Human Capital and Income Inequality*

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Abstract

This study investigates empirically how human capital, measured by educational attainment, is related to income distribution. The regressions, using a panel data set covering a broad range of countries between 1980 and 2015, show that a more equal distribution of education contributes significantly to reducing income inequality. Educational expansion is a major factor for reducing educational inequality, and thus income inequality. Public policies improving social benefits and price stability contribute to reducing income inequality, while public educational spending helps to reduce educational inequality. In contrast, higher per capita income, greater openness to international trade, and faster technological progress tend to make both income and education distributions more unequal. Using the calibration of empirical results, we find the rising income inequality within East Asian economies in recent decades can be attributed to the unequalizing effects of fast income growth and rapid progress in globalization and technological change, which have surpassed the income-equalizing effects from improved equality in the distribution of educational attainment during the period. We also find that a more equal distribution in educational attainment tends to be associated with greater intergenerational mobility in schooling and earnings.

Keywords: income distribution, inequality, human capital, education, globalization, technological change, intergenerational mobility

JEL classification codes: D31, H52, I24, O53

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1. Introduction

In recent decades, rising income inequality has attracted attention. In many countries, alongside income growth, income inequality has also been on the rise (Piketty 2014). Many East Asian economies that have achieved the "miracle" of "growth with equity" have also witnessed the deterioration of income distribution (Jain-Chandra et al. 2016; Zhuang et al. 2014).

High income inequality, especially that originating from prevalent inequality in opportunities in a society, is undesirable from the perspective of social justice. Furthermore, unfair income distribution can be harmful to sustainable economic growth. Higher inequality provides fewer education opportunities for talented yet underprivileged individuals and discourages investment by making a society more unstable. Hence, all states endeavor to ensure basic livelihoods for the poor and disadvantaged by building social security systems and to reduce inequalities in wealth and income by adopting redistribution policies.

Human capital, measured by educational attainment, is often emphasized as one of the major factors affecting the degree of income inequality. Educational attainment embodied in a worker is a major determinant of the worker's lifetime earnings. Parents consider educational investment in their children as an important way to improve the children's future earnings. Many governments use higher educational spending as an effective tool for reducing educational inequality and thus income inequality. Despite this general perception of and interest in the importance of education for income distribution held by the public and policymakers, the relationship between educational attainment and its distribution in populations with income equality is not always clear in theoretical and empirical studies.[1]

In the recent period, educational attainment has been expanding and educational inequality has been narrowing in many countries and regions, but at the same time income inequality has been widening, as shown in section 3. If increases in average educational attainment and educational equality are predicted to lower income inequality, this trend is puzzling. We must determine the exact contribution of education to income distribution by assessing the roles of all the important factors in income distribution. For example, during this period, rapid

[1] See the literature survey in section 2.

globalization and technological progress have occurred worldwide. While many studies have investigated the causes of income inequality, the exact contribution of education to income inequality has not been thoroughly analyzed, especially in intertemporal, cross-national contexts.

Against this backdrop, this paper empirically analyzes important factors for income inequality across countries over the past four decades and assesses how the level and distribution of educational attainment are related to income distribution. We also assess how international trade, technological progress, and public policies such as social benefits and educational spending are related to income and education distribution.

Another important question is how education affects the degree of intergenerational mobility, meaning the likelihood that children from low-income families will be relatively rich as adults and vice versa. Studies show that greater income inequality at a given point in time is associated with less intergenerational mobility, which is known as "The Great Gatsby Curve" (Corak 2013). Education is likely to play an important role in the link between income equality and intergenerational mobility. This paper analyzes how the distribution of educational attainment among the population is associated with intergenerational mobility in education and earnings.

The remainder of this paper is organized as follows. Section 2 briefly reviews the literature on education and income inequality. Section 3 discusses the data and presents stylized facts on the evolution of education and income inequality. In Section 4, we analyze the determinants of income inequality, using a panel data set covering a broad range of countries for the period between 1980 and 2015. Using the regression results, we discuss the role of educational attainment and its distribution in terms of income inequality. For illustration, we also apply the results to East Asian economies and assess to what extent education and other major determinants contributed to the change in income inequality in recent decades. Section 5 analyzes the determinants of educational inequality and discusses how educational expansion can affect educational inequality and thus income inequality. Section 6 assesses the role of education in intergenerational mobility. Section 7 concludes.

2. Literature Review on Education and Income Inequality

The human capital model suggests that the distribution of earnings is determined by the level and distribution of schooling across the population (Becker and Chiswick 1966; Mincer 1974). Hence, the model predicts that the supply and demand of educated people influence earnings inequality in a society. While the model predicts an unambiguously positive association between educational inequality, as measured by the variance of schooling, and income inequality, the effect of average years of schooling on income inequality may either be positive or negative, depending on the evolution of rates of return on education.

Consider the following human capital earnings function (De Gregorio and Lee 2002):

$$logY_S = logY_o + \sum_{j=0}^{S} \log(1 + r_j) + u \quad (1)$$

where *Ys* is the level of earnings with *S* level of schooling, r_j is the rate of return on the j^{th} year or level of schooling, and *u* represents other non-school-related factors that affect earnings. This function can be approximated by:

$$logY_s = logY_o + rS + u \quad (2)$$

Taking the variance yields the following earnings distribution function:

$$Var(logY_S) = \bar{r}^2 Var(S) + \bar{S}^2 Var(r) + 2\bar{r}\bar{S}Cov(r, S) + Var(u) \quad (3)$$

This implies that income inequality increases unambiguously with educational inequality, *Var(S)*, if other things are controlled for. However, if the return on education, *r*, decreases with educational inequality, the relationship can be ambiguous. For most cases, however, educational inequality and wage premium for higher education would move in the same direction, as an increase in the supply of higher-level educated people tends to lower both educational inequality and wage premium. Meanwhile, educational expansion, that is an increase in *S*, leads to a more unequal income distribution when *r* and *S* are independent. However, if the covariance between the return on education and level of education is negative, the relationship between education expansion and income inequality can reduce income inequality. Since the covariance term is expected to be negative, the relationship between education expansion and income inequality should be ambiguous.

Education expansion, *S*, would be expected either to improve or to deteriorate educational distribution, *Var(S)*, depending on its initial level and distribution (De Gregorio and Lee

2002). In a society where only a small fraction of the population has received formal education, average educational attainment is low and educational inequality is high. With an expansion of educational attainment, the level of educational inequality would increase if the more educated people receive a higher level of education, but decrease if the uneducated people receive some education.

Knight and Sabot (1983) suggest that educational expansion has an ambiguous effect on income distribution. They show that educational expansion has two offsetting effects on income distribution: the "composition effect," where wage inequality rises initially, when the educational expansion leads to an increase in the proportion of more educated workers; and the "wage compression effect," implying that when the supply of educated labor exceeds demand as a result of educational expansion, the premium on educated workers will eventually diminish, and thereby wage inequality decline.

Empirical literature studying the relationship between education and income inequality using cross-country data often present contradicting results. Two measures of educational inequality are commonly used in the empirical literature: the standard deviation of schooling (Lam and Levinson 1991; Ram 1990; De Gregorio and Lee 2002) and the education Gini coefficient (Checchi 2001; Thomas et al. 2002).

Several studies, including Park (1997) and De Gregorio and Lee (2002), find that a larger educational dispersion has an unequalizing effect on income distribution, while higher educational attainment has an equalizing effect on income distribution. Jaumotte et al. (2013) show that income inequality decreases with the average years of schooling. However, holding average education constant, income inequality tends to increase as the share of population with secondary or tertiary education increases.

Conversely, Ram (1984) finds no adverse effect of educational inequality on income distribution, while higher educational attainment appears to have a mild equalizing effect. Földvári and van Leeuwen (2011) also find an insignificant effect of schooling inequality on income inequality. Checchi (2001) confirms that educational achievement has a strong negative impact on income inequality. Furthermore, a U-shaped relationship between educational inequality and income inequality can be found when education attainment is controlled.

Cross-country studies also show a negative and nonlinear relationship between years of schooling and educational inequality (Ram 1990; Thomas et al. 2002; De Gregorio and Lee 2002), indicating that educational inequality increases as the average level of schooling increases but starts to decline after reaching a peak.

Lim and Tang (2008) suggest that human capital inequality can be measured by using the distribution of the Mincerian-type measure of human capital, rather than average years of schooling. They show the measure of human capital inequality has an inverted U-shape relation with average years of schooling as well as educational inequality. Castelló-Climent and Doménech (2017) find that the distribution of Mincerian-type human capital has a positive relation with income distribution.

The findings of existing studies using micro-level data are also broadly consistent with cross-country studies. Overall, educational inequality has an unequalizing effect on income distribution, while educational expansion has an ambiguous effect on income distribution.

Katz and Murphy (1992) show that the changes in the wage structure in the United States in the period of 1963 to 1987 could be explained by changes in the relative earnings of college graduates, which were related to fluctuations in the supply of college graduates and strong demand for skilled workers. Goldin and Katz (2009) show that an education slowdown caused much of the increase in U.S. wage inequality in the recent period. The premium for higher education and skills has also risen across many developed countries in recent decades, contributing substantially to the rise of inequality in earnings (Autor 2014).

A substantial body of literature has also analyzed the change in labor demand and supply and wage inequality in developing countries using micro-level data. Since the mid-1990s, average returns on an additional year of schooling increased significantly in China (Fleisher and Wang 2004; Zhang et al. 2005; Fang et al. 2012). In urban India, wage inequality has increased since the start of the economic reform in 1991, mainly owing to increases in the returns on skills (Kijima 2006). Lee and Wie (2017) show that rapid development in China and India was associated with an increase in the relative wage of workers with higher education.

