Economic Openness and Educational Expansion

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ABSTRACT

This paper documents the vast expansion of schooling over the past several decades. It begins by considering international panel data and makes the observation that poor countries today have higher average education levels than countries at the same level of economic development used to have in the past. It is then argued that this trend can be attributed to the enhanced demand for schooling because of the increase in openness. The analysis of educational expansion in cross-country framework and in China's provinces provides support for the view that educational expansion is related to economy's openness.

1. Introduction

The last several decades have witnessed a remarkable expansion of schooling around the world. The increase in various measures of schooling in particular, at the primary and secondary level, has been rapid and steady.[1] Accumulation of human capital, alongside with that of physical assets, has been widely viewed as a central component of growth and development, see e.g., Barro, 1991; Pritchett, 2003, contains a critical assessment of this perspective. The incentive to invest in human capital derives, partly at least, from the objective of putting it to use in mastering existing knowledge. Thus, skill formation can be considered as being derived from complementary inputs, the global knowledge frontier and local schooling. Because promotion of knowledge has public goods components (Romer, 1986, Lucas, 1988), research and development efforts leading to it have been dominated by advanced countries; but its spillover effects across national borders provide impetus for schooling in developing world. Such technology diffusion has become more prevalent than ever before as a result of a global and more interconnected world economy.[2]

The seminal work of Nelson and Phelps, 1966, points out these linkages arguing that technological spillovers increase an incentive for human capital investment, and the recent empirical research provides support for this hypothesis, see Bartel and Lichtenberg, 1987, in the US context, and in Foster and Rosenzweig, 1996, in the context of India; Coe and Helpman, 1995, and Schiff and Wang, 2004, exhibit international linkages in R&D. Our interpretation of international evidence detailed below is that the demand for schooling has increased over time. Specifically, schooling has increased at a faster pace than income

[1] In particular, the average years of schooling for the adult population (15 years old and above), grew from 3.7 years in 1960 to 5.0 in 1980 and to 6.3 in 2000. The average gross enrolment rate – defined as the ratio of total enrolment to the population of a given age group - at the primary (secondary) level increased from about 79 in 1970 to 92 in 1980 to 101 in 2000; the figures for secondary schooling are 32, 51, and 70 respectively. Ch. 2 in Gradstein et al., 2004, contains more evidence on the expansion of schooling, especially in advanced countries.

[2] To take just one recent example, while major advances in information technology, say, the internet, have been made in the United States, its outreach spreads far beyond the national borders creating incentives to study this technology and related subjects it elsewhere in the world.

growth, implying that the returns to schooling have risen over time. Alternatively, a developing country has now a better educated labor force than its advanced counterpart at a similar level of development used to have in the past. Following some earlier research (Hanushek, 1997, in the US context; Gundlach et al., 2001, in the OECD context) it is argued that this is due to an increase in demand.

Building on these observations, our theoretical framework similarly to Nelson and Phelps, 1966, assumes that a higher level of aggregate skills generates productivity improvements, thus pushing the world technology frontier. This then increases the demand for schooling in the next generation, more so the more open a country is. The newly added implication, that openness generates demand for schooling, is empirically tested using both the international and China's provinces' data. We present evidence that economic openness increases school enrollment, which is consistent with the hypothesized relationship. In particular, in the context of China's provinces, a doubling of exports results in a nine percent increase in enrolment. China's evidence is particularly gratifying because, since the reforms of 1978, the country's provinces beginning with the coastal provinces, gradually became more open by design.

The rest of the paper proceeds as follows. Section 2 sets the stage by describing the intertemporal trends in schooling. Section 3 presents a simple framework that is used to generate empirical predictions. The latter are then tested, in Section 4, using international data and, in Section 5, based on the data from Chinese provinces. Section 6 concludes with brief remarks.

2. Expansion of schooling

Schooling has fast expanded over the past several decades. From 1960 to 2000, the average number of years of schooling went up by more than 70 percent, and the increase has been

remarkably steady (see figure 1) as well as universal across the levels of schooling, more so the more advanced the level is.[3] The expansion has taken place across the world's regions and was accompanied by an increase in spending on education which, over the forty-year period our data cover, grew by almost 500 percent, see Gradstein and Nikitin, 2003, for further details.

INSERT FIGURE 1

Moreover, comparing figures across time reveals that, controlling for income, the pace of educational enrolment has increased. In other words, a currently advanced country at an earlier phase of its development had much lower educational enrolment than its modern developing counterpart. This can be seen from Figure 2, which shows that, with time, income "buys" more educational attainment.

INSERT FIGURE 2

This finding can be interpreted in at least two ways. Either the productivity of school spending has increased, decreasing the marginal cost of enrolment; or the demand for schooling has grown over time; or a combination of the two. Existing evidence, however, suggests that the productivity of education spending has not increased. Thus, Gundlach et al., 2001, find that, in a sample of OECD countries between 1970 and 1994 it actually decreased, for many countries quite substantially, and even more so than the "productivity collapse" in the US schools diagnosed in Hanushek, 1997. To confirm this in our sample, we ran a regression of the average years of schooling on public spending for different years, both in logarithms; the regression coefficient is thus interpreted as the elasticity of years of schooling with respect to spending. The elasticity has been steadily decreasing over time, from .24 in

[3] Thus, between 1970 and 2000, the average enrollment in secondary education went up by nearly 180 percent (from around 33 to 70 percent) while the enrolment rate in tertiary education nearly quadrupled (from less than 7 to 26 percent).

1965, to .19 in 1975, to .14 in 1990. Thus, the reason for a massive increase in enrolment over time seems to be the increase in demand, not of the supply of schooling.

To further substantiate this hypothesis, we have constructed a cross country panel data set, which includes information on school enrollment as well as on measures of trade openness. The data on the average years of schooling for the population 15 years old and older come from Barro and Lee, 1993, 2001.[4] Gross enrolment rates as well as the data on share of public expenditure on education in GDP, and the total number of students in primary and secondary schools come from World Bank's WDI (World Development Indicators) data base.[5] The GDP data come from the Penn World Tables, version 5, and are reported in 1985 constant PPP-adjusted prices; population is from the same source. Tables A1.1 and A1.2 in the appendix contain statistical description of the main variables of interest.

