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Does the diversity of human capital increase GDP? A comparison of education systems

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ABSTRACT

This paper examines how different education systems affect GDP by influencing the diversity of human capital. We construct an overlapping generation model in which agents are heterogeneous in income and innate ability, and the final goods are produced with differentiated intermediate goods. It is shown that under a realistic condition, the diversity of human capital induced by income inequality always lowers the GDP of the next period, while the diversity of human capital induced by heterogeneous ability can increase GDP, if the produced intermediate goods are sufficiently substitutable and firms have a large span of control. Hence, as public education equalizes education resources across households, it mitigates the negative effect of income inequality on GDP, while the effects of ability tracking crucially depend on the production structure of the economy.

1. Introduction

Economists typically consider that education can improve the human capital of workers and raise GDP. Several researchers estimate the *level* of human capital from education attainment and examine the impact of human capital on GDP or economic growth (e.g., Mankiw, Romer and Weil, 1992). On the other hand, relatively little is known about the effect of the *diversity* of human capital on GDP.

Apparently, the diversity of human capital differs across countries. Several recent international surveys reveal this variation. Although different surveys compare different abilities at different ages, some common tendencies can be found in the surveys.[1] Brown, Micklewright, Schnepf and Waldmann (2006) find that among 18 OECD countries, results from three surveys (Trends in International Mathematics and Science Study, Programme for International Student Assessment, and International Adult Literacy Survey) consistently indicate that Finland and the Netherlands have relatively small inequalities of achievements; the United Kingdom, New Zealand and the USA have relatively large inequalities of achievements.[2]

How does this diversity of human capital influence GDP? The importance of this question can be understood when we recognize that one of the central aims of an education policy is to provide students with equal education resources. For example, several reforms have been conducted to achieve equity in education outcomes in the United States. The 1971 landmark decision in Serrano vs Priest transformed the public education system in California, and other states (e.g., Michigan in 1994 and Washington in 1979) have also centralized their education systems in order to achieve equity in education resources. More recently, the "No Child Left Behind Act" by the George W. Bush administration aims to achieve equity in and a

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[1] Trends in International Mathematics and Science Study (TIMSS) covers achievement in mathematics and science for early or middle teens, the Programme for International Student Assessment (PISA) covers achievement in reading, mathematics and science for early or middle teens, the International Adult Literacy Survey (IALS) examines 'document', 'prose' and 'quantitative' literacy for all people of working age, and the Progress in International Reading Literacy Study (PIRLS) examines the reading skills of young children.

[2] Brown, Micklewright, Schnepf and Waldmann (2006) compare the difference between the 95th percentile and 5th percentile of achievement distributions for 18 OECD countries, converted from the data in TIMSS, PISA, and the late teens and early 20s in IALS. The 18 countries include Finland, Denmark, Netherlands, Canada, Czech Republic, Sweden, Australia, Portugal, Norway, Germany, Ireland, Italy, Belgium, Hungary, Switzerland, UK, New Zealand and USA. The countries are ordered from the most equal achievement to the least equal achievement using the average ranking of the three surveys.

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high quality of education by raising the performance of the lowest achieving students. Hence, the previous question leads us to ask a more important question: can an egalitarian education policy raise GDP?

The answer is not obvious. On the one hand, if a government fails to provide everybody with enough literacy skills, it would be difficult for workers to communicate and cooperate with each other. On the other hand, as top managers' decisions are influential in a company, we want them to understand the varieties of opinions and to make sound decisions. Hence, some may insist that an education policy should target the bottom of ability distribution; others may advocate the importance of education for the elite.

In order to evaluate the impact of an egalitarian education policy on GDP, we need a model to link education reform, the diversity of human capital and GDP in a unified framework. This paper aims to accomplish this task. It constructs an overlapping generation model in which education systems influence GDP by changing the variance in human capital and compares alternative education systems by their effects on GDP.

This model is distinguished from the previous literature in two aspects. First, we tractably parameterize the structure of industries and firms and examine how an education system and the production structure of an economy have an interactive effect on GDP. In particular, this paper pays special attention to the span of control in a firm and the complementarity of goods in an industry. A large span of control gives an individual the authority to reallocate large amounts of resources. Without authority, an able person cannot fully utilize his/her unusual talents. Hence, a high level of control favors an education system that produces a few highly educated workers. If complementarity of goods exists, the value of a firm's product depends on other firms' product, and a good produced by incompetent persons may reduce the value of other firms' product. Hence, high complementarity of goods demands an education system that produces many reasonably well-trained workers.[3]

Secondly, different from the previous literature that analyzes education policies in a dynamic general equilibrium model, education systems are characterized not only by their financing systems, but also by their ability-tracking programs. Hence, education systems change the way the heterogeneities of both income and ability influence the diversity of human capital. A private education system yields more diverse human capital than a public education system because the rich spend more on education than the poor.[4] On the other hand, ability tracking students into separate groups according to their ability restricts those with whom they can interact as schoolmates or classmates. Since advantaged students interact with advantaged students, ability-tracking benefits advantaged students more than disadvantaged students through the peer effects. Hence, a streamed program yields more diverse human capital than an untracked program by amplifying the benefits from high innate ability.