Case studies on income distribution dynamics in three East Asian countries—Indonesia, Malaysia, and China—and four in Latin America—Argentina, Brazil, Colombia, and

Mexico—observe that while the mean years of schooling rose and schooling level became more equal among the working-age population within the period studied, income inequality also rose in most economies, except in Brazil where the distribution slightly improved (Bourguignon et al. 2004). They find changes in the distribution of education also had an overall unequalizing effect on household income, except in Brazil and Taiwan. For example, the greater improvement in education among high-income groups had the greatest unequalizing effect on household income in Indonesia. Conversely, in the case of Taiwan, education increased substantially such that average schooling among poor households also improved, and, as a result, inequality in education fell. Meanwhile, the rising inequality trend in Latin American countries was reversed beginning in the mid-1990s. Lustig et al. (2013) explain that the decline in labor income inequality was associated with higher education and, consequently, with more equal educational distribution.

Using a microeconometric decomposition method and comparing the distributions of household incomes between the United States and Brazil in 1999, Bourguignon et al. (2008) find that educational distribution was important in explaining differences in household income distribution between the two countries.

3. Evolution of Education and Income Inequality

Analysis of income inequality is confronted with challenges of data comparability for intertemporal, cross-country comparison. We rely on the Gini index of net income (that is, post-tax, post-transfer) taken from the Standardized World Income Inequality Database (SWIID), compiled by Frederik Solt (2016). This data set provides measures of income inequality with reasonable comparability for the broad range of countries in the world since 1960. Since the database provides more observations from 1980, our analysis focuses on the period from 1980 to 2015.

We have compiled the net income equality of countries and economies since 1980. We use five-year averages such as 1980–84, 1985–89, …, and 2010–14 to reduce short-term variations as well as possible measurement errors. Figure 1 presents the trend of income equality by major regions, using the unweighted averages for the panel of 60 countries that have complete observations at five-year intervals. The regions consist of “advanced countries” and six “developing regions”: East Asia/Pacific, Eastern Europe/Central Asia, Latin

America/Caribbean, Middle East/North Africa, South Asia, and Sub-Saharan Africa.[2] The figure shows that the advanced countries and Eastern European countries, on average, have maintained considerably more equal distribution of income than have countries from other developing regions throughout the period. The levels of income inequality in Latin America and Sub-Saharan African countries have been higher than in other regions, but have shown declining trends in recent decades. In contrast, income inequality in the East Asian countries has been relatively low but risen in recent decades.

[Figure 1 here]

Figure 2 presents data for 16 individual economies in the East and South Asian regions. We observe most Asian economies have experienced increasing income inequality in recent decades. The Gini coefficient of net income worsened in 12 East and South Asian economies. From the late 1980s to the mid-2010s, it increased from 0.34 to 0.51 in China, from 0.38 to 0.45 in Indonesia, and from 0.28 to 0.31 in the Republic of Korea. During the same period, it also increased from 0.43 to 0.48 in India and from 0.34 to 0.40 in Bangladesh. In contrast, four Asian economies, including Malaysia and the Philippines, have reduced income inequality in recent decades. Figure 3 presents the changes in income inequality measured by the Gini coefficient of net income in the selected economies in other regions.

[Figures 2 and 3 here]

For the measure of human capital, we use average years of schooling for the working-age population, constructed by Barro and Lee (2013) and Barro and Lee (2015). The most recent Barro-Lee data set provides estimates of educational attainment for the populations of 146 countries, disaggregated by gender and five-year age group, from 1950 to 2015 at five-year intervals. The data set distinguishes between seven different levels of education: no formal education, incomplete primary, complete primary, lower secondary, upper secondary, incomplete tertiary, and complete tertiary. These data were used to calculate the average years of schooling among the adult population both as a whole and at the primary, secondary, and tertiary levels.

The number of average years of schooling for the population aged 15–64, *S*, is constructed as:

[2] See Appendix Table 1 for a list of the countries included in each region/group.

$$S_t = \sum_{a=1}^{A} l^a S^a = \sum_{a=1}^{A} l^a \left(\sum_j h_j^a Dur_j^a \right) \quad (4)$$

where l^a is the population share of five-year age group a in the working-age population, and S^a is the number of years of schooling of age group a. The average years of schooling of age group a is constructed by the sum of the fraction of group a that has attained the educational level j (h_j^a) weighted by the corresponding duration in years (Dur_j^a).

To measure educational inequality, we construct the Gini coefficient of educational distribution, following Castelló and Doménech (2002):

$$Education\ Gini = \frac{1}{2S} \sum_{i=0}^{6} \sum_{j=0}^{6} \left| \hat{x}_i - \hat{x}_j \right| l_i l_j \quad (5)$$

where S is the average years of schooling in the population aged 15–64 years old, i and j stand for different levels of education, $\hat{x}_i$ refers to the cumulative average years of schooling of each level of education, and l is the share of the population with a given level of education.

Figure 4 presents the trend of educational attainment for each region from 1980 to 2015 for the 138 countries that have complete information. The numbers are unweighted averages for the countries in each region. The figure shows that education has expanded greatly within the region and worldwide. This dramatic increase in educational attainment reflects increases in school enrolment, especially at the secondary and tertiary levels in the earlier periods (Barro and Lee 2015). Notwithstanding the significant improvements, the gap between advanced countries and developing countries, in particular South Asian and Sub-Saharan African countries, still remains.

In contrast, educational inequality has continuously declined in all regions for the period (Figure 5). Even in the regions with greater inequality, such as South Asia and Sub-Saharan Africa, there has been a substantial reduction in educational inequality.

[Figures 4 and 5 here]

We look at the simple cross-correlation between income inequality and the educational variables. Figure 6 plots educational inequality against the income Gini coefficient from 1980 to 2015 at five-year intervals. It shows there is a positive relationship between income and

educational inequality. However, the correlation between the income and education Gini coefficients is low (correlation coefficient = 0.318). Figure 7 shows that there is a negative relationship between educational attainment and income inequality, but their correlation is also not very high (0.42).

[Figures 6 and 7 here]

We also look at the relationship between the changes in income inequality and in educational inequality. Figure 8 shows that there is a positive relationship between changes in income inequality and educational inequality from 1980 to 2015. However, they are weakly correlated (0.14). Some countries (e.g., Brazil, Iran, Peru, and Sierra Leone) have shown decreases in both income and educational inequality over the period, as predicted by human capital theory. Conversely, some others (e.g., China, Egypt, India, and Nepal) have experienced improvement in educational distribution but deterioration in income distribution. Figure 9 shows the relationship between the changes in educational attainment and income inequality is negative but very weak (0.15).

[Figures 8 and 9 here]

We also confirm that educational attainment has a strong negative relation with educational inequality, in terms of both level and change (Figures 10 and 11). As discussed in the previous section, expansion of education to less-educated, lower-income people appears to reduce the level of educational inequality.

[Figures 10 and 11 here]

Although the evidence presented in this section is suggestive, further statistical analysis is required to assess the magnitude of the independent effect of educational factors in explaining differences in income distribution across countries after controlling other important explanatory variables for income distribution.

4. Empirical Analysis of Income Inequality

This section explores major factors that can explain income inequality for a broad number of countries over three decades. The empirical strategy is to figure out the relationship between educational variables and income inequality, when other important determinants of income

inequality are controlled for.

The empirical framework is represented by:

$$Income\ Gini_{I,t} = \beta_0 + \beta_1\, log\left(y_{i,t}\right) + \beta_2\, log\left(y_{i,t}\right)^2 + \beta_3\, Education\ Gini_{I,t} + \beta_4\, Educational\ Attainment_{I,t} + \beta_5 X_{i,t} + \varepsilon_{i,} + \theta_{t,} + u_{i,t}\,, \quad (6)$$

where y_{it} is the country's per-capita income, and X_{it} denotes a group of environmental and policy variables that influence country i's income inequality. The specification includes period dummies.

The regression applies to a panel set of cross-country data for 95 economies over seven five-year periods from 1980 to 2014, corresponding to 1980–1984, 1985–1989, 1990–1994, 1995–1999, 2000–2004, 2005-2009, and 2010-2014.[3] The dependent variable is the net Gini coefficient of income distribution, averaged over each period.

The basic specification controls for the log of per capita GDP and its square in order to capture the Kuznets inverted-U curve for the relationship between income distribution and the level of income (Kuznets 1955). We want to see the effect of education factors, independently from per capita income, on income inequality. For the environmental and policy variables, we consider trade openness, inflation, fiscal policy (government consumption and social benefits), democracy indicator, and technological progress.

Trade openness is measured by the ratio of exports plus imports to GDP. Theoretically and empirically, international trade is considered to influence income inequality. According to a Heckscher-Ohlin trade model, when it opens up to trade, a country with abundant low-skilled labor would experience an increase in the relative wage of unskilled workers, thus reducing wage inequality. However, if trade transmits skill-biased technological change to developing countries, increased trade openness could cause higher wage inequality by shifting labor demand toward more skilled workers. Evidence suggests that trade liberalization has a significant effect on wage inequality, through its impact on adoption of new skill-intensive

[3] The sample is an unbalanced panel of 95 economies because many economies have incomplete data on income inequality in the 1980s. The main results reported here are robust when the sample is restricted to the balanced panel of 59 countries that have complete data.

technologies (Berman et al. 1998; Bourguignon et al. 2004; Lee and Wie 2015).[4]

Inflation (measured by changes in consumer price index over five-year intervals) is expected to worsen income distribution. Inflation tends to decrease real wage and redistribute income from wage earners to profit takers, which can deteriorate income distribution. Easterly and Fisher (2001) find that high inflation tends to lower the share of the bottom quintile and the real minimum wage, increasing income inequality. As inflation is a tax on cash balances, it can disproportionately hurt poor households, whose wealth is mostly held in liquid assets such as currency, thereby increasing inequality (Albanesi 2007).