The basic regression specification is as follows:

$$SCHOOL_{jt} = \beta_0 + \beta_1 GDP_{jt} + \beta_2 GDP_{jt}^2 + \beta_3 SPEND_{jt} + \varepsilon_{jt} \qquad (1)$$

where $SCHOOL_{jt}$ – the average of years of schooling in country j in period t (in logarithms); GDP_{jt} – the average GDP per capita in 1985 constant PPP-adjusted prices in country j in period t (in logarithms); GDP_{jt}^2 – the square of the GDP above; $SPEND_{jt}$ – a PPP-adjusted total public spending on education (in logarithms); ε_{jt} - random component.

As can be seen from Column 1 in Table 1, which presents the results of this specification, all coefficients are highly significant and indicate a positive and concave relationship between income and educational attainment and a positive association between the latter and public spending on education.[6] The regression explains almost 60 percent of the variation in the years of schooling. The breakdown into fixed cross country effects and the between country effects in columns 2 and 3 shows that most of the relationship between

[4] Also available from http://sima.worldbank.org/edstats/td10.asp
[5] WDI database was last updated in August 2003 and can be accessed at http://sima.worldbank.org/.
[6] In what follows we will avoid any causal interpretation of the relationship between spending and schooling; unfortunately, there exist no good instrument which would allow us to confront this issue directly.

schooling and spending has to do with changes across time, whereas most of the association between schooling and income has to do with cross country differences. The coefficient of public education spending in the fixed effects specification implies that a doubling in spending is associated with a forty percent increase in the number of years of schooling over time. The results are robust to the inclusion of additional control variables, such as the population size (columns 4-6) and the regional dummies (columns 5-7 in Table 1);[7] the main results remain unchanged.

INSERT TABLE 1

3. Conceptual framework

To provide a simple analytical framework which is consistent with the above stylized facts, consider an economy indexed *J* populated by a measure one of identical households indexed by *i*, each comprised of a parent and child, operating in discrete time *t*; for simplicity we assume that the economies are also of measure one. The initial level of household *i*'s income residing in country j is exogenously given at y_{jo}, and the income level in period *t*, y_{jt} is determined endogenously. In each period every household is also endowed with one unit of time. In each period, the households' income is allocated between consumption (c_{jt}) and investment in human capital (e_{jt+1}); and the unit of time is allocated between studying (q_{jt+1}) and leisure consumption (n_{jt+1}).[8] As most education spending in all countries is public, we assume that the decision in this regard is public and is financed by taxes. Given the uniformity of incomes, this then implies that the tax rates are identical across the households. Letting T_{jt} denote the common tax paid by every household in country j in period t and normalizing the prices to one, the budget constraint then is

[7] Based on the classification used by the World Bank: LAC – Latin America and the Caribbean; ECA – East Europe and Central Asia; MENA – North Africa and Middle East; SSA – Sub-Saharan Africa; SAR – South Asia Region; EAP – East Asia and Pacific.

$$y_{jt} = c_{jt} + T_{jt} \quad (2a)$$

The time constraint is:

$$1 = q_{jt} + n_{jt} \quad (2b)$$

Education spending and effective time devoted to schooling generate human capital through the following production function:

$$s_{jt+1} = T_{jt}^{\alpha} q_{jt}^{\gamma}, \ \alpha, \gamma > 0, \quad \alpha + \gamma < 1 \quad (3)$$

The income production function in an individual country has the quality of human capital as its input:

$$y_{jt} = A s_{jt}^{\beta_j g(S_t)}, \ 0 < \beta_j < 1 \quad (4)$$

Here $A > 0$ is the standard productivity parameter; $\beta_j g(S_t)$ is the productivity parameter of human capital, which depends on the average level of human capital across countries S_t; $g' > 0$, $g_j(0) = g_o$, $0 < g_o < 1$. The dependence of productivity on the average level of human capital, while reminiscent of endogenous growth theories, has somewhat different flavor here. In particular, because it affects marginal productivity of human capital, the equilibrium accumulation of human capital will also be affected by it. In addition, the differences in β_j imply that the marginal productivity of human capital may vary across countries depending on their level of interaction with the rest of the world. Thus, the degree of access to the world technology differs in general across countries; it may be represented by measures of countries' openness.

Each parent's preferences derive from private good consumption as well as from the consumption of leisure and amount of income accrued to the child. Assuming for simplicity symmetric logarithmic preferences, we write the expected utility:

$$V(c_{jt}, y_{jt+1}) = \ln(c_{jt}) + \ln(n_{jt}) + \ln(y_{jt+1}) \quad (5)$$

[8] As all individuals in a country are assumed identical, their choices are identical as well. We will omit the

The spillover effect embodied in (4) captures the essence of complementarity between innovation activities in advanced countries and the accumulation of human capital in less advanced ones. Electricity, the internal combustion engine, motorization, fertilizers, the computer technology have all been invented in the former; yet, after some time they increased the demand for skilled labor in the latter. Globalization should then have been a catalyst for the adoption of new technologies by the less developed countries. A more complete microfounded model, presented in Acemoglu and Zilibotti, 2001, has two types of labor, skilled and unskilled. It focuses on the possible mismatch between technological inventions made in advanced countries and the labor force composition of the less advanced countries. The abundance of unskilled labor in the latter implies a much less efficient use of technological innovations than in the advanced countries, the end result of which is productivity differences across the countries, which Acemoglu and Zilibotti, 2001, emphasize. But this then implies that the demand for skilled labor in less advanced countries should increase as in the above implied specification. The derivations below focus on the implications of the complementarity between the knowledge frontier and skills for human capital accumulation.