This paper shows that when the intergenerational income elasticity (i.e., the elasticity of children's income to parents' income) is less than one, a public system with equal provision of resources to students yields higher GDP than a private system, regardless of industry and firm structure, while the effect of an ability-tracking program on GDP depends on the production structure. As far as the intergenerational income elasticity is less than one, it is shown that, given a current GDP and an ability distribution, a larger income difference reduces GDP at the next period. Since the public system always lowers income inequality more than the private system through the redistribution of income, it always attains a higher GDP than the private system.

The required condition that the intergenerational income elasticity is less than one seems realistic. In fact, it is easy to find evidence that can support this condition. Solon (1992) finds that the intergenerational income elasticity is around 0.4 in the United States.[5] Charles and Hurst (2003) find that the intergenerational wealth elasticity is 0.37. Moreover, Solon (2002) shows that there is no cross-country evidence that the elasticity is greater than 0.6. With these pieces of empirical evidence, our theory unambiguously predicts that providing students with financially equal education resources raises GDP.

A similar mechanism is emphasized in the previous literature when the human capital accumulation function is concave in expenditure on education and the production function is linear in human capital (e.g., Loury, 1981). Our result shows that their result still holds under a realistic condition, even if the diversity of human capital increases GDP on the production side.

However, when the diversity of human capital is enhanced by ability tracking, the structure of the production side becomes important. Different from the dynamics of income distribution, it is shown that a rise in inequality in ability can increase GDP at the next period. It is also shown that an ability-tracking program attains higher GDP if and only if goods in an industry are fairly substitutable and the span of control in a firm is sufficiently large. This result highlights a distinctive role of ability tracking in macroeconomics.

This paper is based on the literature that compares the performance of different education systems in a dynamic general equilibrium model (e.g., Glomm and Ravikumar, 1992; Bénabou, 1996; Fernández and Rogerson, 1998). These papers compare different financing methods for education.

Although it is considered that the redistribution of income through the public education system increases GDP in this strand of literature, Glomm and Ravikumar (1992) firstly identify the advantages of private education. They show that private education can increase GDP if a child can choose to exert effort in the accumulation of human capital. As parents must pay for tuition for their children in the private education system, when parents are young, they are provided with an incentive to make more effort in human capital accumulation to prepare income for their future children's education. In contrast to Glomm and Ravikumar (1992), we exclude effort choice and include ability tracking in the human capital accumulation function. This deviation allows us to focus on the productive impacts of sorting in human capital accumulation. In fact, this paper shows that if private schools are better able to screen students according to ability than the public system, there is a production structure through which the private system attains higher GDP.

The importance of sorting is also analyzed by Bénabou (1996). Bénabou (1996) examines the effect of diversity of human capital on economic growth when the human capital of individual agents have interactive effects on GDP. His main focus is to examine the role of complementarity of human capital at the community level and at the production level. By contrast, we do not consider a local interaction at the community level and pay more attention to the interaction at a production level. In particular, we explicitly examine the role of

[3] For example, in a financial market, fund managers are allowed to allocate a large amount of resources to buy different stocks that are highly substitutable. It is likely to demand unusual talent. On the other hand, firms in the car industry need to combine a number of complementary intermediate goods (e.g., the quality of tires is likely to influence the value of brakes). This might demand many well-trained workers. The level of control in the car industry would be influenced by the structure in the firm. If intermediate good sectors are less vertically integrated, or bottom-up decision making is common, the level of control would be low. Again, it must demand reasonably well-trained workers. It is interesting to note that the structure of industries and firms in the United States, which is regarded as having relatively heterogeneous human capital, seems to relatively favor unusual talent, while that in Japan, which is seen as having a relatively homogeneous human capital, relatively favors reasonably well-trained workers.

[4] In this paper, a private education system is defined as an education system in which the costs of education are financed by tuition, and a public system is defined as an education system in which the costs are financed by taxes.

[5] Strictly speaking, Solon (1992) estimates the intergenerational earnings elasticity; however, in this paper, there is no difference between permanent income and permanent earnings. Hence, we interchangeably use the two words in this paper.