The Trade-off between Child Quantity and Child Quality: An Application of the Kremer-Chen Model to Households in Rural Terengganu, Malaysia

Nor Azam Abdul-Razak (corresponding author)
School of Economics, Finance and Banking, College of Business
Universiti Utara Malaysia, 06010 UUM Sintok, Kedah, Malaysia
Tel: 60-4-928-3631 E-mail: azam@uum.edu.my

Roslan Abdul-Hakim
School of Economics, Finance and Banking, College of Business
Universiti Utara Malaysia, 06010 UUM Sintok, Kedah, Malaysia
Tel: 60-4-928-3556 E-mail: ahroslan@uum.edu.my

Russayani Ismail
School of Economics, Finance and Banking, College of Business
Universiti Utara Malaysia, 06010 UUM Sintok, Kedah, Malaysia
Tel: 60-4-928-3546 E-mail: russ1140@uum.edu.my

Received: November 18, 2010 Accepted: November 30, 2010 doi:10.5539/ijef.v3n3p257

Abstract

The idea of the trade-off between child quantity and child quality has long been documented in economics. In the past, this trade-off has been attributed to the rising marginal cost of child quantity and quality. In recent years, this trade-off has been attributed to a declining direct cost of childrearing and an escalating opportunity cost of childrearing induced by rising household income. Exploiting a micro data set from rural Terengganu, we revisit the idea based on this new postulate. Our goal is to investigate whether a rise in household income has a *positive* impact on child quality and a *negative* impact on child quantity. In a series of empirical exercises, we find that household income has a positive impact on *both* child quantity and child quality. We take these findings as evidence that there is *no* trade-off between child quantity and child quality among rural households in Terengganu, Malaysia.

Keywords: Child quantity, Child quality, Direct cost of childrearing, Opportunity cost of childrearing, Household income, Kremer-Chen model

1. Introduction

The idea of the trade-off between child quantity and child quantity has long been documented in economics. A basic premise is that households treat both child quantity and child quality as normal goods. This means that the demand for both child quantity and quality is expected to increase with an increase in household income. However, the marginal cost of child quality increases with income because higher quality applies to more children. By the same token, the marginal cost of child quantity increases with income because educated children are more costly. The rising marginal cost of child quality and quantity, coupled with a budget constraint, means that a given household has to choose between having more children and having educated children. Apparently, if a household prefers to have more children, then these children have to be relatively less educated; conversely, if a household prefers to have educated children, then there should be relatively few of them; hence, the trade-off between child quantity and child quality [see Becker and Lewis (1973) and Becker and Tomes (1976), among others].

The hypothesized child quantity-quality (CQQ) trade-off has been tested in a variety of settings early on by specifying child's education (a proxy for child quality) as a function of fertility (child quantity). In some studies, the hypothesized adverse relationship between fertility and child's quality is supported by the data. In other studies, the hypothesized adverse relationship is rejected by the data. A partial list of these studies includes Rosenzweig and Wolpin (1980), Black et al. (2005), Conley and Glauber (2006), Caceres-Delpiano (2006), Lee (2008), Li et al.

(2008), Angrist et al. (2010), and Qian (2009). Of these studies, two influential ones are Black et al. (2005) and Li et al. (2008). Black et al. (2005) analyze the CQQ trade-off issue based on a large sample of the Norway population during the period 1986-2000. In a series of estimations, they fail to find evidence in favor of the adverse relationship between fertility and child's education. Li et al. (2008) revisit the issue based on a large sample of the Chinese population in 1990. In a series of estimations, they find evidence in support of such an adverse relationship. Li et al. argue that these contradicting findings might be due to the level of development of these countries. In high-income countries such as Norway and Israel, the government provides good education infrastructures and facilities. In contrast, in low-income countries such as China, education infrastructures and facilities are relatively poor. Therefore, it is interesting to test their hypothesis in the context of another developing country where education infrastructures and facilities are comparable to those of the developed countries. One such example is Malaysia, where education infrastructures and facilities are well-developed, primary and secondary education is provided virtually for free, and tertiary education is highly subsidized. In this study, therefore, we revisit the issue using data that are gathered from Terengganu, Malaysia. Although Terengganu is a relatively less-developed state in Malaysia, education infrastructures and facilities are well-developed, similar to those of developed countries. Accordingly, we conjecture that there is little or no trade-off between child quantity and child quality in Terengganu.