Maximization of the utility function with respect to the time devoted to study yields $q_{jt} = [\gamma/(1+\alpha+\gamma)]\ \beta_j g(S_t)/[1 + \beta_j g(S_t)]$, so that in a given cohort a constant share is devoted to study, but this share positively depends on the aggregate amount of schooling in the period; maximization of the utility function with respect to the amount of investment in human capital yields $T_{jt} = [\alpha/(1+\alpha+\gamma)]\ \beta_j g\ (S_t)/[1 + \beta_j g\ (S_t)]y_{jt}$, implying that richer and more open countries are expected to invest more resources in human capital. The next-period levels of schooling are then given by:

$$s_{jt+1} = C\ \{\beta_j g\ (S_t)/[1 + \beta_j g\ (S_t)]\}^{\alpha+\gamma}\ y_{jt}^{\ \alpha+\gamma} = C\ \{\beta_j g\ (S_t)/[1 + \beta_j g\ (S_t)]\}^{\alpha+\gamma}\ A\ s_{jt}^{\ (\alpha+\gamma)\beta_j g(S_t)} \qquad (6)$$

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individual household's index for notational simplicity.

where $C = [\alpha/(1+\alpha+\gamma)]^{\alpha} [\gamma/(1+\alpha+\gamma)]^{\gamma}$; and the aggregate level of human capital in the next period is

$$S_{t+1} = C A E\{\beta_j g(S_t)/[1 + \beta_j g(S_t)]\}^{\alpha+\gamma} s_{jt}^{(\alpha+\gamma)\beta_j g(S_t)} \quad (7)$$

Differentiation of (7) reveals that future aggregate level of schooling increases with the degree of openness; it also increases with the current aggregate level of human capital – which also implies that school attendance also grows over time. Moreover, the pace of the intertemporal increase is higher the higher is the degree of economy's openness, β_j.

Substitutions reveal the next-period income levels:

$$y_{jt+1} = A C\{[\beta_j g(S_t)]/[1 + \beta_j g(S_t)]\}^{\beta_j g(S_t)} y_{jt}^{\beta_j g(S_t)} \quad (8)$$

Clearly, openness promotes higher future income. Suppose that income is positively correlated with a country's degree of openness, β_j. This then may well imply divergence in income levels. Alternatively, suppose that the degree of openness is identical across countries, $\beta_j = \beta$. If the aggregate level of human capital is low so that $\beta g(S_t) < 1$, it follows from (6) and (8) that both schooling and incomes converge. Note, however, that at high enough aggregate levels of human capital, so that $\beta g(S_t) > 1$, incomes still diverge. Yet, from (6), this may be accompanied by a convergence in human capital across countries, provided that $(\alpha+\gamma)\beta g(S_t) < 1$.[9]

To sum up,

Proposition 1. School attendance and the amount of school resources increase over time, more so the more open is the economy. When the countries differ in their degree of openness, so that openness is positively correlated with income, then incomes may diverge over time. When the degree of openness is identical across countries and the aggregate level of human capital is low, both human capital and income levels converge across countries; however,

when the aggregate level of human capital is high enough, incomes may diverge because of the high marginal productivity of the world technology, while human capital still converges.[10]

4. **Openness and schooling: cross country analysis**

One of the main implications of the analytical framework - that openness causes schooling - is now tested, first using cross-country data and then, in the next section, using data from Chinese provinces. For the purposes of the cross-country analysis, we build on the data set used in Section 2 to illustrate the increase in the demand for schooling, adding a proxy for openness.

The index of openness – defined here as the combined share of imports and exports relative to the GDP – varies significantly across countries and time. For example, in 1960 the most open country was Singapore with the openness index of more than 300 percent, whereas the least open was Uganda, where the index was 4 percent; in 2000 Hong Kong was the most open and Brazil was the least open. Significant changes in the degree of openness, in both directions, have taken place over the studied period in many countries. For example, South Korea is the country with the most improvement in openness, and Ghana is the one which has deteriorated the most, alongside with some other African nations.

To test the model's predictions, first we run the following regression:

$$SPEND_{jt} = \beta_0 + \beta_1 GDP_{jt} + \beta_2 GDP_{jt}^2 + \beta_3 OPEN_{jt} + \beta_4 POP_{jt} + \varepsilon_{jt}$$

where $OPEN_{jt}$ is the degree of openness of economy j in period t, measured as the share of the sum total of imports and export of the GDP (in logarithms). The estimation results of a fixed effects regression (the covered period is 1960-2000, 155 countries, 2129 observations)

[9] In particular, note that the lower the productivity of education spending, α, the more likely this is to hold.
[10] The second part of the proposition is also in line with Acemoglu and Zilibotti, 2001, which shows that, equal access to technologies notwithstanding, productivity differences may still arise.

are as follows:

$$SPEND_{jt} = \underset{[19.95]}{-9.32} + \underset{[43.43]}{1.16GDP_{jt}} + \underset{[11.00]}{0.11\ OPEN_{jt}} + \underset{[38.67]}{1.27\ POP_{jt}} + \varepsilon_{jt} \qquad (9)$$

(absolute value of *t* statistics in brackets, all coefficients are highly significant at 1%; R-squared = .77).

The elasticity of spending with respect to income per capita is slightly larger than unity, 1.16; and the marginal increase in the openness index results in 11 percent increase in education spending.[11] Thus, openness has a significant positive effect on education spending, which is consistent with our model's implications. To consider the effect of openness on schooling we ran a fixed country effects regression with the following results (112 countries, 767 observations):[12]

$$SCHOOL_{jt} = \underset{[17]^{**}}{-16} + \underset{[.78]}{.17\ GDP_{jt}} + \underset{[4.0]^{**}}{.39\ OPEN_{jt}} - \underset{[3.53]^{**}}{.04\ OPEN_{jt}^2} + \underset{[28.4]^{**}}{.98\ POP_{jt}} + \varepsilon_{jt} \qquad (10)$$

where the double asterisks indicate statistical significance at 1%.

As can be seen from (10), the direct effect of openness on schooling is substantial and very significant statistically. The quadratic term, negative and significant, indicates the concave functional form of schooling with respect to openness. Increased access to technological innovation, for which openness proxies in our framework, indeed corresponds to improvements in schooling outcomes.

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[11] When the squared GDP component is included the essence of the results remains basically unchanged:

$$SPEND_{jt} = \underset{[13.95]}{-13.56} + \underset{[10.14]}{2.27GDP_{jt}} - \underset{[11.00]}{0.068GDP_{jt}^2} + \underset{[11.16]}{0.11\ OPEN_{jt}} + \underset{[38.43]}{1.26\ POP_{jt}} + \varepsilon_{jt}$$

Again, all coefficients are highly significant with R-squared = .78.