Democracy is also added as a determinant of income inequality. In nondemocratic regimes where political power is concentrated within a narrow segment of the society, income inequality is expected to be higher. Democratic institutions, by shifting the median voter towards poorer people, can increase redistributive activities, reducing income inequality. On the other hand, democracy can cater to the preferences of the richer population or the middle class, thus exacerbating inequality (Acemoglu et al. 2015). The empirical evidence does not support a strong effect of democracy on income inequality. However, it appears to support that democracy influences income inequality through the indirect channels of tax rate and education (Acemoglu et al. 2015). We use as the measure of democracy the Freedom House Political Rights Index (converted from seven categories to a 0–1 scale, with higher values representing the increasing presence of political rights).

Fiscal policy is an important factor that influences income distribution. Redistributive policies are expected to reduce income inequality (Benabou 2000; De Gregorio and Lee 2002). The effect of overall government expenditures on income distribution must depend on composition, coverage, and targeting. We consider the extent of government consumption, defined as the average of government consumption of final goods to GDP, as a fiscal policy variable. We also use social benefit expenditure, which includes direct transfers to the poor for unemployment compensation, social security pensions, and the provision of medical services, as another fiscal policy variable redistributing income from rich to poor.[5]

[4] We also considered financial openness as a potential driver of income inequality, but it turns out to be statistically insignificant.

[5] We also considered public education appending as another fiscal variable that can influence income distribution, but it turns out to be statistically insignificant. However, educational spending has a significantly positive effect on education equality, as shown in Section 5.

The principal link between technology and income inequality is the channel through skill-biased technical change. Technological change, which causes relative demand shift favoring those with a high level of education, increases the relative wage of more-educated workers relative to under-educated workers. A difficulty arises regarding the accurate measurement of technological change. In this study, we adopt two measures, considering data availability: number of patents and the share of high-technology exports in total manufactured exports. Patents is the total number of applications filed by "applicant's origin" under the World Intellectual Property Organization (WIPO)'s Patent Cooperation Treaty (WIPO 2016). High-technology exports are products with high research and development (R&D) intensity such as in aerospace, computers, electrical machinery, pharmaceuticals, and scientific instruments (World Bank 2017).

[Figures 12 and 13 here]

Figures 12 and 13 present the trends of trade openness and technological progress, respectively, for each region from 1980 to 2015 for the sample of countries that have complete information. The numbers are unweighted averages for the countries in each region. Trade openness shows significant variation across regions. It has been high and risen fast on average in advanced economies and East Asian economies. The measures of technological progress also show significant regional variations but have been high in advanced economies and East Asian economies.

This system of seven equations in (7) is estimated with and without country fixed effects. The fixed-effects estimation controls for possible bias when unobserved and persistent country characteristics that influence the income Gini variable correlate with the explanatory variables. However, the fixed-effects technique eliminates information from cross-sectional variations and does not allow for estimation of the effects of variables that have little within-country time variation. To reduce reverse causality, we use per capita income and educational variables at the beginning of the period. For other policy variables, we have used the values for the contemporaneous period corresponding to the income distribution variable. The reverse causality from income distribution to our environmental and policy measures (such as international trade, inflation and technological progress) may not be substantial. Note that it is practically difficult to adopt instrumental variable estimation techniques by constructing a set of fully convincing exogenous instruments in this panel structure. The use of lagged

values as instruments would reduce the number of observations in the early period.[6]

Regression (1) of Table 1 presents the estimation results of the basic specification (6) using only income and education variables in the absence of country fixed effects. Regression (2) adds country fixed effects. Regressions (3) and (4) add four policy variables—trade openness, inflation, government consumption, and democracy indicator—without and with fixed effects, respectively. The sample includes 608 observations for seven periods for 95 countries.

The estimates on per capita GDP and education variables do not change much with inclusion of four policy variables in (3) and (4), compared to the results of (1) and (2), respectively. The results support the nonlinear effects of per capita income proposed by the Kuznets curve. The coefficients of per capita GDP and its square terms are positive and negative, respectively, and they are individually and jointly statistically significant in most specifications. This configuration of coefficients indicates an initial increase and a subsequent decline in income Gini with log per capita income when other variables are controlled. In regression (3), the linear term of 0.0776 and the squared term of -0.0041 imply that for low-income countries in the range below the per capita GDP breakpoint of $12,880 per year (in 2011 purchasing power parity-adjusted dollars), an increase in income worsens income inequality, with values of the other explanatory variables remaining constant. After the breakpoint, income distribution becomes more equal with higher income.

The inverted-U relationship between income level and income inequality is much weaker in regression (4), where country fixed effects are controlled. The square term is only marginally statistically significant. The estimated coefficients—the linear term of 0.0672 and the squared term of -0.0027—imply that the breakpoint is well above the range of per capita income in the sample. Hence, an increase in income tends to worsen income inequality. According to the estimated coefficients, an increase of log per capita income by one standard deviation (1.16) at mean (9.03 or $8,350) leads to an increase of income Gini coefficient by about 0.018 (that is, 1.8 percentage points), which accounts for about 20 percent of the standard deviation of the Gini coefficient.

[6] The instrumental variable (IV) estimation using lagged values as instruments provides qualitatively similar results, except that trade openness becomes statistically insignificant. The IV estimation results are available upon request.

[Table 1 here]

The results in regressions (1)–(4) show that educational inequality, measured by the Gini coefficient of educational attainment among the population, has a significantly positive effect on income inequality. In regression (4), the estimated coefficient (-0.089) suggests that an increase of education Gini by one standard deviation (0.18) increases the income Gini coefficient by about 0.016 (that is, 1.6 percentage points), which accounts for about 18 percent of the standard deviation of the Gini coefficient.

In contrast, educational attainment has a statistically insignificant effect on income inequality when other variables including per capita income and educational inequality are controlled. Note that as long as educational inequality is related to the level of educational attainment, the average level of educational attainment can have an indirect effect on income inequality by changing educational inequality. We discuss this issue in the next section.

Trade openness is estimated to have a significantly positive impact on income inequality. In regression (4), the estimated coefficient (0.017) suggests that an increase of international trade-to-GDP ratio by 0.56 (one standard deviation) increases the Gini coefficient by about 1 percentage point.

The positive estimate of the coefficient of inflation also supports the theoretical prediction. The estimated coefficient (0.019) implies that an increase of inflation by one standard deviation (1.42) increases the income Gini coefficient by about 0.3 percentage points. Conversely, democracy and government consumption are not statistically significant when per capita income, educational inequality, average educational attainment, and other policy variables are controlled.

Regressions (5) and (6) of Table 1 add number of patents as a measure of technological progress. The sample size shrinks because observations of this variable are less available. Regression (6) shows that when other explanatory variables and country fixed effects are controlled for, income inequality is strongly positively associated with technological development, measured by the number of patents. The estimated coefficient (0.146) suggests that an increase of patents by 0.06 million (one standard deviation) increases the Gini coefficient by about 0.9 percentage points. In regressions (7) and (8), income inequality is

also positively, though only marginally statistically significantly, related to high-technology exports, which is another measure of technological development. The estimated coefficient of high-technology exports (0.038) suggests that an increase of the ratio of high-technology exports to manufacturing exports by 0.12 increases the income Gini coefficient by about 0.5 percentage points.

Regressions (9) and (10) of Table 1 add government social benefits as an explanatory variable. Because the sample size shrinks substantially, the results for other explanatory variables change a lot. Notably, the estimates for per capita income and educational inequality variables become statistically insignificant. Nevertheless, social benefit spending has a significantly negative effect on income inequality. The estimated coefficient (-0.086) in regression (10) with inclusion of country fixed effects indicates that an increase of government social expenditures by 0.07 (one standard deviation) reduces the education Gini coefficient by about 0.6 percentage points. Interestingly, democracy enters positively and statistically significantly in this sample with controlling for government social expenditures, implying that a democratic regime tends to be positively associated with activities worsening income inequality when redistributive activities are controlled for.

To quantitatively assess the effects of education and other explanatory variables on income distribution, we decompose evolution of income inequality in the East Asian region. Many East Asian economies have been seen as examples of "growth with equity," but in recent decades they have experienced significant deterioration of income distribution. Columns (1)–(3) of Table 2 show the actual values of income Gini coefficient and all explanatory variables for 1985–89 and 2010–14 and their differences between the two periods for the average of eight economies that have complete data: China; Hong Kong, China; Indonesia; Malaysia; the Philippines; the Republic of Korea; Singapore; and Thailand. Columns (1)–(3) show the actual values of income Gini and all explanatory variables. The actual average values were 0.396 and 0.429 in 1985–89 and 2010–14, respectively, and increased by 3.3 percentage points over 25 years in East Asia. Using the regression result in column (6) of Table 1, we construct the values of income Gini predicted by each explanatory variable for each period and the difference between the two periods. The model-based predicted values of income Gini in 1985–89 and 2010–14 are about 2–3 percentage points lower than the actual values, and increased by 2.5 percentage points between two periods.

[Table 2 here]

Column (4) of Table 2 shows to what extent the change in each explanatory variable contributes to the predicted change of income Gini of 2.5 percentage points over the period in the region. We find that per capita income increase played an important role, contributing 0.9 percentage points. Trade openness and technological progress also made significant contributions of about 1.0 and 1.4 percentage points, respectively. More equal distribution of education counterbalanced these unequalizing effects by reducing income Gini as much as 1.6 percentage points. However, an increase in educational attainment has a deteriorating effect on income distribution by 0.5 percentage point.[7]

We can also gauge the role of social benefits in explaining the change in income inequality. During this period, the share of social benefits in GDP increased from 0.7% to 2.9% on average in East Asian economies. Using the estimated coefficient of social benefits in column (10) of Table 1, the increase in government social spending is estimated to contribute to reducing income inequality by about 0.2 percentage points. Hence, the small increase in social benefits had only a minor impact on income distribution in East Asia. If social spending had increased to 10% of GDP, the world average, it would have decreased income Gini by 0.8 percentage points, as much as education factors.