2. The Kremer-Chen Model

Thus far, the existing empirical studies are based on the standard CQQ trade-off theory developed by Becker and his associates. In recent years, some economists have nested this CQQ trade-off framework into the growth theory. Three well-known contributions are made by Kremer and Chen (2002), de la Croix and Doepke (2003), and Moav (2005). A common feature of these papers is that households make a conscious decision on the quantity and quality of children in the family; hence, child quantity-quality decision. In Kremer and Chen (2002), this decision is based on the assumption that the cost of education is a decreasing function of household income and the cost of raising children is an increasing function of household income. In de la Croix and Doepke (2003), this decision is based on the idea that the cost of raising children is an increasing function of household income but the cost of education is independent of household income (because education is provided by teachers). In Moav (2005), this decision is based on the premise that the cost of education is a decreasing function of household income (because education is provided by parents) but the cost of raising children is independent of household income. Of these, the model developed by Kremer and Chen is particularly appealing because it is amenable to data availability. Accordingly, the Kremer-Chen framework is employed in this study.

To begin with, Kremer and Chen (2002) introduce a representative agent model of the economy with endogenous fertility decisions; i.e. households make a conscious decision on the optimal number of children that they wish to have. This optimal decision hinges on the trade-off that households face between the quantity and quality of children that they wish to have. This trade-off arises from the total cost of raising children, which consists of direct cost (i.e. food, clothing, and education) and indirect or opportunity cost (i.e. income that could have been earned if one chooses not to have and raise additional children). As household income rises, the direct cost of childrearing becomes immaterial; thus, children's education (which is part of the direct cost) rises with household income. As their income rises, however, the indirect or opportunity cost of childrearing becomes more prominent; hence, fertility declines with income. As a result, rich people tend to have few yet more educated children and poor people tend to have many yet less educated children. A society characterized by a higher proportion of the poor than the rich is a society in which income inequality is high. In this society, the fertility differential between the poor and the rich is expected to be high. According to the Kremer-Chen model, the higher the fertility differential, the higher the education differential of their children is. This, in turn, results in a smaller stock of human capital and a lower the level of per capita income in the future.

In this study, we focus on the impact of a change in household income on child outcomes only. In this regard, we can deduce two premises. First, an increase in household income has a negative effect on the direct cost of childrearing, which in turn, has a negative effect on child quality. Second, an increase in household income has a positive effect on the indirect or opportunity cost of childrearing, which in turn, has a negative effect on child quantity. Taken together, a change in household income has opposite effects on child quantity and child quality (hence, the trade-off between them). These opposite effects can be succinctly depicted by the following diagram:

$$\uparrow \mathit{Income} \rightarrow \begin{bmatrix} \downarrow \mathit{Direct\ Cost} \rightarrow \uparrow \mathit{Child\ Quality} \\ \uparrow \mathit{Indirect\ Cost} \rightarrow \downarrow \mathit{Child\ Quantity} \end{bmatrix}$$

3. Model Specification and Data

The trade-off between child quantity and child quality could be tested if we have access to the data on direct and indirect costs of childrearing. As mentioned earlier, the direct cost of childrearing includes the cost of children's food, clothing, and education incurred by parents. Although the complete data on the direct cost of childrearing are hard to come by, it could be argued that the cost of children's education is what matters for inducing changes in child quality. Accordingly, the cost of children's education borne by parents can be used as a proxy for the direct cost of childrearing.

In regard to the indirect or opportunity cost of childrearing, it goes without saying that the actual data are not available. To get around this problem, consider a typical household consisting of a husband, a wife, and children. Then, it seems plausible to assume that the wife's income is what matters for inducing changes in child quantity. If we assume that wife's income is proportional to the opportunity cost of childrearing (i.e. the higher the wife's income, the greater the opportunity cost of childrearing), then wife's income can be used as a proxy for the opportunity cost of childrearing.

3.1 Model Specification

Given the plausible proxies for the direct and indirect costs of childrearing, our model specification can be couched in terms of the following two sets of equations.

The first set of equations can be written as

$$Educ_i = \beta_1 + \beta_2 Educ\$_i + \mathbf{x}_\mathbf{i}^{'}\boldsymbol{\gamma} + \varepsilon_i \quad (1)$$

$$Educ\$_i = \alpha_1 + \alpha_2 HHInc_i + \mathbf{x}_\mathbf{i}^{'}\boldsymbol{\delta} + \eta_i \quad (2)$$

where $Educ_i$ is the average educational attainment of children in household *i* (measured by the average years of education of these children), *Educ$* is the cost of children's education incurred by parents (measured by RM/month), *HHInc* is household income (measured by RM/month), and **x** is a vector of parental characteristics (i.e. husband's age, wife's age, husband's educational attainment, and wife's educational attainment).

A priori, we expect the coefficients of *Educ$* and *HHInc* to be negative (i.e. $\beta_2 < 0$, $\alpha_2 < 0$) since *Educ* is a decreasing function of *Educ$*, which in turn, is a decreasing function of *HHInc*. Let us call this set of equations the Educ model.