[12] The coefficient of the quadratic term of the GDP is insignificant, close to zero, and is not reported here.

5. Openness and education in China

We begin by describing the institutional background for economic reforms, and then proceed with the empirical analysis.

5.1. Economic reforms in China

Since 1978 China has embarked on the road of economic reforms, which centered around openness to trade and foreign investment, but were accompanied by a radical and comprehensive restructuring of virtually all domestic economic relations. Gradual liberalization of prices took place, radical changes in labor regulation (e.g. elimination of guaranteed life-time employment, employment contract system) were introduced; the financial sector underwent notable restructuring.[13] A new vision of regional development – which anchored the economy's economic growth on the success of the coastal region in foreign trade – replaced the Maoist policy of equalization of regional levels of welfare and growth potential through purposeful development of the central and western regions. Thus, almost by design, the Deng Xiaoping's reforms promoted regional inequality in openness, welfare, educational attainment, etc.

Prior to the reforms, foreign trade was marginal to the Chinese government's vision of economic development. Overall, China's economic policy was inwardly oriented and used the revenues from foreign trade (collected through changes of tariffs) as a means of balancing the supply and demand under the national plan. The orientation toward internal development persisted through the early years of the reform, but since the mid-eighties the focus of China's foreign trade policy shifted to export production. The first serious step toward openness was creation of Special Economic Zones (SEZ), which were established in

[13] For more detailed information, see OECD (2003), pp. 13-29; Demurger (2000), Annex I; Martin et al. (2003), pp. 153-179; and Fukasaku (1996). The account of the evolution of the "open door" policy is broadly based on these sources.

Guandong (Zhuhai, Shenzhen, and Shantou), immediately followed by the establishment of the Xiamen SEZ in Fujian province. The choice of these specific sites as the first four SEZs was motivated by their small size relative to the economy, their proximity to Hong Kong, Taiwan, and Macao, and existing infrastructure (primarily ports). In the second cycle of liberal reforms in 1984, 14 more coastal cities were given the status of SEZs[14], and a year later virtually all urban and semi-urban coastal centers became open to foreign investors. In these coastal SEZs local authorities were sanctioned to stimulate FDI through a system of fiscal incentives. Later the same practices were extended to inland areas.

Since its inception, the new foreign trade policy proceeded in the direction of increased decentralization. With regard to exports, this meant a movement away from the system of centralized allocation of inputs to designated exporters and limitations on the quantity of outputs targeted for export. If prior to 1978 all export commodities (i.e. 100% of exports) were covered by mandatory plans, by 1988 only 112 export commodities were covered by mandatory plans (45% of exports), in 1993 this number fell to 16 in 1993 (about 15 % of exports).[15] With regard to imports, similarly, the degree of mandatory planning was scaled down to about 20% of all imports. Changes in the import regulation complemented the export policy; tariffs were used strategically to stimulate output in exports. To this end the tariff barriers were lowered substantially (or exemptions granted) for imports of raw materials or intermediate inputs used by export producers, technologically intensive capital goods, and to imports into SEZs. The main instrument of decentralization of exports in China was the local foreign trade corporations (FTCs), which acted independently of the central government's 12 national FTCa. The practice of independent provincial management of exports was initiated by the Guandong province in 1978, which was quickly followed by other regions and led to the creation of over 800 FTCs by mid-eighties and 5000 by the end

[14] These are Shanghai, Tianjin, Dalian, Qinhuangdao, Yantai (including Weihai), Wingdao, Lianyungang, Nantong, Ningbo, Wenzhou, Fouzhou, Guangzhou, Zhangjiang, and Beihai.

of 1980s. While overall the trade regime still remained rather restrictive – there are various formal barriers to trade and FDI, for instance, in the form of non-tariff controls, local governments have a substantial degree of discretion to lower or remove these barriers and they have actively exercised such discretion, greatly contributing to China's success in foreign trade (de Menil, 1995). Coast provinces, especially Guangdong, reaped the greatest benefits from the initial preferential status. By 1996 the coastal provinces captured 88% of all cumulative FDI (since 1978) while Guangdong along captured 30% of all cumulative FDI.[16] By 1983 the coastal provinces had captured 93% of all cumulative FDI, while Guangdong alone captured 69% of all FDI (Demurger, 2000, p. 22).

Education system also underwent a major transformation during the reform of 1985.[17] Its main ingredient was the skill building view of schooling as opposed to the previously dominating ideological view. The stated goal of the reform was to promote a nine-year compulsory basic education to meet the demand of a rapidly growing economy. Given the traditionally low levels of government commitment to education spending (2 percent of the GDP in 1967; 7.7 percent in 1985) and large disparities in regional development, this posed a huge financial challenge for the economy. Decentralization of education finance and administrative responsibilities under the slogan "eating from separate pots" constituted one of the main pillars of the reform. In a country where previously all financial powers vested with the central government, this was a dramatic move. As its result, by the early 1990s, financing of primary and secondary education came almost exclusively from regional and, especially, local (county) sources. In particular, counties, towns and villages, and other local administrative units assumed a growing responsibility for the operation of the school system within their respective jurisdictions. Regional differences in educational expansion have

[15] See Fukakasu and Solignac Lecomte, 1996.
[16] In 1983 the numbers were 93% of all cumulative FDI for coastal provinces, while Guangdong alone captured 69% of all cumulative FDI.
[17] The following account is based, in particular, on Tsang, 1996.

been pronounced as well as the urban-rural differences. In particular, the coefficient of variation in education spending across the administrative regions in 1989 was between 40-50 percent, strongly correlated with the regional income per capita.

