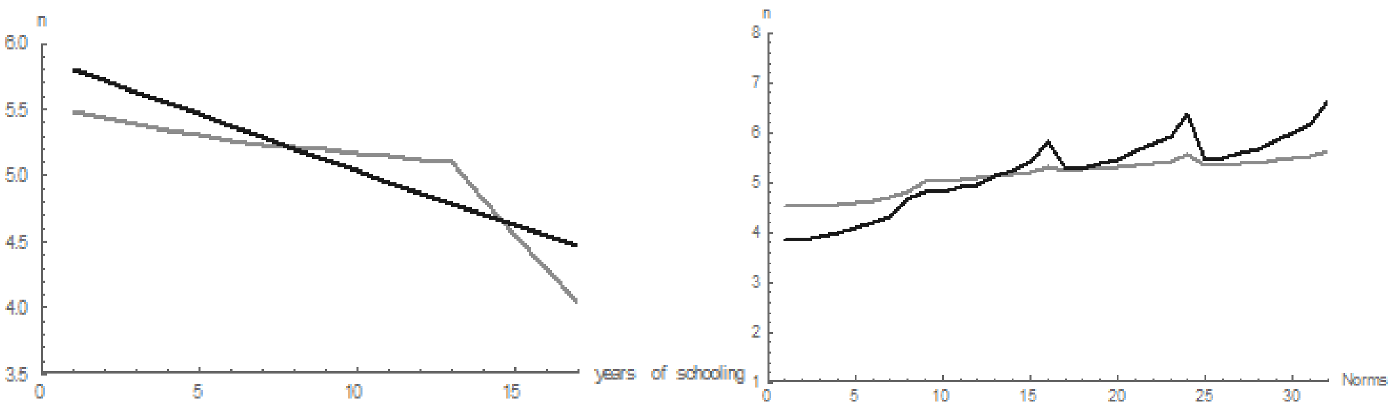

Figure 5: Simulated moments (gray lines) versus empirical moments (black lines)

The interpretation of the values of the parameters is straight forward. p is the price of per unit of education and a rise in it's value will lead to a decline in quality. θ and λ are the preference parameters for quantity and quality respectively. A higher value of θ compared to λ suggests a society that puts more weight on quantity than quality. The estimated value of θ is almost double the estimated value of λ for Pakistani women. This reflects a higher preferences for quantity which leads to a lower quality. This is also evident in the overall situation of education of children in the country. The π_L is bigger than π_E which shows that the intensity of effect of ethnic norms is higher than that of education norms. This is also observed in the results of empirical model which shows ethnic norms play a bigger role in affecting fertility than education norms. R is the mean value of non-labour income for whole sample. A rise in R would increase both quantity and quality as they are both normal goods in my model. Notice that the three mincer rates of return ϱ_i are very small compared to what is found in the literature for Pakistan. The literature suggests a this rate varies between 5 to 7 percent for each additional year of schooling. [12] Here this very small rate of return also captures the probability of employment of a woman. The data set has no clear information on the employment status of the women throughout her reproductive years. In Pakistan the female labour force participation is very low and amounts to a mere 25%. This may be the reason why the estimated mincer rates are so small in value as they capture both returns to schooling and employment probability of women in different education groups.

4.2 Quality of children

Using the ϱ_i identified in the previous section I generate wages for women with different years for schooling. These are shown in table 14 in appendix D. I then simulate the model to retrieve information on fertility and investment in education (relative to consumption share) made by women belonging to different ethnic and wage groups. The results are shown in table 5. The values are estimated at relevant ethnic and education norm for each group. Remember there are four education groups as defined in section 2.2 and the values are for the women who have completed fertility. The results show that women of Punjabi ethnicity belonging to the highest wage group spend highest on education and have the lowest fertility of 3.32 children. The highest fertility of is observed in the women of Baruhi ethnicity with lowest wage. They also show a lowest investment in education of children. The expenditure on education is expressed as percentage share relative to expenditure on consumption.

The quantity and quality difference between the highly educated Punjabi woman and least educated Baruhi woman is $+2.50$ and -4.09 respectively. These differences could be driven by opportunity cost and/or norms. It would be interesting to quantify the contribution of norms and wage to the variation in quantity and quality across the two groups. Figure 6 shows the the role of norms versus opportunity cost in explaining the difference in quantity-quality between Punjabi and Baruhi women. The difference in wage 58% of fertility difference while it explains more than 80% of the difference in quality of children between the two type of women. Norms matter more in explaining the fertility differences than the quality of children. The two type of norms together explain more than one third of the difference in fertility between the two type of women. Less than one fourth of the difference in quality comes from the difference in ethnicity and education norms. The interaction of the norms and wages changes the fertility by 0.4% while changes the quality by 0.73%.

[12] See Nasir and Nazli, 2000; Khan and Toor, 2003; Jamal et al, 2003; Hyder, 2007; Aslam, 2007

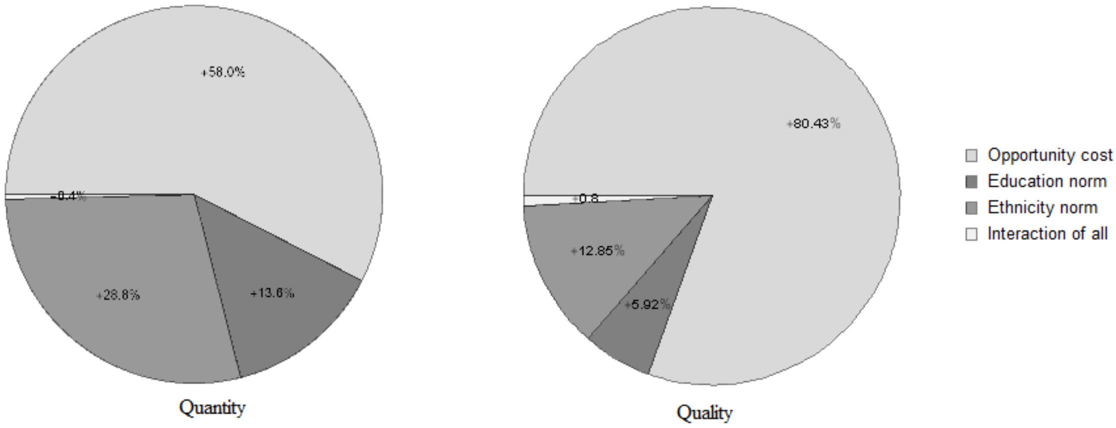

Figure 6: Contribution of norms and opportunity cost to variation in quantity-quality