The second set of equations can be written as

$$Kids_i = \phi_1 + \phi_2 WfInc_i + \mathbf{x}_\mathbf{i}^{'}\boldsymbol{\lambda} + u_i \quad (3)$$

$$WfInc_i = \pi_1 + \pi_2 HHInc_i + \mathbf{x}_\mathbf{i}^{'}\boldsymbol{\tau} + v_i \quad (4)$$

where $Kids_i$ is the number of children in household *i*, *WfInc* is the wife's income (measured by RM/month) and other variables are as defined before.

A priori, we expect the coefficient of *WfInc* to be negative while the coefficient of *HHInc* to be positive (i.e. $\phi_2 < 0$, $\pi_2 > 0$) since *Kids* is a decreasing function of *WfInc*, which in turn, is an increasing function of *HHInc*. Let us call this set of equations the Kids model.

3.2 Data

The data in this study are obtained from an interview-based survey conducted on a sample of 2500 rural households in Terengganu in May, 2009. However, our model specification requires that the sample be restricted to dual-parent households only. With this sample restriction, our sample size reduces to 2187 (i.e. the sample size reduces by 313 observations). In addition, dubious and missing values shrink the sample size further to 1650 (i.e. the sample size shrinks by another 537 observations).

Given this substantially reduced sample size, the summary statistics of the key variables are as follows: *Educ* ranges from 0 to 17 years with the average of about 7 years, *Kids* ranges from 1 to 11 children with the average of about 5 children, *HHInc* ranges from RM100 to RM15,750 with the average of RM1,936 per month, *WfInc* ranges from RM0 to RM8,250 with the average of RM214 per month, and *Educ$* ranges from RM0 to RM1,500 with the average of RM149 per month (see Table 1 for the summary statistics of all variables).

Before we conduct a formal analysis, let us take a cursory look at the relationship between a) household income and child quantity, and b) household income and child quality. A priori, we expect that the number of children (*Kids*) declines while the average number of years of children's education (*Educ*) increases as household income increases. As shown in Table 2, however, this appears not to be the case: as the range of *HHInc* rises from ≤ RM1000 to RM3001–RM4000, *Kids* rises from an average of 4.32 children to 6.04 children, and *Educ* rises from an average of 6.11 years to 9.07 years.

Although the results of this exploratory data analysis are clearly at odds with the Kremer-Chen predictions, they could be easily explained away. That is, the seemingly unfavorable pattern could be attributed to the varying age range of householders: as householders get older, they tend to have more children, and more educated children. Table 3 confirms this conjecture: as household head's age range rises from 21–30 to 51–60, *HHInc* rises from an average of RM1382 to RM2251, *Kids* rises from an average of 1.64 children to 6.01 children, and *Educ* rises from an average of 0.26 years to 10.25 years.

4. Estimation Results

Given the necessary data for a sample of 1650 rural households in Terengganu, we estimate each of the Educ and Kids models by the instrumental variable method. In the Educ model, *Educ$* is instrumented by *HHInc*. Hence, Eq.(2) represents the first-stage regression while Eq.(1) the second-stage regression. In the Kids model, *WfInc* is instrumented by *HHInc*. Hence, Eq. (4) represents the first-stage regression while Eq.(3) the second-stage regression.

The estimation results of the Educ model are shown in the first two marked columns in Table 4. In column (1), we observe that the estimated coefficient of *HHInc* is positive and significant at the 1% level. In column (2), we see that the estimated coefficient of *Educ$* is positive and significant at the 1% level. These results suggest that, as household income increases, the direct cost of childrearing is expected to increase as well. As the direct cost increases, householders are expected to invest more in their children's education. Apparently, both parts of these results are inconsistent with the predictions of the CQQ theory.

The estimation results of the Kids model are shown in the last two marked columns in Table 4. In column (3), we see that the estimated coefficient of *HHInc* is positive and significant at the 1% level. In column (4), we note that the estimated coefficient of *WfInc* is positive and significant at the 1% level. These results imply that, as household income increases, the opportunity cost of childrearing is expected to rise as well. As the opportunity cost increases, householders are expected to bear more children. Evidently, the second part of these results contradicts the predictions of the CQQ theory.

What could have given rise to these apparently poor results? Consider the Educ model. The theory states that the education cost of raising children becomes immaterial as household income increases. It could be plausibly argued that the declining importance of the education cost is not to be interpreted in the absolute sense. Instead, it should be construed in the relative sense; i.e. the education cost as a fraction of the total household expenditures (which include grocery expenses, utility bills, transportation costs, mortgage payments, car hire-purchase payments, medical expenditures, and so on). The rationale is that householders may spend disproportionately more on luxury-type goods as opposed to necessity-type goods (such as education) as their income rises. Hence, the relative cost of educating children may probably fall although the absolute cost may still rise. Hence, the education cost variable should be modified to be the cost of educating children as a fraction of total household expenditures, *Educsh* = *Educ$*/*HHExp*.