It is commonly held that the increase in the demand for skilled labor (Tsang, 1996) was stimulated by the boom in the export-oriented private sector which raised the premium on education. Public education expenditure has increased, from the average of 6.5 percent of the budget in the period 1950-1978 to the average of 11 percent in the period 1979-1992. The increase was at an impressive annual rate of 8.1 percent in the period 1986-1992. Gustafsson and Shi, 2004, report an increase in the household expenditure on education (as a share of total household expenditure) among rural households in 18 provinces between 1988 and 1995; increases in the price of schooling in urban household most likely have risen even more dramatically. The quality of school inputs, such as building conditions, availability of laboratories and equipment, teachers' qualifications have all shown significant improvement in that period. Rapid growth of employment in the export sector was accompanied by an increase in wages, particularly in the coastal urban centers. The level of real wages in urban areas increased by 37% for men and 29% for women of (Schultz and Yu, 1998) between 1986 and 1994. At the same time, wages in coastal provinces expanded at a faster rate over the same period. For instance, Schultz and Yu, 1998, report 30% higher wage rates in the more open coastal Guangdong than in the less open in-land Sichuan and Hunan provinces in 1985. By 1995 the differential rose to 70%. Virtually all sources document increases in total wage returns to education at all levels of schooling, the point estimates vary, however, depending on the sample and methodology employed[18]. Zhang and Zhao, 2002, indicate that returns to schooling increased between 1988 and 1999 from 3.2 to 9.2 percent for men, and from 6.1 to 15 percent for women. The largest wage returns to education have been observed in

[18] Li, 2003, argues that estimating hourly wage equations as opposed to monthly or yearly wage rates corrects for the downward bias in the latter.

the private sector (Li, 2003), which is by far more open than the state, public or collective enterprises.

5.2. Empirical results

The cross-country methodology above is now applied to the expansion of education in China. While in a cross-country setting institutional differences could be partly responsible for differences in educational outcomes, these factors are likely to matter much less in a single country. This will be especially true in China, where the strong central government effectively curbed local autonomy until mid-eighties, thus minimizing the heterogeneity of institutions across provinces.

In this context, regional variation in openness will be used, whereby exports data will serve the proxy for openness[19]. As before, the main hypothesis is that greater openness leads, through the increase in the demand for skilled labor, to greater educational enrolment. We look at enrolment and exports at three points in time – 1988, 1995 and 2001. Our data come from several sources. All enrolment and 1995 and 2001 exports data come from China Statistical Yearbook (1989, 1996, and 2002); 1988 exports data comes from the Almanac of Foreign Trade Statistics (1988); and household expenditure data from various censuses. Summary statistics for the provinces for 1988-2001 are reported in Appendix B.

In 1986, the largest exporters were Shanghai ($280 per capita), Tianjing ($146 per capita) and Laoying ($77 per capita); the smallest exporters were Guizhou ($1.8 per capita), Tibet ($3.1 per capita), and Sichuan ($4.5 per capita). Between 1986 and 2001 the exports of Chinese provinces rapidly expanded. Overall, the initial size of provincial exports did not have any significant effect on the pace of this expansion (the correlation between initial exports and change in exports is .07 and is not statistically significant). The highest export

[19] Demurger (2000) demonstrates that imports and exports are highly correlated. This is in part due to the above mentioned government policy of tying imports to the needs of the export sector.

growth rates were reported in Fugijan (averaging 19.8% annually), Zhejiyang (averaging 19.3% annually) Guandong (18.2%). Exports in Hubei, Xijiyang, and Jilin grew at the slowest pace – averaging, correspondingly, 3.0%, 4.1%, and 4.2% per year. In 2001, the largest exporters in per capita terms are Shanghai ($1197), Guangdong ($885) and Tianjin ($635); the smallest exporters were Guizhou ($9.7 per capita), Gangsu ($13.3 per capita), and Henan ($13.8 per capita).

Similarly to the cross-country setting, we regress enrollment on per capita income of urban households in a province (UINC); the provincial volume of exports (OPEN); and the province's population size (POP), all in logarithms. Provincial enrolments in 1988, 1995 and 2001 are measured in number of students, and exports are measured in constant 1987 USD ('0000) in the same years.[20] Additionally we control for the average monthly of income of the urban households (in 1980 Yuan) and provincial population size ('0000 people). The results of this regression are shown below.[21]

$$SCHOOL_{jt} = -10.87 - .36\ UINC_{jt} + .09\ OPEN_{jt} + .69\ POP_{jt} + \varepsilon_{jt} \qquad (11)$$
$$\qquad\qquad [4.67]^{**} \quad [3.71]^{***} \quad [2.02]^{**} \qquad [2.04]^{**}$$

These results lend support to our hypothesis that expansion of exports is positively associated with expansion of schooling. Recalling that both schooling and exports are entered in the log form, we interpret the coefficient as an elasticity, so that a doubling of provincial exports corresponds to a 9% increase in primary enrolment.

In addition, we find that household per capita income is significantly and negatively associated with enrolment in the first specification - the greater the income the lower primary enrolment. But once we allow for a concave relationship between enrolment and household income (the quadratic term) in the second specification in Appendix B2, it becomes clear that the negative sign on income in the first specification is due to declining marginal returns to

[20] Provincial export figures for 1988 were not available to us, so we substituted for them with 1986 exports.
[21] These results are presented in Appendix B2.

household income.[22] The sign of the population variable is positive and the effect is significant, indicating, not surprisingly, that more populous provinces have a larger number of enrolled primary students.

The literature on China's regional development has repeatedly emphasized the qualitative difference of coastal and inland regions when it comes to openness. For a set of historical (changes in foreign trade policy were first implemented in the coastal provinces) and economic (e.g. lower transportation costs to exporters) reasons coastal provinces have a favorable climate for foreign investment and trade. Given the favorable climate for international trade in coastal regions, the effect of openness on enrolment should be more pronounced. Separate estimation of equation (11) for coastal and non-coastal provinces renders the following results (see Appendix B3 for full details):

Coastal provinces:

$$SCHOOL_{jt} = \underset{[0.42]}{-4.39} + \underset{[1.68]}{3.75}\, UINC_{jt} - \underset{[1.98]*}{.31}\, UINC_{jt}^2 + \underset{[2.68]**}{.17}\, OPEN_{jt} + \underset{[0.93]}{.75}\, POP_{jt} + \varepsilon_{jt} \qquad (12.1)$$

Inland provinces:

$$SCHOOL_{jt} = \underset{[1.21]}{-12.92} - \underset{[1.68]}{1.41}\, UINC_{jt} - \underset{[0.38]}{.08}\, UINC_{jt}^2 + \underset{[0.50]}{.04}\, OPEN_{jt} + \underset{[2.44]**}{.92}\, POP_{jt} + \varepsilon_{jt} \qquad (12.2)$$

As can be seen from equations (12), in coastal provinces, the effect of openness on enrolment is much larger than in the inland provinces, where primary enrolment seems to be unaffected by our measure of openness. The overall fit as measured by R-squared is also much better in coastal provinces than inland, see appendix B3. One reason for the coastal-inland differences is that many goods, especially those that are used for exports, have a non-tradable dimension. Additionally, inter-provincial and urban-rural mobility of labor was significantly restricted. Even though the official administrative restrictions on urban-rural migration were lifted in

1988, the costs of moving to the urban areas remained prohibitive.[23] Taken together, these two factors may explain why in the coastal provinces openness is more closely associated with education than in the inland provinces.