In sum, economic growth, trade openness, and technological progress have been three major factors that have led to the deterioration of income distribution in East Asia in recent decades. The unequalizing effects of these factors on income distribution have surpassed the income-equalizing effects of educational equality and government social expenditures. Improvements in level and distribution of education have been important factors counterbalancing the forces of deteriorating income distribution.

5. Empirical Analysis of Educational Inequality

The previous section shows that income inequality is positively related to educational inequality. In this section, we analyze the determinants of educational inequality.

[7] Note that educational expansion can have an indirect effect on income inequality through its effect on educational inequality. According to the estimation result in the next section, a 3.5-year increase in average schooling years in East Asia over 1985–89 and 2010–14 would have a significantly positive effect on educational distribution, and thus income distribution.

The empirical framework is represented by:

$$Education\ Gini_{I,t} = \beta_0 + \beta_1\, log\left(y_{i,t-1}\right) + \beta_2\ Income\ Gini_{I,t-1} + \beta_3\ Educational\ attainment_{I,t-1} + \beta_4\ X_{i,t-1} + \varepsilon_{i,} + \theta_{t,} + u_{i,t} \quad (7)$$

The regression applies to a panel set of cross-country data for 95 economies at five-year intervals from 1985 to 2015. The dependent variable is Gini coefficient of educational distribution for 1985, 1990, 1995, 2000, 2005, 2010, and 2015. To reduce reverse causality, we use one-period lagged values for per capita income and educational attainment variables and averaged values over the previous five years for environmental and policy variables. The regression includes a lagged value of income inequality to see the possible impact from income distribution to educational distribution.

We use public educational spending, instead of social benefits (which turns out statistically insignificant), as a fiscal policy variable. Educational spending is expected to help the poor to get access to education, thereby contributing to education equality, especially when credit markets are imperfect (Benabou 2000; De Gregorio and Lee 2002).

Regression (1) of Table 3 includes only per capita income, income inequality, and educational attainment as explanatory variables, without country fixed effects. The results show a strong negative effect of educational attainment on income inequality. However, both income level and income inequality are statistically insignificant. In Regression (2), with country fixed effects included, the negative effect of educational attainment on income inequality remains strong. The estimated coefficient of educational attainment (-0.037) suggests that an increase of average schooling by about 3 years (amounting to one standard deviation) decreases the education Gini coefficient by about 0.11 (that is, 11 percentage points), which accounts for about 60 percent of the standard deviation of the education Gini coefficient. Therefore, the increase in educational attainment is the major driver improving the education Gini coefficient. According to the result in Table 1, a decrease of education Gini by 0.11 reduces the income Gini coefficient by about 1 percentage point. Hence, an increase in the level of educational attainment can contribute significantly to reducing income inequality through the channel of change in educational inequality.

[Table 3 here]

With the inclusion of country fixed effects, the estimated coefficients of income level and income inequality become statistically significant and positive. Hence, the increases in per-capita income and income inequality over time tend to increase educational inequality. An increase of log per capita income by one standard deviation (1.16) increases education Gini coefficient by 1.9 percentage points. An increase of income Gini by one standard deviation (0.18) leads to an increase of education Gini by 1.0 percentage point. Income Gini becomes statistically insignificant in Regressions (5)–(10), where other policy variables are added.

Regressions (3) and (4) add four policy variables—trade openness, inflation, government consumption, and democracy indicator—without and with country fixed effects, respectively. The coefficient of trade openness is significantly positive. In Regression (4), the estimated coefficient (0.031) suggests that an increase of international trade by 0.56 (one standard deviation) increases the education Gini coefficient by about 1.7 percentage points. Government consumption is also significantly positive. The estimated coefficient (0.166) suggests that an increase of government consumption by 0.07 (one standard deviation) increases the education Gini coefficient by about 1.2 percentage points. Conversely, inflation and democracy are not statistically significant. The positive effects of trade openness and government consumption on educational inequality, with income and educational attainment variables controlled for, seem to suggest that distribution of education among the population tends to become more uneven, for instance, by disproportionally increasing the schooling years of higher-educated people when an economy increases openness to international trade or the size of government consumption.

Regressions (5)–(8) include technology variables. In contrast to the regressions of income inequality, there is no significant effect of technological development, measured by either the number of patents or high-technology exports, on educational inequality.

Regressions (7) and (8) add government educational spending as an explanatory variable. The coefficient of educational spending is negative, implying that higher public educational expenditure helps to decrease the inequality of schooling. The estimated coefficient (-0.034) in (8), which includes country fixed effects, suggests that an increase of government educational spending by 0.016 (one standard deviation) reduces the education Gini coefficient by about 0.5 percentage points. The results for other explanatory variables in these regressions remain quite similar to those in Regressions 3 and 4.

The results in Tables 1 and 3 show that public policies are effective in reducing income inequality. Government social expenditure helps to reduce income inequality, and educational spending can reduce dispersion of education, and thereby income inequality.

6. Education and Intergenerational Mobility

In the previous sections, we assessed the determinants of income inequality using five-year panel data. Another important question is how economic inequality is transmitted from one generation to the next. The existing literature suggests a positive relationship between income equality and intergenerational mobility.

Intergenerational mobility is often measured by intergenerational earnings elasticity (Black et al. 2011; Corak 2013), which is the elasticity of children's adult earnings to parental income. Intergenerational elasticity in earnings measures the likelihood that children will inherit their parents' relative income level position. Therefore, a higher value implies a lower degree of intergenerational mobility.

Corak (2016) compiles comparable estimates of intergenerational earnings elasticities between father and son earnings for 22 countries from published studies. The estimates are applied to a cohort of children who were born, roughly speaking, in the 1960s and had earnings in the 1990s. Figure 14 plots these intergenerational earnings elasticities against a cross-sectional measure of income Gini over the period 1980–84. It confirms the strongly positive correlation between income inequality and intergenerational earnings elasticity (0.79), indicating that great inequality in income distribution at a point in time is associated with less intergenerational mobility.

[Figure 14 here]

The strong association between income equality and intergenerational mobility can originate from many factors that lead to a high proportion of inequality being transmitted across generations (Black et al. 2011). Most importantly, more unequal income distribution among families causes opportunities for economic advancement to be more unequally distributed among children. In particular, parental income and education levels have important roles in determining their investment in children's education. Parents' income determines whether they can afford to send children to school. More educated parents are likely to have a stronger

desire to educate their children. Empirical studies have supported the significant influence of parents' income and education for children's education, especially at the secondary and tertiary levels (e.g., Haveman and Wolfe 1995; Chetty et al. 2017). Empirical evidence also shows that income inequality has a significant negative effect on school enrolment rates (e.g., Flug et al. 1998; Barro and Lee 2015).

Hence, one important link between income equality and intergenerational mobility must be the distribution of schooling (in terms of quantity and quality) among the population, especially the younger generation. Figure 15 confirms the positive relationship between education Gini coefficient and intergenerational earnings elasticity, with a correlation coefficient of 0.51, indicating that the more unequal a society is in terms of educational distribution, the lower the degree of intergenerational mobility will be. This result reflects a positive association between educational inequality and income inequality, as shown in Section 4.

[Figure 15 here]

The distribution of education among the population can perpetuate across generations. Hertz et al. (2007) measure the intergenerational persistence of education attainment using national survey data for parents' and children's education levels by birth cohort for 42 nations, using survey data from 1994 to 2004. The study shows that educational attainment is highly persistent within families.[8] We use Hertz et al.'s (2007) measure of averages across cohorts of the regression coefficients and see how it is related to our measure of the education Gini coefficient. Figure 16 shows that educational inequality is strongly positively associated with the measure of intergenerational educational persistence, with a correlation coefficient of 0.69.

[Figure 16 here]

The intergenerational persistence in education is considered an important channel that transmits interpersonal income inequality from one generation to the next (Hertz et al. 2007).

[8] At least part of the observed intergenerational persistence in education must be attributable to genetic differences in ability that are transmitted from parent to child (Black et al. 2011). Investigating the mechanism and factors that determine the intergenerational transmission in education and income is beyond the scope of this study.

Figure 17 shows that the measures of persistence in income and education attainment across generations tend to be positively correlated (0.70).

[Figure 17 here]

The empirical results in Section 5 suggest that educational expansion, especially involving lower-educated people, plays an important role in reducing educational inequality. Hence, educational investment for children, especially in poor families, must be an important driver of reducing educational inequality, and thus income inequality over generations. Further investigation of the underlying mechanism and exact magnitude of the impact of educational attainment and inequality on intergenerational mobility would require in-depth analysis using micro-level data in individual economies.

6. Concluding Remarks

This paper provides evidence that human capital measured by educational attainment plays an important role in income distribution. The regressions using panel data for a broad range of countries for the period between 1980 and 2015 show that more equal distribution of education contributed significantly to reducing income inequality. Increase in educational attainment reduces educational inequality, and thus helps to reduce income inequality. The empirical results also show that the rising income inequality in many economies in recent decades is attributed to a fast income increase, trade expansion, and rapid technological progress. Reduced educational inequality is an important factor that counterbalanced these income-unequalizing forces over the period. We also find that increased social benefit expenditures and lower inflation contributed to making income distribution more equal. Increased public education spending also played an important role in improving education distribution and thus income distribution. We also find that more equal distribution of schooling contributes to enhancing intergenerational mobility in education and earnings.

Understanding the impact of education, globalization, and technological changes on income distribution is important to design and implement deliberate policies toward more inclusive and sustainable economic development. Policy measures to reduce income inequality should include effective human capital policies, such as inclusive education and training for unskilled workers, rather than building barriers to international trade and technological innovation that would be harmful to sustaining economic growth. The public education

system must be improved to provide equal opportunities for good-quality education for all children, thus allowing greater social mobility. In addition, social benefits and redistributive policies should also be enhanced to protect the weak and ameliorate income distribution and intergenerational mobility.