Now consider the Kids model. Earlier, we argued that wife's income is proportional to the opportunity cost of childrearing. It could be further argued that the proportionality is not to be interpreted in the absolute sense as well. Rather, it should be construed in the relative sense; i.e. the wife's income as a fraction of household income. The rationale is that, if wife's income constitutes a major percentage of household income, then it is more costly for householders to bear more children. Hence, the opportunity cost variable should be modified to be the wife's income as a fraction of total household income, *WfIncsh* = *WfInc*/*HHInc.*

Given the modified variables, we reestimate both models, and report the results in Table 5. In columns (1) and (2) of Table 5, we see that the estimated coefficients of *HHInc* and *Educsh* are each negative but individually insignificant even at the 10% level. These results suggest that there is weak evidence that an increase in household income is expected to decrease the direct cost of childrearing. As this direct cost falls, there is weak evidence that householders are expected to invest more in their children's education. Both of these results appear to be moderately consistent with the predictions of the Educ model. In columns (3) and (4) of Table 5, we note that the estimated coefficients of *HHInc* and *WfIncsh* are each positive and individually significant at the 1% level. These findings imply that an increase in household income is expected to raise the opportunity cost of childrearing. As this opportunity cost rises, householders are expected to have more children. While the first part of these results is consistent with the CQQ theory, the second part is not.

The weak evidence of the positive relationship between household income and child quality notwithstanding, both parts of the results imply that there is no trade-off between child quantity and child quality among rural households in Terengganu, Malaysia. These results appear to be consistent with those obtained by Black et al. (2005), who investigate the CQQ trade-off issue in the context of a developed country, Norway. However, these results clearly contradict those obtained by Li et al. (2008), who examine the issue in the context of a developing country, China. According to Li et al., the contradicting results between their study and that of Black et al. could be attributed to the level of development of a country. In developed countries such as Norway, the trade-off is probably very mild because education is relatively cheap for the citizens. In contrast, the trade-off is probably very strong in developing countries such as China because education is relatively costly to the citizens. However, our study seems to suggest that the trade-off may probably be weak even in developing countries such as Malaysia. One possible explanation for this phenomenon is that education is highly subsidized in Malaysia. During the period 2001-2005, for example, the public expenditures on education constituted about 25% of the federal government allocation and actual expenditures (Malaysia, 2006).

It could be argued that the discrepancy between the behavior of the poor and rich households (i.e. the poor tend to have many yet uneducated children and the rich few yet educated children) is not purely due to economic reasons (i.e. education and opportunity costs). Rather, the discrepancy might also be driven by the fact that the rich (and educated) households tend to spend more of their youth time on acquiring education. As a result, they tend to have late marriage, have children at relatively later age, and have shorter productive years than the poor (and less educated) households.

To isolate this productive-years effect, we add mother's age at first birth to each of the Educ and Kids models. This variable is obtained by subtracting the age of the first-born child from the mother's age. It turns out that mother's age at first birth has considerably low (and even negative) values for some households. One way to explain this anomaly is to argue that, for a given household in question, the mother is not the biological mother of the children in that household (she might be a stepmother). Unfortunately, however, the information is not available to verify our surmise. For this reason, we choose to omit the observations in which the value of the mother's age at first birth is too low. Casual observations suggest that the minimum marriage age for females in Malaysia is 15, and this implies that the minimum mother's age at first birth is 16. Excluding the observations in which mother's age at first birth is less than 16, we end up with 1543 observations (i.e. a reduction of 107 observations).

Given the reduced sample size, and the addition of mother's age at first birth (denoted as *MomAge1*) as a new variable, we reestimate both models and report the results in Table 6. Columns (1) and (2) show that the coefficients of *HHInc* and *Educsh* are individually negative, conforming to the theory. However, while the coefficient of *HHInc* is significant at the 5% level, the coefficient of *Educsh* is insignificant even at the 10% level. Nonetheless, the t-value increases a little bit. Columns (3) and (4) indicate that the coefficients of *HHInc* and *WfIncsh* are positive and significant at the 1% level. Since the sign, magnitude, and significance level of the coefficients of interest in Table 6 are broadly similar to the corresponding coefficients in Table 5, we conclude that the baseline results in Table 5 are quite robust to the addition of mother's age at first birth.