6. Concluding remarks

Education has expanded tremendously over the last several decades. As we find no evidence for a decrease in cost of schooling, this expansion is attributed to the secular increase in the demand for human capital accumulation. The paper's central message is that among the factors positively associated with educational expansion is the economy's openness, which is interpreted here as an improved access to technological opportunities. In particular, openness is a robust predictor of educational expansion, both internationally and in the case of China's provinces. The latter case, it is argued, is of a particular interest since liberalization in China was implemented, almost by design, with significant policy differences across the provinces. These results, while offering an explanation for the vast expansion of schooling, also indicate how school enrolment is likely to evolve in developing countries in response to further globalization.

[23] Thus, under the Household Responsibility Act, farmers have land-use rights to their plots but not the right to alienate the land property. If a rural household were to decide to move to the city, it would be able to sell the land and use the proceeds to finance the relocation. Instead it would have to return the land to the state, thus forfeiting any future income from the land. The settlement costs to rural residents wishing to migrate to urban areas are additionally increased by the fact that the market for housing, health and social services is heavily regulated and are often provided by the working units in urban areas to their employees (Yang, 1997).

APPENDIX A: Cross-country data

A1: Statistical data summary

Table A1.1: Summary of relevant variables for the entire sample (all available observations)

Variable	N	Mean	Std. Dev.	Min	Max
Enrolment, primary	2292	93.56	24.05	3.01	165.96
Enrolment, secondary	2212	57.92	34.21	0.00	160.76
Enrolment, tertiary	2166	17.59	17.36	0.02	97.35
Years of schooling	1018	4.99	2.87	0.09	12.05
Real GDP per capita, PPP	5944	3852.31	4003.99	196.26	21841.57
Real Public Expenditure on Education, PPP	2458	6035.57	22388.27	1.05	302286.00
Population	7874	22.44	89.39	0.01	1246.51
Openness	5194	70.4692	51.16297	4.31E-09	440.5004

Population and expenditure are reported in millions

Table A1.2: Summary of variables used in regressions with respect to years of schooling.

	Variable	Obs	Mean	Std. Dev.	Min	Max
All Years	Years of schooling	633	5.12	2.79	0.12	11.86
	Real GDP per capita, PPP	633	4509.21	4216.54	313.00	19192.67
	Real Public Expenditure on Education, PPP	633	5916.76	21366.87	1.05	230079.20
	Population	633	35.84	122.66	0.04	1200.27
1960	Years of schooling	60	3.93	2.60	0.12	9.73
	Real GDP per capita, PPP	60	2790.79	2489.96	313.00	9895.00
	Real Public Expenditure on Education, PPP	60	2287.16	10652.48	1.05	82058.18
	Population	60	20.08	60.97	0.04	434.83
1965	Years of schooling	71	4.04	2.59	0.17	9.74
	Real GDP per capita, PPP	71	3402.57	2959.94	409.00	11649.02
	Real Public Expenditure on Education, PPP	71	3897.89	16749.52	13.80	138753.20
	Population	71	22.19	62.58	0.19	487.34
1970	Years of schooling	77	4.37	2.61	0.20	10.24
	Real GDP per capita, PPP	77	3730.92	3351.54	418.00	12963.00
	Real Public Expenditure on Education, PPP	77	5110.23	22801.73	3.70	196432.90
	Population	77	23.65	67.80	0.05	547.57
1975	Years of schooling	80	4.74	2.71	0.35	11.27
	Real GDP per capita, PPP	80	4185.29	3764.19	416.00	13681.99
	Real Public Expenditure on Education, PPP	80	6334.08	25169.45	11.81	216892.60
	Population	80	37.65	124.09	0.20	916.40
1980	Years of schooling	87	5.16	2.76	0.54	11.86
	Real GDP per capita, PPP	87	4964.28	4451.58	505.00	19192.67
	Real Public Expenditure on Education, PPP	87	6700.35	25955.67	6.96	229913.60
	Population	87	38.05	129.42	0.04	981.24
1985	Years of schooling	83	5.58	2.65	0.61	11.57
	Real GDP per capita, PPP	83	5171.69	4541.89	518.00	16569.99
	Real Public Expenditure on Education, PPP	83	7411.97	22949.18	20.19	189519.80
	Population	83	42.47	142.75	0.07	1051.01
1990	Years of schooling	97	6.13	2.72	0.82	11.74
	Real GDP per capita, PPP	97	5131.51	4782.12	483.19	18054.02
	Real Public Expenditure on Education, PPP	97	7001.47	24483.65	26.57	230079.20
	Population	97	43.35	145.00	0.26	1133.68
1995	Years of schooling	78	6.40	2.62	0.76	11.70
	Real GDP per capita, PPP	78	5952.51	5246.55	423.50	18040.29
	Real Public Expenditure on Education, PPP	78	7100.59	12671.51	42.97	60429.41
	Population	78	51.68	170.98	0.27	1200.27

Population and expenditure are reported in millions

A2: Regression results with respect to enrolment

Table A2: Enrolment (N Pupils) with Respect to Public Spending on Education and Per Capita Income, 1960-2000