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Table 1. Regression Results for Income Inequality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
log (per capita GDP)	0.0697**	0.0552*	0.0776***	0.0672**	0.0974***	0.0858***	0.0598*	0.0509	-0.0115	-0.0283
	(0.0289)	(0.0283)	(0.0291)	(0.0281)	(0.0302)	(0.0292)	(0.0322)	(0.0311)	(0.0407)	(0.0395)
log (per capita GDP) squared	-0.0037**	-0.0021	-0.0041**	-0.0027*	-0.0055***	-0.0042***	-0.0039**	-0.0023	-0.0008	0.0008
	(0.0016)	(0.0016)	(0.0016)	(0.0016)	(0.0017)	(0.0016)	(0.0018)	(0.0017)	(0.0022)	(0.0022)
Educational inequality	0.0888**	0.106**	0.0862**	0.0893**	0.0873**	0.0978**	0.0532	0.103**	0.0267	0.0658
	(0.0411)	(0.0412)	(0.0437)	(0.0441)	(0.0426)	(0.0426)	(0.0495)	(0.0490)	(0.0527)	(0.0546)
Educational attainment	-0.0041	0.0004	-0.0042	0.0002	-0.0030	0.0014	-0.0045	0.0023	-0.0071**	-0.0035
	(0.0030)	(0.0030)	(0.0031)	(0.0031)	(0.0030)	(0.0030)	(0.0034)	(0.0033)	(0.0033)	(0.0033)
Trade openness/GDP			0.0073	0.0168***	0.0107**	0.0176***	0.0002	0.0127**	-0.0004	0.0050
			(0.0055)	(0.0057)	(0.0053)	(0.0054)	(0.0059)	(0.0062)	(0.0053)	(0.0057)
Inflation			0.0020**	0.0019**	0.0017**	0.0016**	0.0025***	0.0024***	0.0014**	0.0011*
			(0.0008)	(0.0008)	(0.0007)	(0.0007)	(0.0008)	(0.0007)	(0.0006)	(0.0006)
Democracy indicator			-0.0004	0.0042	0.0030	0.0083	0.0050	0.0118*	0.0142**	0.0191***
			(0.0062)	(0.0060)	(0.0059)	(0.0057)	(0.0074)	(0.0069)	(0.0065)	(0.0063)
Government consumption/GDP			-0.0157	-0.0206	-0.0082	-0.0156	0.0096	0.0265	-0.0048	-0.0256
			(0.0241)	(0.0231)	(0.0231)	(0.0223)	(0.0333)	(0.0319)	(0.0338)	(0.0327)
Patents					0.137***	0.146***				
					(0.0287)	(0.0275)				
High-technology exports/ manufacturing exports							0.0359	0.0379*		
							(0.0224)	(0.0214)		
Social spending/GDP									-0.195***	-0.0862*
									(0.0494)	(0.0504)
Country fixed effect	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
N, N of country	608, 95	608, 95	608, 95	608, 95	542, 93	542, 93	460, 91	460, 91	333, 71	333, 71
R^2	0.174	0.102	0.175	0.131	0.194	0.206	0.321	0.156	0.565	0.305

Notes: The regression applies to an unbalanced panel data set for 95 economies over seven five-year periods from 1980 to 2014. The dependent variable is net income Gini coefficient, averaged over each period. Per capita GDP, educational inequality, and educational attainment are the values in the initial year of each period, and other explanatory variables are period averages. The speciation includes period dummies. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Table 2. Explaining the Change in Income Inequality in East Asia

	Actual values			Income Gini change explained by each factor
	(1)	(2)	(3)	(4)
	1985-89	*2010-14*	*Change*	
Income Gini				
Actual	0.396	0.429	0.033	
(Predicted)	(0.373)	(0.399)	(0.025)	
Determinants				
Log per capita GDP	8.615	9.795	1.180	0.0093
Log per capita GDP squared	74.80	96.68	21.88	
Educational inequality	0.369	0.205	-0.165	-0.0161
Educational attainment	6.62	10.10	3.480	0.0050
Trade openness	0.802	1.370	0.568	0.0100
Inflation	0.060	0.034	-0.026	0.0000
Democracy indicator	0.415	0.473	0.058	0.0005
Government consumption	0.168	0.124	-0.044	0.0007
Patents	0.001	0.099	0.098	0.0143

Notes: We use the regression result in column (6) of Table 1 to calculate the predicted values of income inequality, on average, for the group of eight East Asian economies including China; Hong Kong, China; Indonesia; Malaysia; the Philippines; the Republic of Korea; Singapore; and Thailand. Columns (1)–(3) show the actual values of income Gini and all explanatory variables for 1985–89 and 2010–14, and their changes between the two periods, and Column (4) is the predicted change of income inequality between 1985–89 and 2010–14 using the regression result in column (6) of Table 1. The value of per capita GDP includes both level and square terms.

Table 3. Regression Results for Educational Inequality

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Log (per capita GDP)	0.0056	0.0171***	0.0044	0.0191***	0.0001	0.0163**	-0.0045	0.0136	0.0031	0.0223***
	(0.0051)	(0.0064)	(0.0051)	(0.0061)	(0.00541)	(0.0068)	(0.0061)	(0.0090)	(0.0053)	(0.0065)
Income Gini	0.0008	0.126**	0.0151	0.0819	-0.0356	0.0953	-0.0776	0.103	-0.0350	0.102
	(0.0452)	(0.0580)	(0.0447)	(0.0556)	(0.0490)	(0.0680)	(0.0529)	(0.0757)	(0.0493)	(0.0647)
Educational attainment	-0.0513***	-0.0365***	-0.0509***	-0.0354***	-0.0511***	-0.0356***	-0.0490***	-0.0322***	-0.0508***	-0.0356***
	(0.0022)	(0.0028)	(0.0021)	(0.0026)	(0.0022)	(0.0028)	(0.0025)	(0.0032)	(0.0022)	(0.0027)
Trade openness/GDP			0.0176***	0.0311***	0.0193***	0.0310***	0.0126*	0.0248***	0.0199***	0.0337***
			(0.0062)	(0.0070)	(0.0066)	(0.0076)	(0.0071)	(0.0090)	(0.0068)	(0.0077)
Inflation			0.0006	0.0008	0.0008	0.0008	0.0012	0.0013	0.0017	0.0016
			(0.0010)	(0.0010)	(0.0011)	(0.0010)	(0.0011)	(0.0010)	(0.0015)	(0.0013)
Democracy indicator			-0.0033	0.0035	-0.0045	0.0025	-0.0109	-0.0058	-0.0055	0.0058
			(0.0076)	(0.0075)	(0.0081)	(0.0082)	(0.0097)	(0.0010)	(0.0084)	(0.0083)
Government consumption/GDP			0.153***	0.166***	0.153***	0.174***	0.0988**	0.175***	0.137***	0.162***
			(0.0282)	(0.0271)	(0.0305)	(0.0298)	(0.0429)	(0.0438)	(0.0324)	(0.0314)
Patents					0.0323	0.0204				
					(0.0398)	(0.0405)				
High-technology exports/ manufacturing exports							-0.0161	-0.0375		
							(0.0285)	(0.0309)		
Education spending /GDP									-0.0035**	-0.0034**
									(0.0017)	(0.0017)
Country fixed effect	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
N, N of country	608, 95	608, 95	608, 95	608, 95	542, 93	542, 93	460, 91	460, 91	506, 94	506, 94
R^2	0.875	0.796	0.870	0.820	0.862	0.811	0.862	0.765	0.871	0.806

Notes: The system has seven equations that apply to an unbalanced panel data set for 95 economies. The dependent variable is education Gini coefficient for 1985, 1990, 1995, 2000, 2005, 2010, and 2015. Per capita GDP, educational inequality, and educational attainment five-year lagged values and other variables are averages over the previous five years. The speciation includes period dummies. ***, **, and * indicate statistical significance at the 1%, 5%, and 10% levels, respectively.

Figure 1. Trends of Net Income Gini from 1980–84 to 2010–14 for a Balanced Panel of 60 Economies