Earlier we suggested that the anomalous values for mother's age at first birth could be attributed to the possibility that the mother of a given household is a stepmother. If this is the case, then we may add father's age at first birth instead. This variable might serve as a good proxy for (biological) mother's age at first birth (of which the data might be absent) provided that the father is the biological father of the children in the household (but the information is not available). As in the mother's age case, this variable is obtained by subtracting the age of the first-born child from the father's age. In this case, too, we observe that father's age at first birth has considerably low (and even negative) values for some households. As before, we choose to omit the observations in which the value of the father's age at first birth is too low. Appealing to the same casual observations, we set 17 as the minimum marriage age for males in Malaysia, implying that the minimum father's age at first birth is 18. Excluding the observations in which father's age at first birth is less than 18, we end up with 1593 observations (i.e. a reduction of 57 observations).

Given the reduced sample size, and the addition of father's age at first birth as a new variable, we reestimate both models and obtain results that are similar to those in Table 6; i.e. the coefficient of *HHInc* is negative and significant at the 10% level, the coefficient of *Educsh* is negative yet insignificant even at the 10% level, and the coefficients of *HHInc* and *WfIncsh* are positive and significant at the 1% level. We take these results as evidence that the baseline results in Table 5 are broadly robust to the addition of father's age at first birth. (To conserve space, these results are not reported. However, they are available from the authors upon request.)

It could be argued that the choice of the number of children, as well as their education level, is not solely dictated by economic considerations. Rather, the choice is partly determined by family preferences; i.e. some households prefer big families regardless of their income level. As a result, they have to forego the education of their children. In contrast, some households prefer educated children. Consequently, they have to be contented with small families.

To control for the effect of family preferences, we need to restrict our sample to the one with a uniform sibship size.

Given a sample of 1650 households, and the range of 1 to 11 children, the distribution of sibship size can be depicted as follows: 260 households have 3 children, 254 households have 4 children, 226 households have 5 children, 210 households have 6 children, and so on. Since the sub-sample size is relatively small even for the modal sibship size category, we combine the top two categories (i.e. households with 3 and 4 children) to yield a sub-sample with 514 observations. Given this substantially reduced subsample, we reestimate both models and report the results in Table 7.

As documented in columns (1) and (2) of Table 7, the results for the Educ model appear to be similar to the baseline results. However, the results for the Kids model are quite different [see columns (3) and (4)]: while the coefficient of *HHInc* enters with the usual positive sign and is significant at the 1% level, the coefficient of *WfIncsh* enters with a negative sign and is insignificant even at the 10% level. Apart from the insignificance of the coefficient of *WfIncsh*, the results in Table 7 appear to be consistent with the CQQ theory, and these are the most favorable results that we obtain so far.

Despite the above findings, one could argue that the results might be different if we pick a different sibship size category. To accommodate this objection, we combine the next top two categories (i.e. households with 5 and 6 children) and reestimate the models. It turns out that the results are remarkably different from those with 3 and 4 children. (To conserve space, these results are not reported. However, they are available from the authors upon request.) For the Educ model, the results are consistent with the CQQ theory; i.e. the coefficients of *HHInc* and *Educsh* are negative and individually significant even at the 1% level. For the Kids model, the results are merely partially consistent with the theory; i.e. while the coefficient of *HHInc* is positive and significant at the 1% level (which is consistent), the coefficient of *WfIncsh* is positive and insignificant even at the 10% level (which is inconsistent). Thus, the results are indeed sensitive to the choice of sibship size category.

It could be argued that the baseline results fail to take into account the fact that many children in our sample have not completed their education yet. If this is the case, then a given child's reported number of years of schooling is smaller than his actual to-be-realized number of years of schooling (had he be given a chance to complete education later on). Thus, the results could have been different if we were to have access to the true (not yet available) data.

To overcome this shortcoming, we restrict our sample to families whose children are at least 25 years old. Since some children in a given household may be above 25 while others may be below 25, it is not appropriate to use an individual household as the unit of analysis anymore. Instead, the appropriate unit of analysis would be an individual child who is at least 25 years old. Accordingly, we rearrange the data on an individual child basis. From the total number of 8296 children in our sample, only 2578 children (about 30%) are at least 25 years old. We estimate the Educ model using this subsample of children and report the results in Table 8. As shown in columns (1) and (2), the results indicate that, although the coefficients of *HHInc* and *Educsh* enter with the expected negative signs, they are insignificant. Since the results are quite similar to those in the baseline estimation, we conclude that the baseline results are broadly robust to the sample restriction on children's age.

By the same token, it could be argued that the baseline results fail to consider the fact that some families in our sample have not completed their reproductive period yet. If this is the case, then the number of children born to a family is smaller than the actual number of children to be born (to that family). Again, the results could have been different if we had access to the true (not yet available) data.

To patch up this deficiency, we may restrict our sample to families whose parents have exceeded their reproductive period. Casual observations indicate that many mothers stop giving birth once they reach the age of 40. It turns out that, in the current subsample of households whose children aged at least 25 years old, the minimum age for mothers is 37. Using this sub-sample of households as a proxy (which consists of 784 households), we estimate the Kids model and obtain the following results: a) although the coefficient of *HHInc* enters with the correct sign, it is insignificant; b) although the coefficient of *WfIncsh* enters with the wrong sign, it is significant [see columns (3) and (4) in Table 8]. Since the results are quite similar to those in the baseline estimation, we conclude that the baseline results are robust to the sample restriction on mother's age.