	1	2	3	4	5	6	7	8	9
	OLS	FE	BE	OLS	FE	BE	OLS	FE	BE
Dependent variable: number of students in primary and secondary education									
Log real GDP per capita	1.254	0.48	0.411	2.444	1.086	2.377	2.148	1.086	2.024
	[5.88]**	[1.58]	[0.69]	[19.23]**	[5.63]**	[6.60]**	[13.54]**	[5.63]**	[4.26]**
Log real pub. spending	0.979	0.573	0.954	0.125	0.119	0.059	0.199	0.119	0.136
	[124.13]**	[26.93]**	[47.00]**	[6.76]**	[6.65]**	[1.16]	[10.64]**	[6.65]**	[2.55]*
Sq. log real GDP per capita	-0.143	-0.062	-0.087	-0.156	-0.082	-0.146	-0.141	-0.082	-0.129
	[10.78]**	[3.42]**	[2.32]*	[20.07]**	[7.07]**	[6.66]**	[14.44]**	[7.07]**	[4.39]**
Log population				0.863	1.291	0.911	0.798	1.291	0.851
				[47.79]**	[38.96]**	[18.21]**	[43.41]**	[38.96]**	[16.49]**
LAC							0.214		0.224
							[5.62]**		[1.93]
ECA							-0.124		-0.068
							[3.16]**		[0.58]
MENA							0.062		0.085
							[1.73]		[0.74]
SSA							0.08		0.09
							[1.89]		[0.72]
SAR							0.116		-0.002
							[2.15]*		[0.01]
EAP							0.19		0.229
							[4.88]**		[1.91]
Constant	-6.775	2.499	-3.134	-11.52	-12.073	-11.01	-10.66	-12.073	-10.048
	[7.80]**	[2.07]*	[1.32]	[22.31]**	[14.17]**	[7.67]**	[17.19]**	[14.17]**	[5.59]**
Observations	1184	1184	1184	1184	1184	1184	1184	1184	1184
R-squared	0.93	0.46	0.93	0.98	0.78	0.98	0.98	0.78	0.98
Number of countries		169	169		169	169		169	169

Absolute value of t statistics in brackets
* significant at 5%; ** significant at 1%

APPENDIX B: China's provinces

Table B1:

Summary of Provincial Characteristics, 1988-2001.

province	Enrol. in primary	Enrol. in sec-ry	N primary schools	N sec-ry schools	Urban HH income per capita	Rural HH income per capita	Exports in const. 1986 prices ($10000)	Pop., 10000
Anhui	6594873	2922449	29364.67	4113.67	1001.412	410.2133	95941.59	5906
Beijing	840781.3	605891	2873.333	734.333	1371.615	701.98	356150.5	1238.33
Chongqing	2777859	1540317	13076	1607			84261.77	3097
Fujian	3561917	1670078	18087.67	1681.33	1131.323	643.8367	568254.5	3174
Gansu	2815658	1149969	22001.33	1693	885.0914	288.8467	23194.45	2383
Guangdong	8416319	3577948	24283.33	3996	1563.81	670.8567	3855474	6859.67
Guangxi	5675853	2047253	15876.33	2927.67	1059.994	372.52	85787.96	4473
Guizhou	4717368	1305527	19450.33	1874.67	911.8661	312.37	23714.17	3478
Hainan	1015412	355496.7	4203.333	495	926.0148	385.24	40229.05	716
Hebei	7453153	3458142	42427	5392.33	1086.814	577.1334	177458.7	6310.33
Heilongjiang	3497414	2100995	15358.67	2770.67	874.1119	499.16	143342.4	3659.33
Henan	10301132	4879636	41967.33	7385.67	974.6396	444.7133	94957.77	8916.33
Hubei	6500190	2854766	28025.33	4128	981.0693	466.45	110631.9	5644
Hunan	6865006	3206112	41062.33	4940	1018.813	387.6467	90993.52	6292.67
Inner Mongolia	2203612	1204786	12655.67	1908	908.7971	426.0633	39447.71	2251.67
Jiangsu	6577204	3349438	25083	4742	1156.728	749.53	1002063	6953
Jiangxi	4474066	2147227	25595.33	2821	928.0919	462.8267	56677.88	3952.67
Jilin	2603528	1357743	10037	1855.33	869.4713	536.4067	81118.48	2552
Liaoning	3688386	2097878	14355	2448	974.0814	611.4033	525770.2	4035.33
Ningxia	655843	294597	3693.333	441.333	918.9916	364.5567	14958.39	507
Qinghai	494672.7	225430.3	3435	478.667	907.384	364.3167	7726.202	479.333
Shaanxi	4180386	1870468	34444	2874.67	872.6221	302.4867	64508.45	3436
Shandong	8231872	5153906	43805.33	5743.67	1225.505	589.8667	730247.1	8602.33
Shanghai	944592.3	667625.7	1843	801	1719.218	938.0234	1076715	1430.33
Shanxi	3213571	1754834	39362	3667	843.09	384.08	115287.7	3034.67
Sichuan	9695008	3988304	59667.33	5776.33	999.8735	386.24	105090.6	10180.3
Tianjin	769023.7	467562	2600	720.333	1390.123	692.83	359984.9	929.667
Tibet	238481.3	42407	2430.333	82			2487.372	238.333
Xinjiang	2161380	990684.7	7001.333	1925	1064.476	362.8533	35092.58	1654.33
Yunnan	4677694	1490312	33693.67	2177.67	1146.707	309.05	62314.37	3957
Zhejiang	3584333	2144280	22065.33	3181.33	1409.372	842.8067	817469.5	4367.33
Total	4205759	1974567	21465.04	2779.49	1073.142	499.4589	359258.9	3911.35

Compiled from various sources. See text.

Appendix B2:

China: Logged Primary Enrolment and Openness, 1988-2001. FE.

	Ln(Prim. Enrol.)	Ln(Prim. Enrol.)
Ln(Population)	0.69	0.685
	[2.04]**	[2.06]**
Ln(Urban household income per capita)	-0.36	1.855
	[3.71]***	[1.53]
Ln(Export)	0.089	0.089
	[2.02]**	[2.07]**
[Ln(Urban HH Income per Capita)]^2		-0.16
		[1.83]*
Constant	10.874	3.297
	[4.67]***	[0.70]
Observations	86	86
Number of year	29	29
R-squared	0.21	0.26

Absolute value of t statistics in brackets

* significant at 10%; ** significant at 5%; *** significant at 1%

Appendix B3

China: Logged Enrolment and Openness in Coastal and Inland Provinces, 1988-2001. FE.

