Economies of scale, resource dilution and education choice in developing countries: Evidence from Chinese households☆

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A R T I C L E   I N F O

A B S T R A C T

Recent empirical studies suggest that the negative correlation between the quantity of children within a family and their educational attainment, which is widely observed in developed countries, is inconsistent or even rejected in developing countries. This paper aims to integrate these divergent empirical results into a unified theoretical framework by introducing scale economies into the classical model of Becker and Lewis (1973). As a result, the "anomaly" of an observed upward or an inverted U-shaped relationship can be expected as the scale economies effect dominates when there are few children in a family. Using data from the China's 1990 and 2000 censuses, this study further tests some hypotheses induced from the model. Educational attainment increases with sibling size at first and then drops. Children with one or two siblings achieve the highest education during the period our sample covers. The inverted U-shaped correlation is more robust for rural subsamples, for older cohorts and for economically underdeveloped regions and groups, which is consistent with the prediction of the model.
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1. Introduction

Since *An Essay on the Principle of Population* was first published by Thomas Robert Malthus in 1798, there has been an ongoing debate on the role of population in economic development. The relationship between population growth and human capital accumulation is controversial among both social scientists and policy-makers. The dispute became even more drastic after the quantity-quality trade-off theory was proposed by Becker and Lewis (1973). This theory states that an increase in sibling size raises the marginal cost of children's education, leading to lower educational attainment.[1] The implied negative correlation between quantity and quality (educational attainment) gains some support from early empirical work and the mechanism is mainly ascribed to the diluted resources within a given family (Behrman, Pollak, & Taubman, 1989; Stafford, 1987). However, with the focus being extended to developing countries, the aforementioned tradeoff seems to be weak or even sometimes rejected (Black, Devereux, & Salvanes, 2005; Gomes, 1984). Besides the divergent results between developed and developing economies,

 [1] "Sibling size" and "quantity of children" are used equivalently in the literature. In this paper, we use them indiscriminately.

the quantity-quality relationship can also exhibit significant heterogeneity across time and/or regions within some specific countries (Hermalin, Seltzer, & Lin, 1982; Lu & Treiman, 2008; Maralani, 2008). Using data from 48 developing countries, for example, Vogl (2016) documents that the negative association between the quantity of siblings and their education is only "a recent phenomenon".

Although some efforts were made to explore the causes of the heterogeneous correlation between sibling size and children's education in previous studies which found a non-negative correlation in developing countries, the explanations offered were mainly driven by some country-specific socioeconomic factors rather than a general mechanism. This study aims to integrate these divergent empirical results into a unified theoretical framework by introducing scale economies into the classical model of Becker and Lewis (1973). The two driving forces contributing to the negative correlation between the quantity of children and their education in their pioneering model were: 1) The shadow prices of both quantity and quality increase with the other, while uncorrelated with itself; and 2) the average "observed" income elasticities are unambiguously smaller than the "true" elasticities, which means that even the non-negative true elasticities cannot rule out the possibilities of negative elasticities in the observed data. However, as we will show later, neither of these two properties consistently holds in the presence of scale economies. The shadow price of quantity/quality becomes an increasing function of itself, while not necessarily increases with the other. Also, the relative magnitude of the two types of elasticities is no longer unambiguous.

As our theoretical model illustrates, *resource dilution effect* underlies the mechanism for an ordinary negative correlation between the quantity and quality of children, while *scale economies effect* is associated with a positive correlation. With the increase in sibling size, the former effect rises while the latter diminishes. This therefore predicts an inverted U-shaped curve for quantity and quality due to the waxing and waning of these two opposing forces. Furthermore, when put in a comparative perspective, some other socioeconomic conditions can shift the turning point of the inverted U-shaped curve by changing the relative strength of these two effects. The stronger the scale economies effect is, the later the positive correlation half ends. Therefore, the narrower the range of negative correlation half is, the more likely it is to exhibit an inverted U-shape.

The advantage of this framework is its ability to explain the divergent empirical patterns consistently. For less-developed countries where the average education level remains comparatively low, the increase in marginal cost of quality may not be as significant as in developed countries. Instead, the effect of scale economies in the forms of shared schooling costs and household duties can be rather prominent. Thus, an observed upward or an inverted U-shaped relationship can be expected as the dominant effect of scale economies at a small quantity of children. Nonetheless, for developed economies or some subgroups with more advanced strata, the relative power of scale economies effect can be trivial compared to the role of resource dilution. Consequently, the stylized negative trade-off pattern can be viewed as a truncated right side of inverted U-curve.

To test this hypothesis, we use micro-data from the China's 1990 and 2000 Census, which sample cohorts born between 1950 and 1980. The linear specification supports the standard negative correlation: having an extra child decreases the average years of schooling by 0.12 years. However, when squared sibling size is added, its coefficient is significantly negative and remains stable when controlling for a rich set of covariates. The optimal sibling size (i.e., the quantity of children corresponding to the highest educational attainment) is around 2.5, implying children with one or two siblings attain the highest education. As predicted in our theoretical model, different subgroups exhibit heterogeneous quantity-quality correlation in the data. Scale economies effect matters more for rural samples, for older cohorts and for households with low socio-economic status, we therefore observe larger optimal sibling size in these subgroups. The heterogeneity presented in this paper bears a resemblance to the divergent empirical findings so far and coincides with theoretical predictions. Lastly, to solve the potential endogeneity problem, we use instrument variable (IV) approach to further test the robustness of our results. When sibling size and its square are instrumented by the dummy for twins and sex composition, the inverted U-shaped relationship remains significant and the optimal sibling sizes distribute in a similar pattern.

Our results also shed some light on related policy discussions by providing both a theoretical foundation and empirical evidence, especially for transition economies like China, where birth control policies still exist. Basically, the validity of the One-child Policy in China is built on the belief that a negative correlation between quantity and quality is inevitable, which overlooks the role of scale economies in quantity-quality decisions pertaining to children. Our results indicate that the optimal quantity of children for China in terms of schooling is around 2–3, which suggests that fewer children may hamper the effect of scale economies and consequently hinder the human capital accumulation, especially for rural areas and for less-developed subgroups.

The rest of this paper is organized as follows: Section 2 reviews previous research pertaining to quantity-quality trade-off theory, highlighting the divergent findings between developed and developing countries, and also among different subgroups or cohorts within a developing economy. Section 3 introduces a theoretical framework for education decisions framed by two competing effects: *scale economies effect* and *resource dilution effect*. Section 4 describes data and variables we use and Section 5 tests implied hypotheses using micro-data and provides a rich set of robustness checks. Section 6 concludes the paper.

2. Literature review

Economists have long been interested in the trade-off between the quantity and quality of children. When analyzing determinants of fertility under the framework of modern economics, Becker (1960) discusses the interaction of quantity and quality (for example, educational attainment) of children, but not in depth. Inspired by subsequent empirical results pointing to a negative correlation between quantity and quality of children within a family, Becker and Lewis (1973) further explore the reasons why the tradeoff between quantity and quality of children are "more closely related than any other two commodities chosen at random". The key assumption is that the shadow price (marginal cost) of the quality of children directly incorporates a variable