It could be argued that it is not household income per se that drives the opportunity cost up; instead, it is the household income in the presence of a working wife. The rationale is that, in a dual-parent family, the opportunity cost of childrearing is more likely to change considerably in response to a rise in household income if the wife is also working. If we entertain this line of argument, then household income needs to be replaced by an interactive term between household income and a dummy variable for the working wife, *HHInc*Workwf* , where *Workwf* is equal to 1 if the wife is employed in the marketplace and 0 if the wife is a homemaker. (In our sample of 1650 households, 418 or about 25% of them are characterized by working wives.)

With this slight modification, we reestimate the Kids model where *WfIncsh* is instrumented by the interactive term, *HHInc*Workwf*, and report the results in the last two columns of Table 8. Column (5) indicates that the coefficient of the interactive term enters with the expected sign and is significant at the 1% level. These results are similar to the baseline results. Column (2) shows that the coefficient of *WfIncsh* enters with the wrong sign and is insignificant even at the 10% level. These results differ from the baseline results.

5. Conclusion

In this study, we revisit the issue of the CQQ trade-off based on a sample of rural households in Terengganu. Unlike the previous studies, we test a specific CQQ trade-off theory known as the Kremer-Chen model. The model stipulates that a rise in household income is expected to have a) a *positive* impact on child quality through its *adverse* impact on the cost of educating children, and b) a *negative* impact on child quantity through its *positive* impact on the opportunity cost of raising children. Our baseline empirical analysis produces the following key results. First, a rise in household income is expected to have a *negative* impact on the cost of educating children, which in turn, has a *negative* impact on child quality (but the evidence is weak). Second, a rise in household income is expected to have a *positive* impact on the opportunity cost of childrearing, which in turn, has a *negative* impact on child quantity (and the evidence is strong). Hence, while the first part of the results offers some evidence (albeit, weak) in favor of the CQQ theory, the second part of the results offers evidence against the theory. Since these baseline findings are broadly robust to a host of robustness check, we take them as evidence against the CQQ theory; i.e. it appears that there is *no* trade-off between child quantity and child quality with respect to an increase in household income among rural households in Terengganu, Malaysia.

References

Angrist, J., Lavy, A., and Schlosser. (2010). Multiple experiments for the causal link between the quantity and quality of children. *Journal of Labor Economics*, 28 (4): 773-823.

Becker, G. S. and Lewis, H. G. (1973). On the interaction between the quantity and quality of children. *Journal of Political Economy*, 81 (2): S279-S288.

Becker, G. S. and Tomes, N. (1976). Child endowments and the quantity and quality of children. *Journal of Political Economy*, 84 (4): S143-S162.

Black, S. E, Devereux, P. J., and Salvanes, K. G. (2005). The more the merrier? The effect of family size and birth order on children's education. *Quarterly Journal of Economics*, 120 (2): 669-700.

Caceres-Delpiano, J. (2006). Impact of family size on investment in child quality: multiple births as natural experiment. *Journal of Human Resources*, 41 (4): 738-754.

Conley, D. and Glauber, R. (2006). Parental educational investment and children's academic risk: Estimates of the impact of sibship size and birth order from exogenous variation in fertility. *Journal of Human Resources*, 41 (4): 722-737.

De la Croix, D. and Doepke, M. (2003). Inequality and growth: why differential fertility matters. *American Economic Review*, 93 (4): 1091-1113.

Kremer, M. and Chen, D. (2002). Income distribution dynamics with endogenous fertility. *Journal of Economic Growth*, 7: 227-258.

Lee, J. (2008). Sibling size and investment in children's education: An Asian instrument. *Journal of Population Economics*, 21: 855-875.

Li, H., Zhang, J., and Zhu, Y. (2008). The quantity-quality trade-off of children in a developing country: Identification using Chinese twins. *Demography*, 45 (1): 223-243.

Malaysia. (2006). *Ninth Malaysia Plan 2006-2010*. Kuala Lumpur: National Printing Department.

Moav, O. (2005). Cheap children and the persistence of poverty. *Economic Journal*, 115 (1): 88-110.

Rosenzweig, M. R. and Wolpin, K. I. (1980). Testing the quantity-quality fertility model: The use of twins as a natural experiment. *Econometrica*, 48 (1): 227-240.

Qian, N. (2009). Quantity-quality and the one child policy: The only-child disadvantage in school enrollment in rural China. Working Paper.