	Coastal		In-land	
	Ln(Primary Enrolment)	Ln(Primary Enrolment)	Ln(Primary Enrolment)	Ln(Primary Enrolment)
Ln(Population)	0.375	0.752	0.934	0.927
	[0.44]	[0.93]	[2.49]**	[2.44]**
Ln(Urban HH Income per Capita)	-0.635	3.745	-0.252	-1.414
	[2.73]**	[1.68]	[2.33]**	[0.46]
Ln(Exports)	0.206	0.173	0.023	0.04
	[3.08]***	[2.68]**	[0.35]	[0.50]
(Log Urban HH Income per Capita)^2		-0.308		0.084
		[1.98]*		[0.38]
Constant	13.705	-4.387	9.023	12.924
	[2.45]**	[0.42]	[3.51]***	[1.21]
Observations	32	32	54	54
Number of provcode	11	11	18	18
R-squared	0.38	0.5	0.23	0.23

Absolute value of t statistics in brackets

* significant at 10%; ** significant at 5%; *** significant at 1%

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Figure 1: Average number of years of schooling for population of 15+ year-olds, 1960-2000.

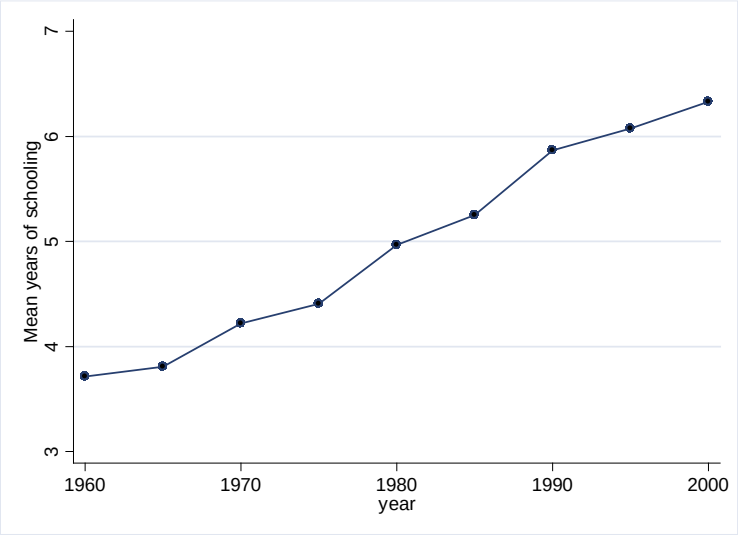
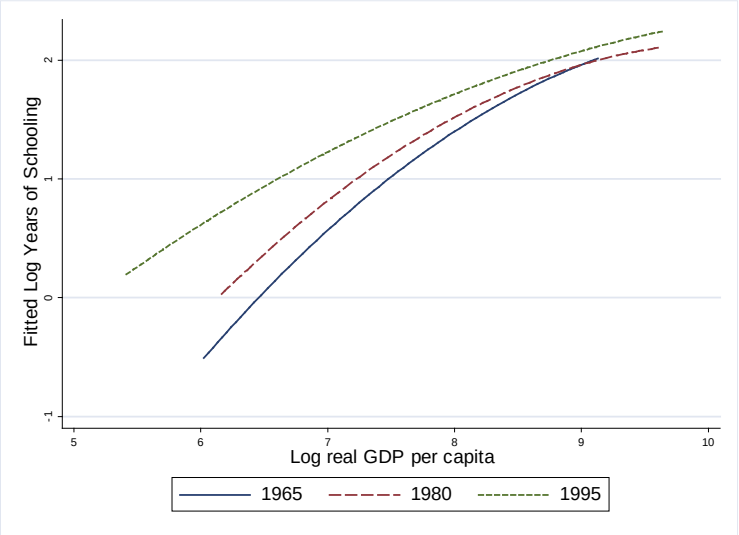


Figure 2: Educational Expansion over Time



Utility level

Table 1: Schooling expansion, 1960-2000

	1	2	3	4	5	6	7	8	9
	OLS	FE	BE	OLS	FE	BE	OLS	FE	BE
Dependent variable: log years of schooling									
Log real GDP per capita	2.185	0.593	2.829	1.979	0.301	2.443	1.356	0.301	1.35
	[6.96]**	[1.79]	[3.77]**	[6.44]**	[1.11]	[3.23]**	[3.86]**	[1.11]	[1.52]
Sq. log real GDP per capita	-0.105	-0.05	-0.145	-0.111	-0.02	-0.138	-0.082	-0.02	-0.082
	[5.32]**	[2.54]*	[3.06]**	[5.74]**	[1.26]	[2.96]**	[3.78]**	[1.26]	[1.50]
Log real pub. spending	0.041	0.407	0.027	0.283	0.102	0.263	0.371	0.102	0.349
	[3.47]**	[15.29]**	[1.09]	[6.83]**	[3.51]**	[2.47]*	[8.81]**	[3.51]**	[3.18]**
Log population				-0.25	0.897	-0.24	-0.349	0.897	-0.34
				[6.08]**	[15.80]**	[2.28]*	[8.02]**	[15.80]**	[3.11]**
LAC							0.047		0.019
							[0.66]		[0.11]
ECA							0.319		0.324
							[3.44]**		[1.91]
MENA							-0.432		-0.498
							[5.39]**		[2.75]**
SSA							-0.252		-0.357
							[2.78]**		[1.79]
SAR							-0.284		-0.339
							[2.72]**		[1.31]
EAP							0.186		0.106
							[2.44]*		[0.60]
Constant	-10.044	-8.428	-12.275	-9.048	-15.995	-10.699	-6.098	-15.995	-5.705
	[8.02]**	[6.60]**	[4.16]**	[7.37]**	[13.89]**	[3.59]**	[4.33]**	[13.89]**	[1.65]
Observations	633	633	633	633	633	633	633	633	633
R-squared	0.59	0.51	0.61	0.61	0.67	0.63	0.67	0.67	0.72
Number of countries		117	117		117	117		117	117

Absolute value of t statistics in brackets
* significant at 5%; ** significant at 1%