Table 6 gives the variation in quantity-quality as we move from a highly educated Punjabi woman to least educated Baruhi woman. The first row shows the quantity-quality for a highly educated Punjabi woman at ethnicity and education specific norms and wage while the last row shows the quantity-quality for a least educated Baruhi woman. The rows in-between show the changes in quantity-quality as we move the Punjabi woman closer to the baruhi woman by changing norms and wages one at a time.

	Urdu		Punjabi		Sindhi		Pashtu		Balochistan		Saraiki		Baruhi		others	
Wage	Quantity	Quality	Quantity	Quality	Quantity	Quality	Quantity	Quality	Quantity	Quality	Quantity	Quality	Quantity	Quality	Quantity	Quality
1.000	5.52	1.65	5.49	1.68	5.61	1.59	5.64	1.56	5.55	1.63	5.69	1.52	5.82	1.42	5.49	1.67
1.005	5.40	1.80	5.37	1.83	5.48	1.74	5.52	1.71	5.42	1.79	5.57	1.67	5.70	1.56	5.37	1.83
1.011	5.36	1.90	5.32	1.92	5.44	1.84	5.48	1.81	5.38	1.88	5.53	1.77	5.66	1.67	5.33	1.93
1.017	5.31	1.99	5.28	2.02	5.39	1.93	5.43	1.91	5.33	1.98	5.48	1.87	5.61	1.77	5.28	2.02
1.023	5.27	2.09	5.23	2.12	5.35	2.03	5.39	2.00	5.29	2.08	5.44	1.97	5.57	1.86	5.24	2.12
1.028	5.22	2.19	5.19	2.21	5.30	2.13	5.34	2.10	5.25	2.17	5.39	2.06	5.52	1.96	5.19	2.21
1.031	5.01	2.38	4.97	2.41	5.09	2.32	5.13	2.29	5.03	2.37	5.17	2.26	5.31	2.16	4.97	2.41
1.034	5.12	2.43	4.95	2.46	5.07	2.37	5.11	2.34	5.01	2.41	5.15	2.31	5.28	2.20	4.95	2.46
1.037	4.96	2.48	4.93	2.51	5.04	2.42	5.08	2.39	4.99	2.47	5.13	2.35	5.26	2.26	4.93	2.50
1.039	4.94	2.53	4.90	2.55	5.02	2.47	5.06	2.44	4.97	2.51	5.11	2.40	5.24	2.30	4.91	2.55
1.043	4.91	2.57	4.88	2.60	4.99	2.52	5.04	2.48	4.94	2.56	5.09	2.45	5.22	2.35	4.89	2.60
1.046	4.90	2.62	4.86	2.65	4.98	2.56	5.02	2.54	4.92	2.61	5.06	2.50	5.20	2.40	4.86	2.61
1.049	4.88	2.67	4.84	2.70	4.96	2.61	4.99	2.58	4.90	2.67	5.04	2.55	5.17	2.45	4.84	2.70
1.088	4.14	3.63	4.10	3.66	4.22	3.57	4.26	3.55	4.16	3.62	4.31	3.50	4.44	3.41	4.10	3.66
1.128	3.87	4.26	3.83	4.28	3.95	4.20	3.99	4.17	3.89	4.24	4.04	4.13	4.17	4.04	3.84	4.28
1.171	3.61	4.87	3.57	4.90	3.69	4.81	3.73	4.79	3.63	4.86	3.78	4.75	3.91	4.66	3.58	4.90
1.215	3.36	5.48	3.32	5.51	3.44	5.43	3.48	5.40	3.38	5.47	3.53	5.36	3.66	5.27	3.31	5.50

Note: The values are calculated at ethnicity and education specific norms for each wage group. Quality is expenditure on education of children expressed as a percentage share relative to the expenditure on consumption.

Table 5: Simulated fertility and quality of children across different ethnic groups

At values	Quantity	Quality	Change in quantity	Change in quality
$N_L = 6.62$, $N_E = 4.66$, $w = 1.215$	3.32	5.51	—	—
$N_L = 7.54$, $N_E = 4.66$, $w = 1.215$	3.66	5.27	+0.34	-0.24
$N_L = 6.62$, $N_E = 6.94$, $w = 1.215$	4.04	4.98	+0.72	-0.53
$N_L = 6.62$, $N_E = 4.66$, $w = 1.000$	4.77	2.22	+1.45	-3.29
$N_L = 7.54$, $N_E = 6.94$, $w = 1.000$	5.82	1.42	+2.50	-4.09

Note: Quality is expenditure on education of children expressed as a percentage share relative to the expenditure on consumption.

Table 6: Role of opportunity cost vs norms in explaining variation in quantity and quality across women

Role of education norms

To emphasize on the role of education norms I compare the women exposed to ethnicity norms to those exposed to both ethnicity and education norms. Figure 7 shows the quantity and quality with and without the effect of education norms. The darker lines in the figure shows the quantity-quality when women differ both by wage and by education norms while the lighter lines show women only by wage. Assuming women are only affected by one kind of fertility norms (the average fertility norm, 6.9) in the society and disregarding the effect of education' norms leads to an over estimated fertility while the quality of the children is underestimated for each wage/education group. The idea of this exercise is to show that education not only affects the quantity-quality trade-off through opportunity cost but also through peer effect.