Table 1. Descriptive statistics of the variables (N = 1650)

	Minimum	Maximum	Mean	Std Deviation
Educ (years)	0	17	7.29	4.33
Kids (quantity)	1	11	4.88	2.50
Educ$ (RM)	0	1500	149.49	169.41
WfInc (RM)	0	8250	214.54	622.40
HHInc (RM)	100	15,750	1936.30	1582.28
HbAge (years)	21	92	49.07	11.52
WfAge (years)	19	90	44.23	10.97
HbEduc (years)	0	18	7.61	3.74
WfEduc (years)	0	19	7.34	3.91

Table 2. The relationship between HHInc and a) Kids, and b) Educ

HHInc Range	Average Kids (quantity)	Average Educ (years)
≤ RM1000	4.32	6.11
RM1001 – RM2000	4.79	7.21
RM2001 – RM3000	5.21	8.47
RM3001 – RM4000	6.04	9.07
RM4001 – RM6000	5.56	8.10
> RM6000	5.75	7.94

Table 3. The relationship between a) HHInc and Kids, and b) HHInc and Educ across age range

HHH's Age Range	Average HHInc (RM)	Average Kids (quantity)	Average Educ (years)
21 -30	1382.35	1.64	0.26
31 – 40	1746.23	3.14	2.12
41 – 50	1958.71	4.74	7.03
51 – 60	2251.43	6.01	10.25
> 60	1689.25	6.09	10.60

Table 4. Estimation with Educ$ and WfInc (N = 1650)

	Educ Model		Kids Model	
	(1)	(2)	(3)	(4)
Dep. Variable	Educ$	Educ	WfInc	Kids
Constant	16.127 (0.57)	–8.348*** (–16.30)	–145.35 (–1.61)	0.065 (0.16)
Educ$	–	0.014*** (4.47)	–	–
WfInc	–	–	–	0.001*** (6.57)
HHInc	0.015*** (5.69)	–	0.186*** (21.46)	–
HbAge	1.335 (1.60)	0.080*** (5.12)	–0.400 (–0.15)	0.052*** (4.49)
WfAge	0.060 (0.07)	0.224*** (13.97)	–2.995 (–1.06)	0.057*** (4.71)
HbEduc	2.711* (1.82)	–0.031 (–1.04)	–0.380 (–0.08)	0.010 (0.47)
WfEduc	2.010 (1.38)	–0.012 (–0.43)	21.099*** (4.53)	–0.087*** (–4.10)
Adj. R^2	0.033	0.513	0.266	0.144

Note: Each model is estimated by the IV method. In the Educ model, the results for the first- and second-stage regressions are shown in columns (1) and (2), respectively. In the Kids model, the results for the first- and second-stage regressions are shown in columns (3) and (4), respectively. The t-values are in reported in the parentheses. *, **, and *** denote the significance level at 10%, 5%, and 1%, respectively.

Table 5. Estimation with Educsh and WfIncsh (N = 1650)

	Educ Model		Kids Model	
	(1)	(2)	(3)	(4)
Dep. Variable	Educsh	Educ	WfIncsh	Kids
Constant	9.087*** (4.94)	–0.299 (–0.05)	13.971*** (4.58)	–2.076*** (–2.95)
Educsh	–	–0.860 (–1.32)	–	–
WfIncsh	–	–	–	0.139*** (4.44)
HHInc	–0.002 (–1.45)	–	0.002*** (6.08)	–
HbAge	0.139** (2.57)	0.219** (2.10)	0.041 (0.46)	0.046*** (2.66)
WfAge	–0.104* (–1.82)	0.135 (1.47)	–0.238** (–2.50)	0.087*** (4.61)
HbEduc	0.0003 (0.00)	0.008 (0.09)	–0.405** (–2.53)	0.066** (2.09)
WfEduc	0.076 (0.81)	0.082 (0.85)	0.423*** (2.69)	–0.118*** (–3.44)
Adj. R^2	0.003	–	0.039	–

Note: Each model is estimated by the IV method. In the Educ model, the results for the first- and second-stage regressions are shown in columns (1) and (2), respectively. In the Kids model, the results for the first- and second-stage regressions are shown in columns (3) and (4), respectively. The t-values are in reported in the parentheses. *, **, and *** denote the significance level at 10%, 5%, and 1%, respectively.