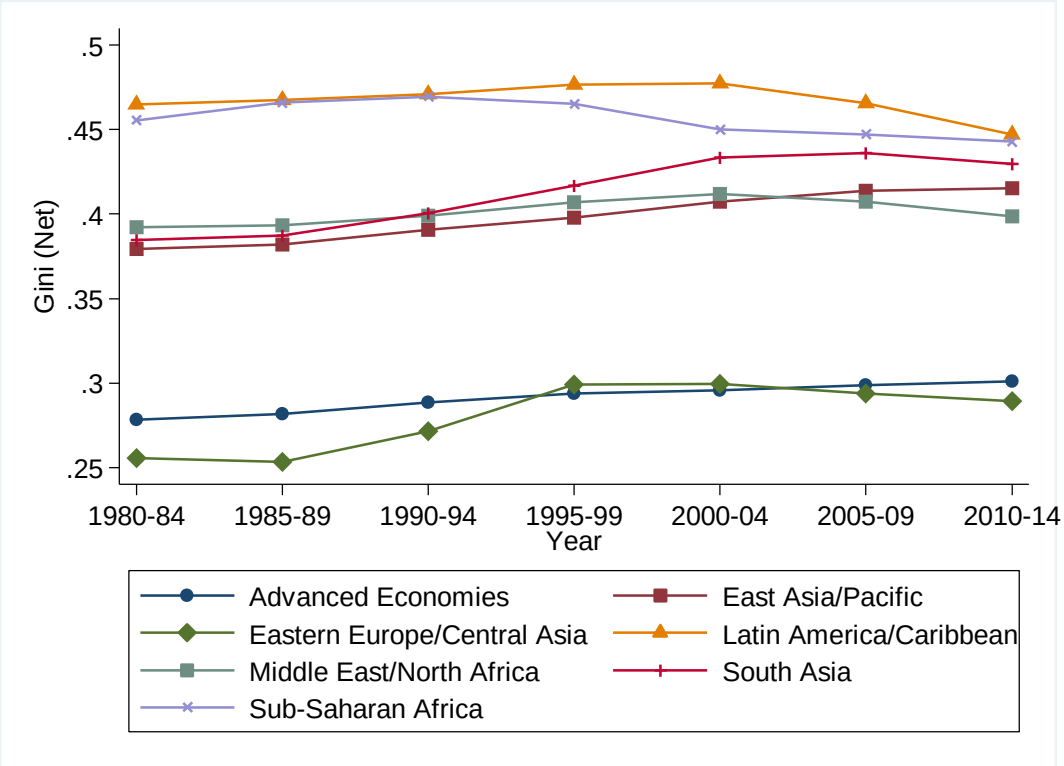


Figure 2. Trends of Income Inequality in East and South Asian Economies

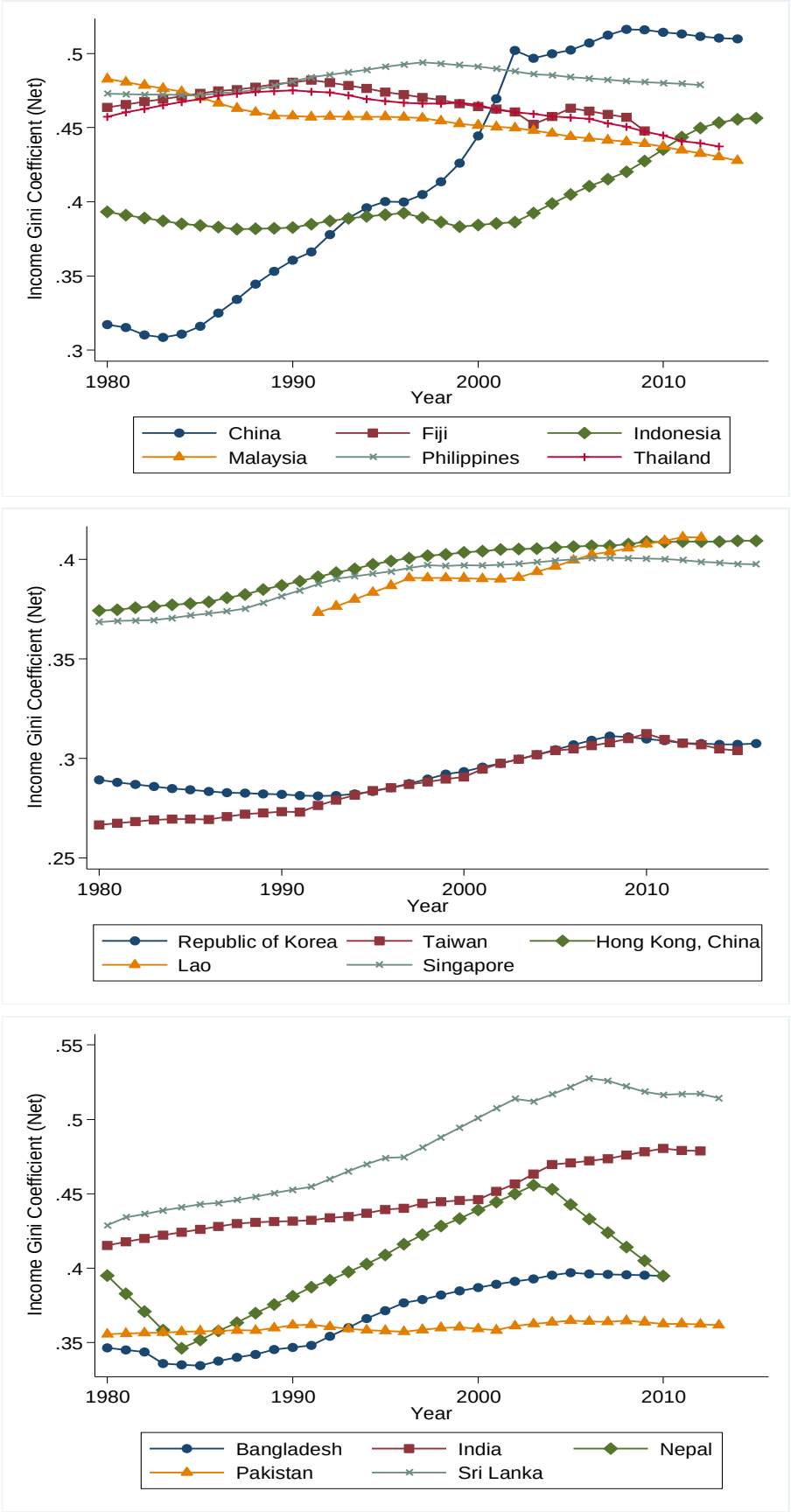


Figure 3. Trends of Income Inequality in Selected Economies of Other Groups/Regions

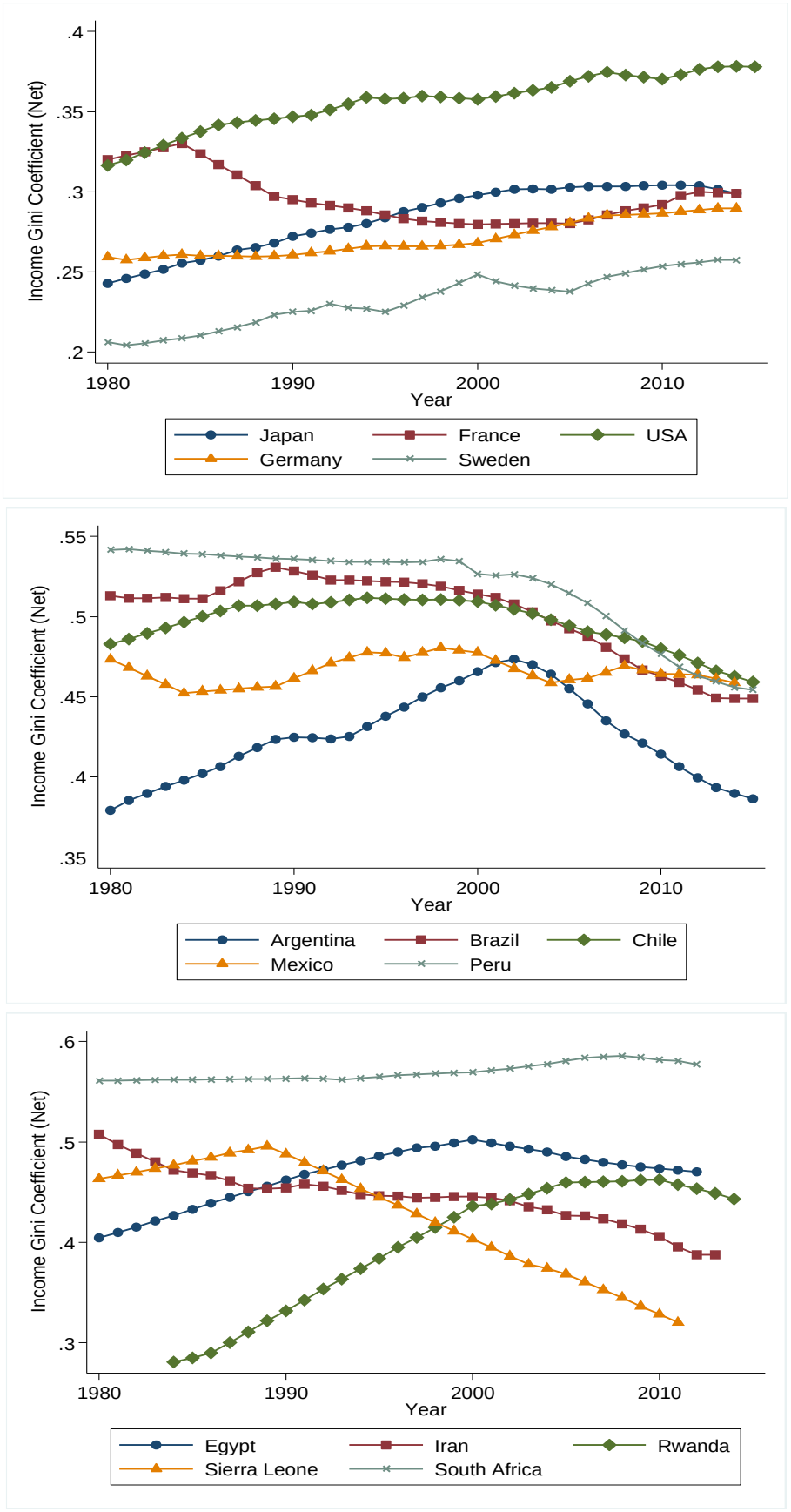


Figure 4. Trends of Educational Attainment from 1980 to 2015 for a Balanced Panel of 138 Economies