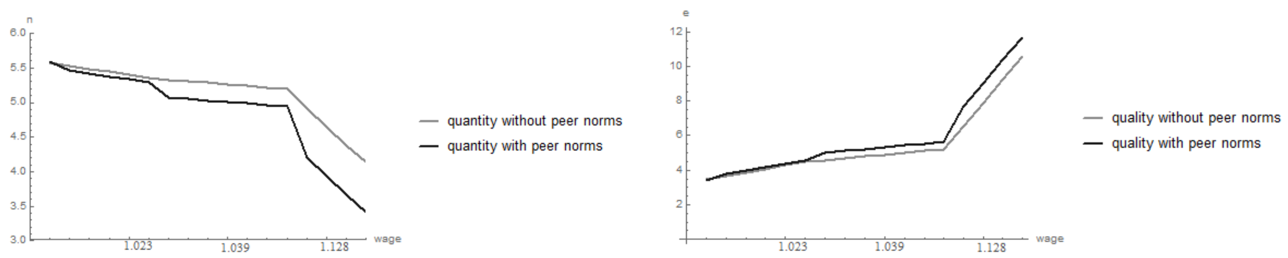

Figure 7: Role of education norms in explaining variation in quantity-quality

All the results in this section are calculated at the mean value of non-labour income as identified by the minimum distance procedure. But the individuals may differ in terms of non-labour income. In the next section I simulate the model to investigate how a variation in non-labour income may lead to different implications for quantity-quality trade-off.

4.3 Simulations with non-labour income, wage and norms

Lowering the norms

In this section I run a counter-factual simulation to understand how lower norms will affect the quantity and quality of children in Pakistan. Table 7 shows the results. In the first column under fertility and quality the ethnic norms are set at 6.9 for all women while the $N_E = i$ (where $i = 6.94, 6.70, 6.09, 4.66$) represent education norms which vary as we move from one education group to another. In the second columns for fertility and quality I set both ethnicity and education norms at the replacement fertility rate of 2. The results show that lowering the norms reduces quantity and improves quality. Lowering the norms reduces the social cost of deviating from the norms which leads the time opportunity cost effect to operate at a lower level of wage as well. It may be noticed that the percentage change in quality (education relative consumption) is the highest for the women with lowest wage and decreases as we move to higher wage groups. The decline in fertility is biggest for the women with lowest wage -3.36 while it is smallest -2.63 for women with 13 years of schooling and more. This difference in fertility in response to lowering of norms across different education/wage groups comes from difference in education group norms. If both ethnicity and education group norms are set at 6.9 then the fertility declines by 2.35 children in all wage groups. This exercise also make the connection of childlessness to norms clear in the analysis. The women with highest wage get closer to childlessness when norm are lowered to replacement level. If childlessness is disregarded in the analysis then we ignore the women who could be childless had they been observing lower norms but currently cannot do so due to exposure to higher fertility norms. Figure 8 shows more clearly the changes in share of expenditure on education relative to consumption. Lowering the norms to replacement level increases the average quality by 148% in the lowest wage group while it increases the quality by 32% in the highest wage group. Table 15 in appendix E shows

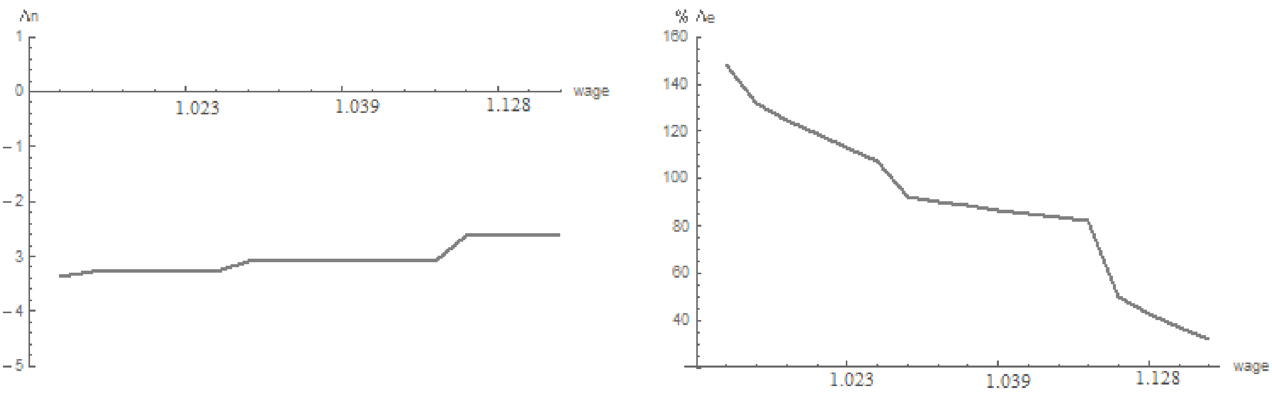

Figure 8: Change in quantity-quality with lower norms

the changes in quantity and quality as a result of decline in fertility norms to the replacement level for each ethnic group. The women with lowest wage belonging to Baruhi ethnicity gain the most in terms of quality of children from lowering the norms. They are able to increase the investment in education of their children relative to consumption expenditure by 180%. They also reduce the quantity of children by the highest number (-3.60) among all women. The women of Punjabi ethnicity and highest wage are least affected by the decline in norms both in terms of quantity and quality. They increase the quality by 30.52% while they reduce the quantity by 2.53 children. It is clear that less educated women are most affected by the changes in norms in terms of both quantity and quality.