Table 6. Estimation with mother's age at first birth (N = 1543)

	Educ Model		Kids Model	
	(1)	(2)	(3)	(4)
Dep. Variable	Educsh	Educ	WfIncsh	Kids
Constant	13.121*** (5.75)	0.477 (0.15)	4.253 (1.13)	3.471*** (6.15)
Educsh	–	–0.363 (–1.64)	–	–
WfIncsh	–	–	–	0.099*** (4.60)
HHInc	–0.004** (–2.07)	–	0.002*** (6.93)	–
HbAge	0.068 (1.14)	0.066** (2.10)	0.109 (1.11)	–0.014 (–0.94)
WfAge	0.001 (0.02)	0.312*** (10.74)	–0.338*** (–3.21)	0.153*** (9.37)
HbEduc	0.005 (0.05)	0.035 (0.77)	–0.382** (–2.34)	0.047* (1.95)
WfEduc	0.163* (1.65)	0.134** (2.52)	0.220 (1.35)	–0.019 (–0.74)
MomAge1	–0.260*** (–3.84)	–0.340*** (–5.37)	0.525*** (4.68)	–0.268*** (–13.87)
Adj. R^2	0.012	–	0.054	–

Note: Each model is estimated by the IV method. In the Educ model, the results for the first- and second-stage regressions are shown in columns (1) and (2), respectively. In the Kids model, the results for the first- and second-stage regressions are shown in columns (3) and (4), respectively. The t-values are in reported in the parentheses. *, **, and *** denote the significance level at 10%, 5%, and 1%, respectively.

Table 7. Estimation with three and four children (N = 514)

	Educ Model		Kids Model	
	(1)	(2)	(3)	(4)
Dep. Variable	Educsh	Educ	WfIncsh	Kids
Constant	20.762*** (6.82)	−5.395 (−1.31)	8.130 (1.32)	3.128*** (19.84)
Educsh	–	−0.175 (−0.93)	–	–
WfIncsh	–	–	–	−0.002 (−0.45)
HHInc	−0.0006* (−1.96)	–	0.004*** (5.59)	–
HbAge	0.014 (0.17)	0.149*** (4.66)	0.102 (0.58)	0.005 (1.24)
WfAge	−0.211 (−2.31)	0.144*** (2.66)	−0.229 (−1.24)	0.002 (0.37)
HbEduc	−0.184 (−1.21)	−0.007 (−0.10)	−0.376 (−1.22)	0.005 (0.61)
WfEduc	0.156 (1.01)	0.094 (1.59)	0.428 (1.37)	0.002 (0.27)
Adj. R^2	0.041	0.275	0.069	0.007

Note: Each model is estimated by the IV method. In the Educ model, the results for the first- and second-stage regressions are shown in columns (1) and (2), respectively. In the Kids model, the results for the first- and second-stage regressions are shown in columns (3) and (4), respectively. The t-values are in reported in the parentheses. *, **, and *** denote the significance level at 10%, 5%, and 1%, respectively.

Table 8. Estimation with children aged at least 25 and HHInc*Workwf

	Educ Model		Kids Model		Kids Model	
	(1)	(2)	(3)	(4)	(5)	(6)
Dep. Variable	Educsh	Educ	WfIncsh	Kids	WfIncsh	Kids
Constant	39.265*** (17.48)	80.964 (0.89)	11.663** (2.14)	−16.891 (−0.27)	17.213*** (7.08)	−0.357 (−0.96)
Educsh	–	−1.811 (−0.78)	–	–	–	–
WfIncsh	–	–	–	2.047 (0.40)	–	0.004 (0.85)
HHInc	−0.0001 (−0.80)	–	0.0001 (0.40)	–	–	–
HHInc* Workwf	–	–	–	–	0.008*** (31.63)	–
HbAge	−0.101** (−2.44)	−0.193 (−0.79)	0.238** (2.27)	−0.478 (−0.39)	0.074 (1.03)	0.051*** (4.68)
WfAge	−0.424*** (−9.02)	−0.761 (−0.77)	−0.373*** (−3.21)	0.734 (0.38)	−0.284*** (−3.77)	0.064*** (5.58)
HbEduc	−0.043 (−0.52)	0.022 (0.12)	−0.164 (−0.81)	0.341 (0.38)	−0.555*** (−4.37)	0.030 (1.57)
WfEduc	0.110 (1.44)	0.299 (1.08)	0.194 (1.02)	−0.455 (−0.41)	−0.003 (−0.02)	−0.044** (−2.33)
Adj. R^2	0.093	–	0.010	–	0.389	–
Obs.	2578	2578	784	784	1650	1650

Note: The first four columns show the results of the Educ and Kids models with a sample restriction on the age of children (i.e. at least 25 years old). Each model is estimated by the IV method. In the Educ model, the results for the first- and second-stage regressions are shown in columns (1) and (2), respectively. In the Kids model, the results for the first- and second-stage regressions are shown in columns (3) and (4), respectively. The last two columns show the results of the Kids model with the inclusion of HHInc*Workwf. As before, the model is estimated by the IV method, where the results for the first- and second-stage regressions are shown in columns (5) and (6), respectively.. The t-values are in reported in the parentheses. *, **, and *** denote the significance level at 10%, 5%, and 1%, respectively.