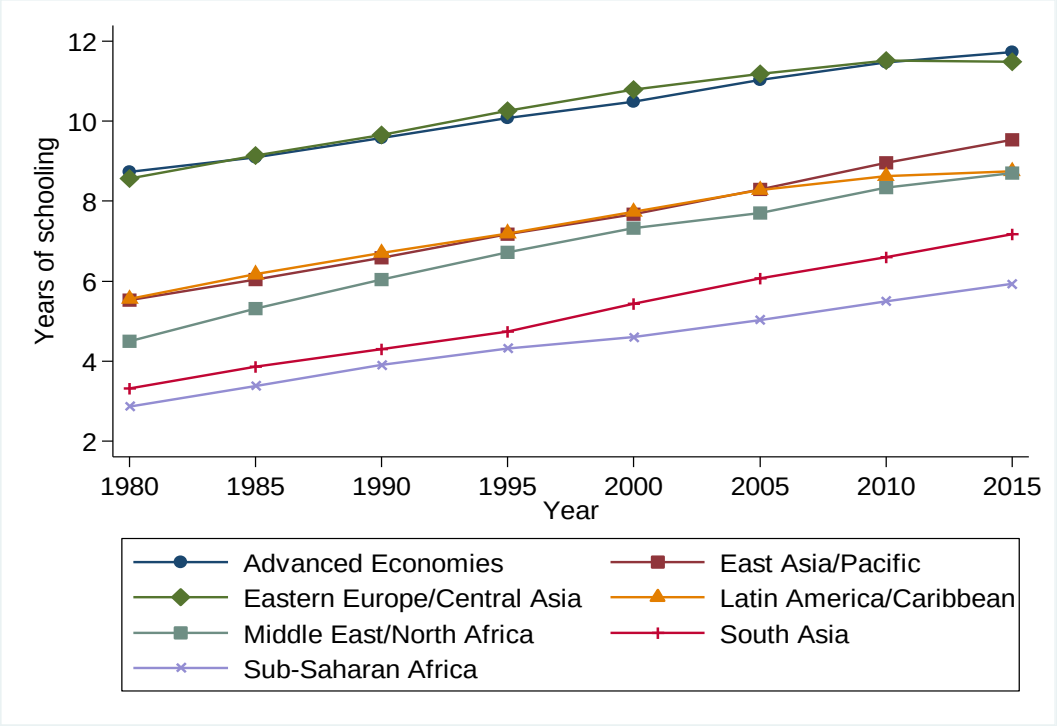


Figure 5. Trends of Educational Inequality from 1980 to 2015 for a Balanced Panel of 138 Economies

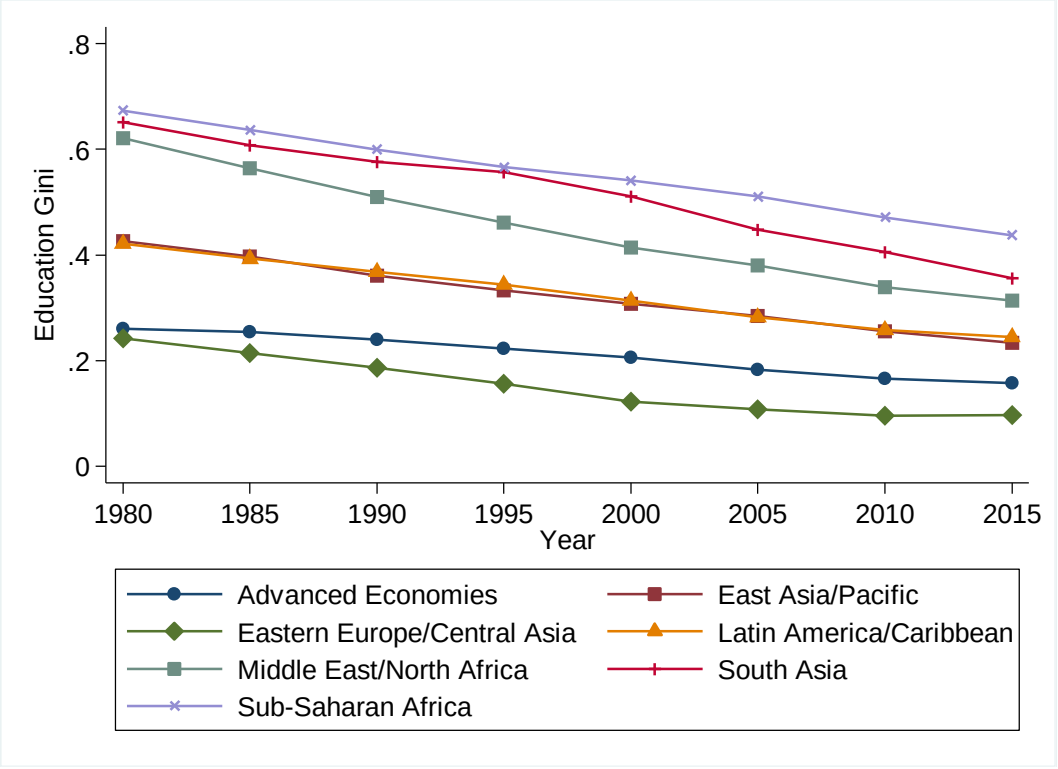


Figure 6. Education Gini and Income Gini Across Countries, Five-year Intervals from 1980 to 2015

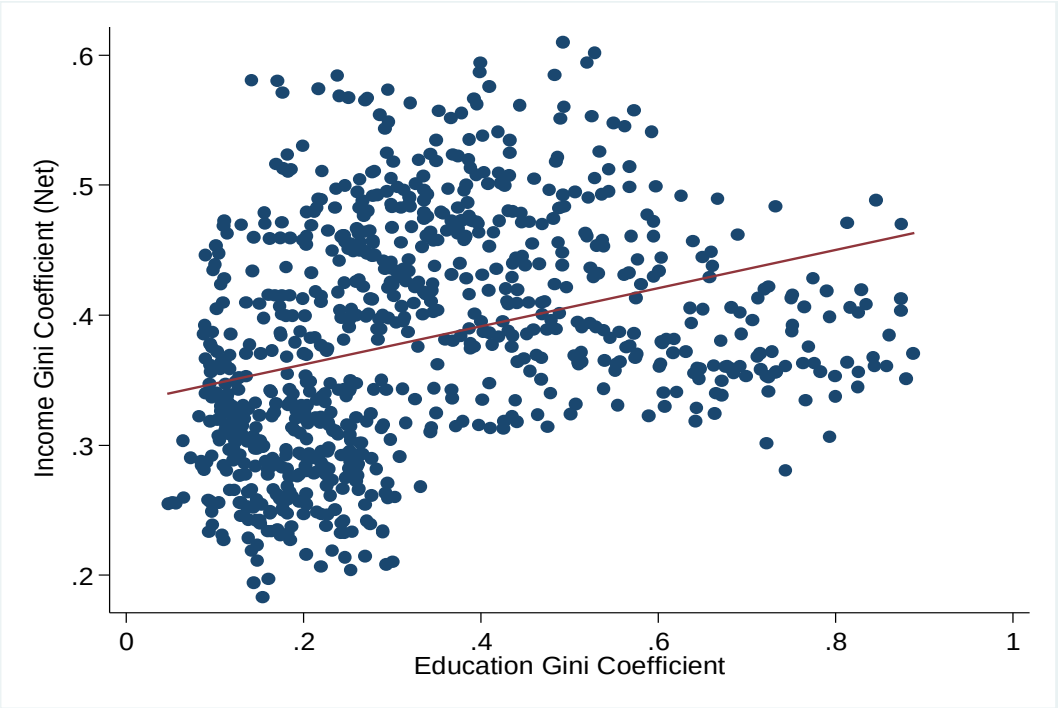


Figure 7. Education Attainment and Income Gini Across Countries, Five-year Intervals from 1980 to 2015

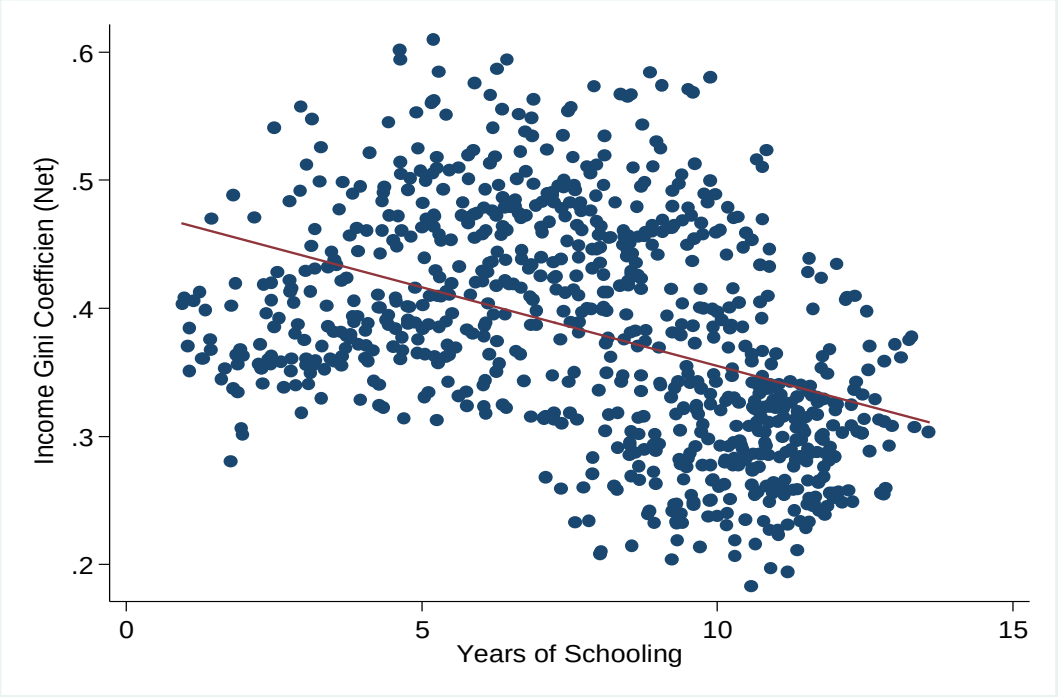


Figure 8. Change in Income and Education Gini Coefficients from 1980 to 2010 for a Balanced Sample of 60 Economies