	Fertility		Quality	
Wage	$N_L = 6.9, N_E = i$	$N_L = N_E = 2$	$N_L = 6.9, N_E = i$	$N_L = N_E = 2$
1.000	5.59	2.23	1.60	3.97
1.005	5.47	2.18	1.75	4.07
1.011	5.42	2.14	1.85	4.16
1.017	5.38	2.09	1.95	4.26
1.023	5.33	2.05	2.04	4.35
1.028	5.29	2.01	2.14	4.45
1.0.31	5.07	1.99	2.33	4.49
1.034	5.05	1.96	2.38	4.56
1.037	5.03	1.94	2.43	4.59
1.039	5.01	1.92	2.48	4.63
1.043	4.99	1.90	2.53	4.68
1.046	4.96	1.88	2.58	4.73
1.049	4.94	1.85	2.62	4.77
1.088	4.20	1.57	3.58	5.39
1.128	3.93	1.30	4.21	5.99
1.171	3.68	1.04	4.82	6.59
1.215	3.42	0.79	5.44	7.19

Note: Quality is expenditure on education of children expressed as a percentage share relative to the expenditure on consumption.

Table 7: Fertility and quality of children with lower norms

Role of opportunity cost and norms in preventing childlessness

In this section I conduct a counter-factual simulation to analyse the effect of wage and norms on childlessness. To do this I first simulate the model at average level of ethnicity norms (6.9) and education specific education norms while increase the wage to the level which leads to opportunity driven childlessness in the most highly waged female. Inducing childlessness in the women with highest wage requires a rise in wage by a 110%. In the second simulation I set both ethnicity and education group norm at replacement level fertility of 2 children per woman. To induce childlessness in women observing the replacement level norms requires the wage to increase by only 15%. Remember that childlessness is an extreme case and analysing this case makes it more clear to understand the strength of the norms in society. If childlessness is tolerated in the society we might observe bigger responses on fertility along the intensive margin to changes in economic development. Figure 9 shows the results of the two simulations. The left panel in the figure compares the fertility in women with same ethnicity and education norm for observed wage group to that of women observing same norms but a wage increased by 110% at each level. The right panel compares the fertility in women with same ethnicity and education group norm for observed wage group to that of women observing norms at replacement level and a wage increased by 15% at each level. Though this clearly indicates that in Pakistan both low wage and higher norms are responsible for low level of childlessness but it also conveys the message that norms affect the response of fertility and quality to the economic development to a significant extent.

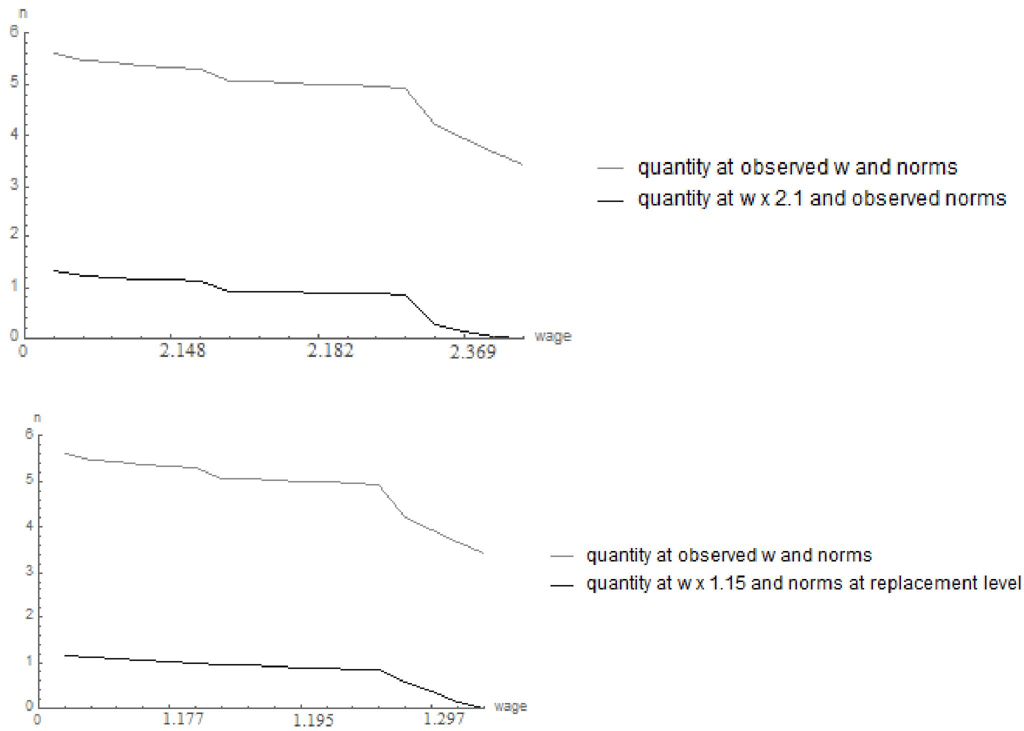

Figure 9: Change in quantity with norms versus wage

Role of non-labour income

The preceding section discusses the quantity-quality of children in each ethnic and wage group assuming each woman has the same non-labour income. Women may not have the same level of non-labour income. The data does not allow to get exact the information on the level of non-labour income, I estimate a mean level for all women in sample. However, in this section I simulate the fertility and education expenditure decision of women by assuming different values of non-labour income.

First it is important to discuss the idea of non-labour income R in the context of Pakistan. Like most of the developing Asian countries in Pakistan also there exist a joint family living arrangement. It reduces accommodation as well as utilities costs. Similarly, joint family system also provides support in terms of providing care services for children in absence of mother. All these benefits can be counted as a part of non-labour income. The system is well in place in country in general but in cities there exist possibilities of nuclear family arrangements. It is also possible that some women contribute more in providing such benefits, for example taking care of the rent of the family house etc.

So, considering the nature of non-labour income I simulate the model by setting R at the half of the estimated mean value 0.41, at 0.82 which is the estimated level of R and at 1.64 that is the double of the estimated non-labour income. I fix N_L and N_P at the average value of 6.9 for all women. The results are shown in table 8 and could be compared horizontally across the columns to see the effect of non-labour income on women with same wages. The R has a positive effect on both fertility and investment in children's education in all women. These results corresponds to the discussion in section 3.1. We know from the eq 9 and 10 of the theoretical model that quantity-quality are positively affected by R. These simulations assists in quantifying the extent to which the quantity and quality are affected by non-labour income in different wage groups.

	Fertility			Quality		
Wage	$R = 0.41$	$R = 0.82$	$R = 1.64$	$R = 0.41$	$R = 0.82$	$R = 1.64$
1.000	2.64	5.58	10.79	0	1.62	8.31
1.005	2.63	5.54	10.71	0	1.71	8.37
1.011	2.61	5.49	10.64	0	1.81	8.43
1.017	2.59	5.45	10.57	0	1.91	8.49
1.023	2.57	5.40	10.49	0	1.20	8.55
1.028	2.56	5.36	10.42	0	2.10	8.61
1.031	2.55	5.33	10.38	0	2.14	8.64
1.034	2.55	5.31	10.35	0	2.19	8.67
1.037	2.53	5.29	10.31	0	2.24	8.70
1.039	2.52	5.27	10.27	0	2.29	8.73
1.043	2.51	5.25	10.24	0	2.34	8.76
1.046	2.50	5.22	10.20	0	2.39	8.79
1.049	2.49	5.20	10.17	0	2.44	8.82
1.088	2.39	4.92	9.71	0	3.07	9.21
1.128	2.87	4.65	9.26	0	3.69	9.60
1.171	2.17	4.39	8.84	0.23	4.31	10.00
1.215	1.99	4.14	8.42	1.03	4.93	10.39

Note: The values are calculated setting N_L and N_{Ei} at average for all women. Quality is expenditure on education of children expressed as a percentage share relative to the expenditure on consumption.

Table 8: Investment in quality of children with alternative assumption about non-labour income

5 Conclusion

Norms affect the fertility decisions of women in all societies. In the context of developing countries fertility norms are usually high and tend to increase the overall fertility rate in the society and reduce childlessness. In this study I put forward that norms may not only affect the fertility behaviour but it also has implications for the quality of children (measured in terms of investment in education of children by mothers). I conduct this analysis for Pakistan. The lack of availability of data on quality of children corresponding to the observed fertility of women does not allow to measure the variation in quantity-quality trade-off explained by fertility norms. To overcome this problem I employ indirect inference which allows me to infer about the quality of children by investigating the fertility behaviour of women in Pakistan. I first conduct an empirical analysis which explains the variation in fertility due to norms. I assume two kind of individual specific norms based on ethnicity and education of the women. The empirical analysis concludes that both norms are significant and may not only affect the intensive margin of fertility but also has an impact on extensive margin of fertility. Ethnicity norms have a stronger impact on fertility.

I then develop a theoretical model which postulates how fertility decision of women are affected by their socio-economic characteristics namely; wages, non-labour income and fertility norms. The theoretical model suggests a positive effect of norms on fertility and non-labour income while wages have a non-linear effect. The theoretical model identifies five fertility regimes; 1) childlessness, 2) interior regime, 3) no quality regime, 4) full specialization without quality, 5) full specialization with quality.

I use the facts obtained from the empirical model on the effect of norms and wages on fertility to identify the structural parameters of my theoretical model. After estimating the structural parameters of the model I simulate the model to generate quality of children for women with different education levels and different ethnic groups in Pakistan. It appears that women from Punjabi ethnicity spend the most in education of their children with expenditure of highly educated women amounting to 5.51% relative to consumption expenditure in education. The uneducated Baruhi women have the highest fertility and they invest the least in the quality of their children. At most 58% of the variation in quantity is explained by wage while about 42% is explained by variation in norms. The quality varies at most by 80% due to difference in wage while the rest 20% of the variation is explained by norms. I also do some counter-factual experiments by lowering the fertility norms. Lowering the norms increase the investment in education as well as reduces fertility in the society. Less educated women are more responsive in terms of changes in quantity-quality trade-ff to changes in norms and in wages. So, the change in quantity and quality is higher at low level of wages. Overall the main contribution of the study is explaining variation in fertility along both extensive and intensive margins due to norms and providing information on what mothers spend on quality of children based on their level of education and exposure to norms.

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6 Appendix

Appendix A

Education Norms	Ethnicity Norms	Probability of childlessness
4.66	6.72	0.069
4.66	6.62	0.070
4.66	6.94	0.069
4.66	7.05	0.068
4.66	6.78	0.069
4.66	7.54	0.069
4.66	7.18	0.068
4.66	6.63	0.070
6.09	6.72	0.044
6.09	6.62	0.044
6.09	6.94	0.044
6.09	7.05	0.044
6.09	6.78	0.044
6.09	7.54	0.046
6.09	7.18	0.044
6.09	6.63	0.044
6.70	6.72	0.036
6.70	6.62	0.036
6.70	6.94	0.036
6.70	7.05	0.037
6.70	6.78	0.036
6.70	7.54	0.039
6.70	7.18	0.037
6.70	6.63	0.036
6.94	6.72	0.033
6.94	6.62	0.033
6.94	6.94	0.034
6.94	7.05	0.034
6.94	6.78	0.033
6.94	7.54	0.036
6.94	7.18	0.035
6.94	6.63	0.033

Table 9: Probability of childlessness with the level of Norms

Years of schooling	Probability of childlessness
0	0.127
1	0.124
2	0.122
3	0.121
4	0.120
5	0.119
6	0.118
7	0.118
8	0.119
9	0.119
10	0.120
11	0.121
12	0.122
13	0.124
14	0.126
15	0.128
16	0.130

Table 10: Probability of childlessness with the years of schooling

Appendix B

Percentage change in expected count for those not always 0			
Variable	Percentage coefficient	Expected log count coefficient	S.E
Years of schooling	-2.8[a]	-0.029	0.006
Education Norm	10.2[b]	0.097	0.044
Ethnicity Norm	16.7[a]	0.154	0.047
Assets	-1.7	-0.018	0.026
Stillbirth/Miscarriage/Abortion	4.6[b]	0.045	0.031
Pun	-5.1	-0.053	0.045
Si	2.3	0.023	0.041
KPK	-8.9[b]	-0.093	0.040
Poorer	1.2	0.011	0.031
Middle	-1.2	-0.012	.034
Richer	-4.9	-0.050	0.039
Richest	-11.4[a]	-0.120	0.046
Small city	1.1	0.011	0.037
Countryside	0.1	0.001	0.040
Constant	——	0.212	0.457
Percentage change in odds of always 0			
Education Norm	33.6.5	0.290	0.988
Ethnicity Norm	-22.3	-0.252	0.620
Years of schooling	-0.9	-0.009	0.123

Note: The sample has 2,118 married women of which 58 have zero children. For region fixed effects, wealth effects, assets effects and experience of a terminated pregnancy/still birth, dummy variables are used. The errors are robust and clustered over primary sampling unit. The reference category is poorest married woman from Balochistan who lives in a big city and has experienced no terminated pregnancy/stillbirth. (a: Significant at 99 percent confidence interval ,b: Significant at 95 percent confidence interval , c: Significant at 90 percent confidence interval)

Table 11: Robustness with completed fertility

Percentage change in expected count for those not always 0			
Variable	Percentage coefficient	Expected log count coefficient	S.E
Years of schooling	-1.6[a]	-0.016	0.004
Education of Spouse	-0.5[a]	-0.005	0.001
Education Norm	15.6[a]	0.145	0.030
Ethnicity Norm	23.3[a]	0.201	0.033
Age in years	24.4[a]	0.218	0.007
Square of Age in years	-0.3[a]	-0.003	0.000
Age of spouse in years	3.3[a]	0.033	.003
Square of Age of spouse in years	-0.0[a]	-0.0003	0.000
Assets	-1.1	-0.011	0.015
Stillbirth/Miscarriage/Abortion	2.6[b]	0.026	0.011
Pun	-2.2	-0.022	0.029
Si	-1.8	-0.018	0.027
KPK	-6.7[a]	-0.069	0.026
Poorer	-1.6	-0.016	0.018
Middle	-2.0	-0.021	0.021
Richer	-7.6[a]	-0.079	0.023
Richest	-13.9[a]	-0.150	0.028
Small city	-0.8	-0.008	0.023
Countryside	-4.0[c]	-0.040	0.024
Constant	—	-6.107[a]	0.349
Percentage change in odds of always 0			
Education Norm	12.9	0.122	1.642
Ethnicity Norm	27.5	0.242	0.318
Age in years	-32.2[a]	-0.389	0.089
Square of Age in years	0.5[a]	0.005	0.001
Years of schooling	-6.7	-0.069	0.131

Note: The sample has 10,884 married of which 1396 have zero children. For region fixed effects, wealth effects, assets effects and experience of a terminated pregnancy/still birth, dummy variables are used. The errors are robust and clustered over primary sampling unit. The reference category is poorest married woman from Balochistan who lives in a big city and has at no terminated pregnancy/stillbirth. (a: Significant at 99 percent confidence interval ,b: Significant at 95 percent confidence interval , c: Significant at 90 percent confidence interval)

Table 12: Robustness with age and education of spouse

Percentage change in expected count for those not always 0			
Variable	Percentage coefficient	Expected log count coefficient	S.E
Years of schooling	-1.0^a	-0.011	0.004
Education Norm	14.6^a	0.136	0.027
Ethnicity Norm	25.4^a	0.226	0.047
Age in years	35.2^a	0.301	0.010
Square of Age in years	-0.3^a	-0.003	0.000
Assets	-1.3	-0.013	0.020
Stillbirth/Miscarriage/Abortion	0.9	0.009	0.014
Pun	-2.2	-0.022	0.034
Si	-3.8^b	-0.038	0.033
KPK	-8.7^a	-0.091	0.032
Poorer	-4.8^b	-0.049	0.025
Middle	-5.7^b	-0.059	0.028
Richer	-12.3^a	-0.132	0.030
Richest	-17.7^a	-0.195	0.036
Small city	-1.3	-0.030	0.028
Countryside	-1.3	-0.025	0.027
Constant	—	-7.319^a	0.430
Percentage change in odds of always 0			
Education Norm	10.2	0.097	0.660
Ethnicity Norm	82.5^b	0.601	0.287
Age in years	-57.7^a	-0.859	0.075
Square of Age in years	1.1^a	0.011	0.001
Years of schooling	-8.1	-0.085	0.062

Note: The sample has 3,981 married of which 693 have zero children. For region fixed effects, wealth effects, assets effects and experience of a terminated pregnancy/still birth, dummy variables are used. The errors are robust and clustered over primary sampling unit. The reference category is poorest married woman from Balochistan who lives in a big city and has at no terminated pregnancy/stillbirth. (a: Significant at 99 percent confidence interval ,b: Significant at 95 percent confidence interval , c: Significant at 90 percent confidence interval)

Table 13: Robustness with age 20 and above at first birth

Appendix C

Maximization problem

$$\begin{aligned} L_i = \; & \log[w_i(1-n_i\phi) - pe_i + R_i] + \theta\log[n_i - \pi N_i + a_1] + \lambda\log[e_i + a_2] + \nu_1(n_i - 0) \\ & + \nu_2(e_i - 0) + \nu_3(\frac{1}{\phi} - ni) \end{aligned} \tag{16}$$

Where ν_1, ν_2 and ν_3 are KT multipliers associated with $n_i \geq 0$, $e_i \geq 0$ and $n_i \leq 1/\phi$ respectively and $c_i = w_i(1 - n_i\phi) - pe_i + R_i$.

First order conditions (focs) are as follows

$$\nu_1 - \nu_3 + \frac{\theta}{a_1 + n_i - N_i\pi} - \frac{w_i\phi}{R_i + pe_i + w(1 - n_i\phi)} = 0 \tag{17}$$

$$\frac{\lambda}{a_2 + e_i} + \nu_2 + \frac{p}{R_i - pe_i + w_i(1 - n_i\phi)} = 0 \tag{18}$$

$$n_i \geq 0, \quad \nu_1 \geq 0 \quad \text{and} \quad \nu_1 n_i = 0 \tag{19}$$

$$e_i \geq 0, \quad \nu_2 \geq 0 \quad \text{and} \quad \nu_2 e_i = 0 \tag{20}$$

$$n_i \leq \frac{1}{\phi}, \quad \nu_3 \geq 0 \quad \text{and} \quad \nu_3(\frac{1}{\phi} - n_i) = 0 \tag{21}$$

Interior regime solution

For the interior solution solving focs for n_i and e_i with $\nu_1 = \nu_2 = \nu_3 = 0$ yields (7) and (8). Remember due to "complementary slackness conditions" either the Lagrangian multipliers or the related constraints must be zero. Using (7) and (8) in c_i gives following level of consumption in interior regime

$$c_i = \frac{a_2 p + R_i + w + w_i(a_1 - \pi N_i)\phi}{1 + \theta + \lambda} \tag{22}$$

Solving $n_i^* = 0$ for wage yields w_3 and gives the upper bound on wage for interior solution. Solving $e_i = 0$ for wage yields w_2 which is the minimum wage required to invest in education of children. Solving $n_i^* = \frac{1}{\phi}$ for wage gives w_1 as the lower bound on wage to avoid full specialization. If the wage is below w_2 the women will not educate their children if the wage goes below w_1 and w_2 the women will both fully specialize and not educate children as long as $R_i \leq \overline{R}$.

No education solution

For no education regime we must have $e_i = 0, \nu_1 = 0, \nu_3 = 0, \nu_2 > 0$. Under these conditions solving focs n_i yields $n^\star$ of (11) and

$$\nu_2 = \frac{a_2 p + a_2 p\theta - R_i\lambda - w_i\lambda - a_1 w_i \lambda\phi + N_i w_i \lambda\pi\phi}{a_2(R_i + w_i + a_1 w_i \phi - N_i w_i \pi\phi)} \tag{23}$$

To get the restrictions on wage for childlessness in this regime I first solve $n^\star = 0$ and get w_4 as the upper bound for childlessness. Remember that when KT multipliers are zero the related variable becomes positive and vice-versa. So, solving $\nu_2 = 0$ yields w_2 which is the minimum wage required to invest in education of children. Because if wage goes above this level ν_2 must be zero and e_i should be positive for optimal solution. So in this regime the individual must have a wage below $Min[w_4, w_2]$ so that she does not reach either to the opportunity driven childlessness level of wage or w_2 which enables her to invest in quality. To solve for the lower bound on wage I solve $n_i^\star = \frac{1}{\phi}$ which yields w_5, the wage below which individuals will fully specialize. Using $n^\star$ and $e_i = 0$ in c_i gives the consumption in no education regime as follows

$$ci = \frac{R_i + w + w_i(a_1 - \pi N_i)\phi}{1 + \theta} \tag{24}$$

Childlessness solution

Solving focs for $n_i = 0$, $e_i = 0$ and $\nu_3 = 0$ yields

$$\nu_1 = -\frac{R_i\theta + w_i(\theta - a_1\phi + N_i\pi\phi)}{(R_i + w_i)(a_1 - N_i\pi)} \quad \nu_2 = \frac{a_2 p - (R_i + w_i)\lambda}{a_2(R - i + w_i)} \tag{25}$$

Solving $\nu_1 = 0$ for w_i gives $w_i = w_3$. As soon as $\nu_1 = 0$, n_i will become positive. So, w_3 is the threshold for keeping $n_i = 0$ and $\nu_1 > 0$. Note that as soon as $n_i = 0$ quality by default takes the value zero. The same result is obtained when $n_i = 0$ in the "interior regime" is solved for w_i. Above w_3 women choose childlessness if they are in interior regime. Solving (11) by putting $n_i = 0$ for w_i gives $w_i = w_4$. This is the upper bound on wage for women in "no education regime". Women in "no education" regime choose childlessness above w_4 due to high opportunity cost. So, the over all restriction on childlessness takes the form as described in proposition in section 3. Consumption in this regime is simply $w_i + R_i$.

Full specialization without quality solution

In this regime individual fully specialize in child production and invest nothing in quality. It means $n_i = \frac{1}{\phi}$ while $e_i = 0$ which means $\nu_1 = 0, \nu_2 > 0, \nu_3 > 0$. I solve focs under these conditions which gives

$$\nu_2 = \frac{p}{R_i} - \frac{\lambda}{a_2} \quad \nu_3 = \frac{\phi(R_i\theta + w_i(-1 - a_1\phi + N_i\pi\phi))}{R_i(1 + a_1\phi - N_i\pi\phi)} \tag{26}$$

Solving $\nu_3 = 0$ for wage gives w_5 as the threshold on wage for full specialization. At this wage the women are indifferent between full specialization and no education while as soon as wage goes above this limit they strictly prefer "no education" regime and supply labour as well. When $\nu_2 = 0$ investment in quality is positive. Solving $\nu_2 = 0$ for R_i gives the threshold level for non-labour income $\overline{R}$ above this level individuals will move into "full specialization with quality" regime.

Full specialization with quality solution

Solving focs under condition $n_i = \frac{1}{\phi}, \nu_1 = 0, \nu_2 = 0, \nu_3 > 0$ yields eq (13) and the following

$$\nu_3 = \frac{\phi((a_2p + R_i)\theta - w_i(1 + \lambda)(1 + a_1\phi - N_i\pi - \phi))}{(a_2p + R_i)(1 + a_1\phi - N_i\pi\phi)} \tag{27}$$

Solving (26) for wage gives w_1 that is the upper bound on wage for the women to stay in "full specialization" regime and not supply labour. Above w_1 the individual will enter into interior regime. Remember in this regime investment in education only depends on R_i and not w_i as regardless of wage the individual is rich enough to afford the education of child. So we have $\overline{R}$ as the required lower bound on non-labour income for an individual to be able to invest in education of children without worrying about wage. Putting $e_i = 0$ in (13) and solving for R_i gives , the same as obtained in "full specialization without quality" regime. At $\overline{R}$ women are indifferent between full specialization with or without quality. Consumption in this regime is given as follows

$$c_i = \frac{a_2 p + R_i}{1 + \lambda} \tag{28}$$

Appendix D

Years of Schooling	Wage
0	1
1	1.06
2	1.13
3	1.20
4	1.27
5	1.35
6	1.43
7	1.52
8	1.62
9	1.72
10	1.82
11	1.94
12	2.05
13	2.18
14	2.32
15	2.46
16	2.61

Note: Wages are calculated using a mincerian rate of return of 0.53

Table 14: Wage by level of education

Appendix E

	Urdu		Punjabi		Sindhi		Pashtu		Balochistan		Saraiki		Baruhi		others	
Wage	Quantity	Quality	Quantity	Quality	Quantity	Quality	Quantity	Quality	Quantity	Quality	Quantity	Quality	Quantity	Quality	Quantity	Quality
1.000	-3.26	+2.33	-3.26	+2.30	-3.37	+2.39	-3.41	+2.41	-3.31	+2.34	-3.46	+2.45	-3.59	+2.55	-3.26	+2.30
1.005	-3.22	+2.26	-3.18	+2.23	-3.30	+2.33	-3.34	+2.35	-3.24	+2.28	-3.38	+2.39	-3.52	+2.49	-3.18	+2.24
1.011	-3.22	+2.26	-3.18	+2.23	-3.30	+2.32	-3.34	+2.35	-3.24	+2.27	-3.38	+2.39	-3.52	+2.49	-3.18	+2.24
1.017	-3.22	+2.26	-3.18	+2.23	-3.30	+2.32	-3.34	+2.35	-3.24	+2.27	-3.38	+2.39	-3.52	+2.49	-3.18	+2.23
1.023	-3.22	+2.26	-3.18	+2.23	-3.30	+2.32	-3.34	+2.34	-3.24	+2.27	-3.38	+2.39	-3.52	+2.48	-3.18	+2.23
1.028	-3.22	+2.26	-3.18	+2.23	-3.30	+2.32	-3.34	+2.20	-3.24	+2.12	-3.38	+2.38	-3.52	+2.48	-3.18	+2.23
1.031	-3.02	+2.11	-2.99	+2.08	-3.10	+2.17	-3.14	+2.19	-3.04	+2.12	-3.19	+2.23	-3.32	+2.33	-2.99	+2.08
1.034	-3.02	+2.10	-2.99	+2.08	-3.10	+2.17	-3.14	+2.19	-3.04	+2.12	-3.19	+2.23	-3.32	+2.33	-2.99	+2.08
1.037	-3.02	+2.10	-2.99	+2.07	-3.10	+2.17	-3.14	+2.19	-3.04	+2.12	-3.19	+2.23	-3.32	+2.33	-2.99	+2.08
1.039	-3.02	+2.10	-2.99	+2.08	-3.10	+2.17	-3.14	+2.19	-3.04	+2.12	-3.19	+2.23	-3.32	+2.33	-2.99	+2.08
1.043	-3.02	+2.10	-2.99	+2.07	-3.10	+2.16	-3.14	+2.19	-3.04	+2.12	-3.19	+2.23	-3.32	+2.33	-2.99	+2.08
1.046	-3.02	+2.10	-2.99	+2.07	-3.10	+2.16	-3.14	+2.19	-3.04	+2.12	-3.19	+2.23	-3.32	+2.33	-2.99	+2.08
1.049	-3.02	+2.10	-2.99	+2.07	-3.10	+2.16	-3.14	+2.19	-3.04	+2.12	-3.19	+2.23	-3.32	+2.33	-2.99	+2.08
1.088	-2.57	+1.75	-2.53	+1.72	-2.65	+1.81	-2.67	+1.84	-2.59	+1.77	-2.74	+1.87	-2.87	+1.97	-2.54	+1.73
1.128	-2.57	+1.74	-2.53	+1.71	-2.65	+1.80	-2.67	+1.83	-2.59	+1.75	-2.74	+1.86	-2.87	+1.96	-2.54	+1.71
1.171	-2.57	+1.72	-2.53	+1.70	-2.65	+1.78	-2.67	+1.81	-2.59	+1.74	-2.74	+1.85	-2.87	+1.94	-2.54	+1.70
1.215	-2.57	+1.71	-2.53	+1.68	-2.65	+1.77	-2.67	+1.79	-2.59	+1.72	-2.74	+1.83	-2.87	+1.92	-2.54	+1.68

Note: The values show difference in quantity and quality of children when both type of norms are set at 2 compared to quantity and quality of children in table 5. Quality is expenditure on education of children expressed as a percentage share relative to the expenditure on consumption.

Table 15: Simulated changes in quantity and quality of children across different ethnic and wage groups for norms set at replacement fertility rate of 2 children per woman