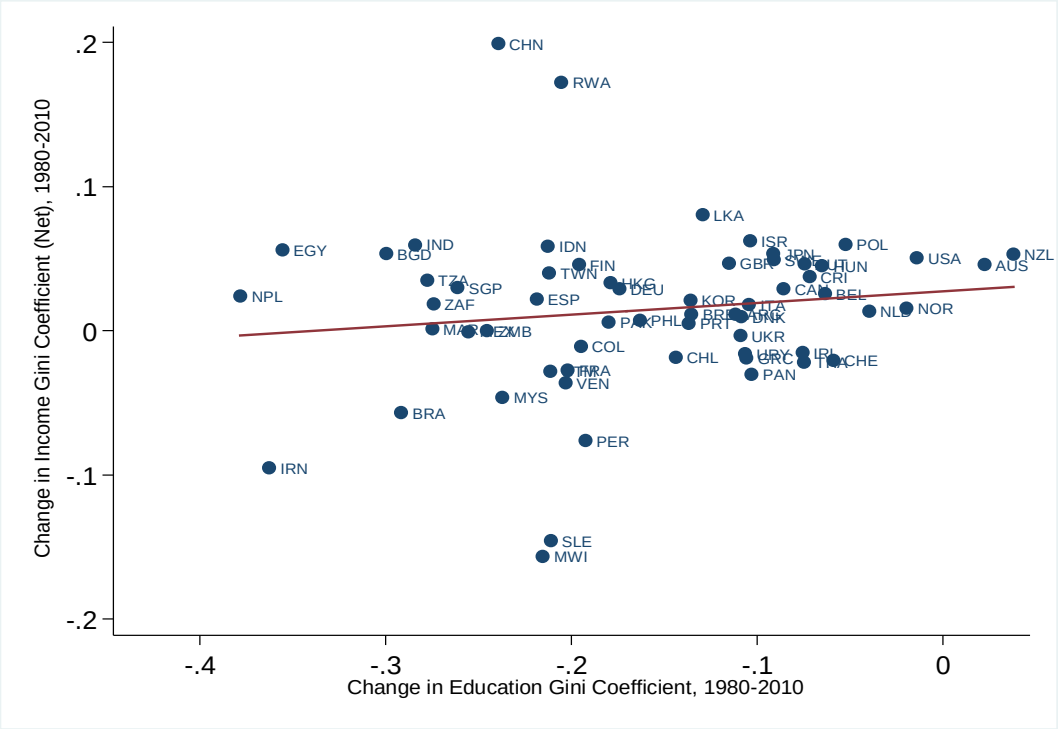


Figure 9. Changes in Education Attainment and Income Gini Across Countries from 1980 to 2010 for a Balanced Sample of 60 Economies

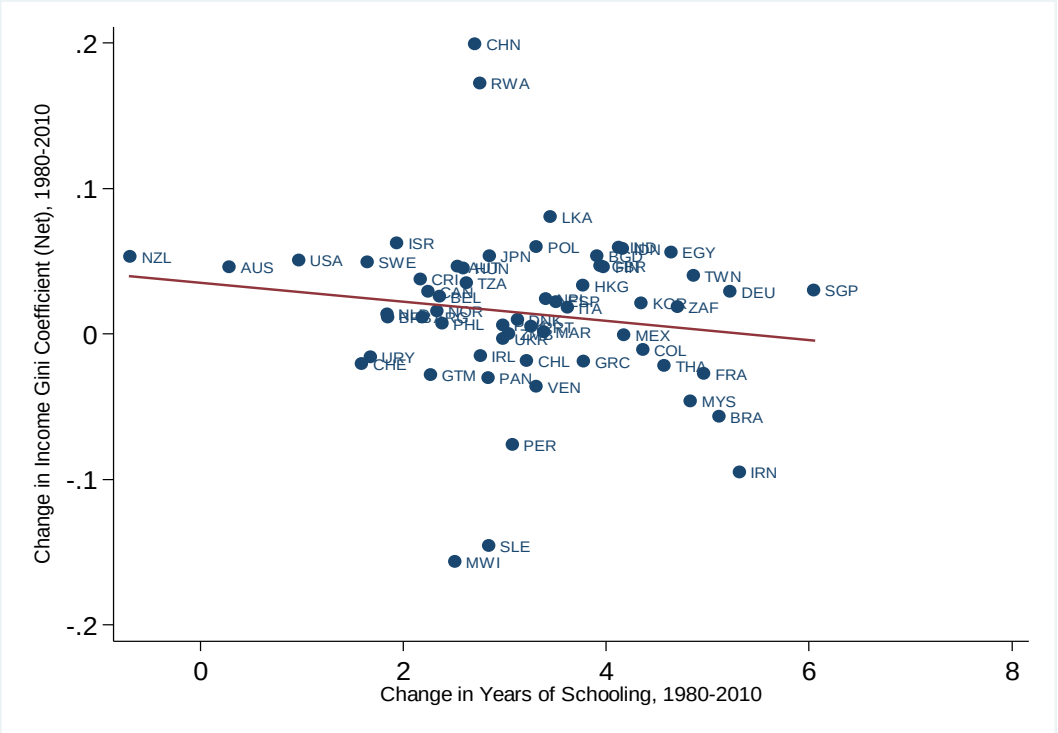


Figure 10. Relationship between Educational Inequality and Educational Attainment, Five-year Intervals from 1980 to 2015

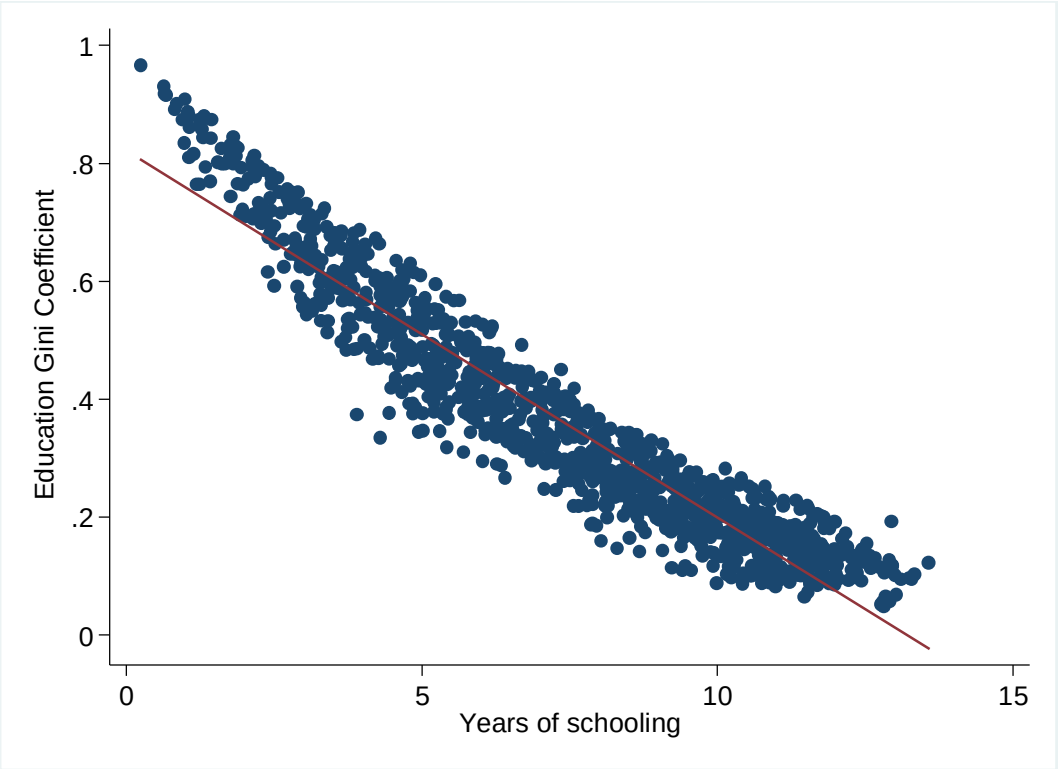


Figure 11. Change in Educational Attainment and Education Gini Coefficients from 1980 to 2015 for a Balanced Sample of 60 Economies

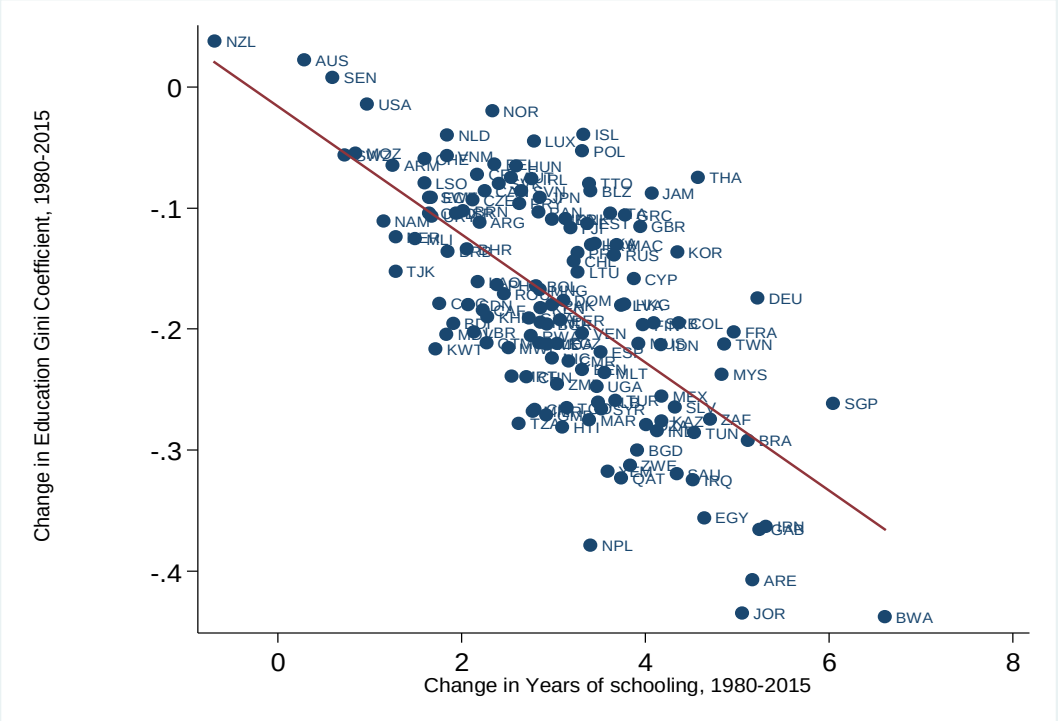


Figure 12. Trends of Trade Openness by Region for a Balanced Sample of 123 Economies

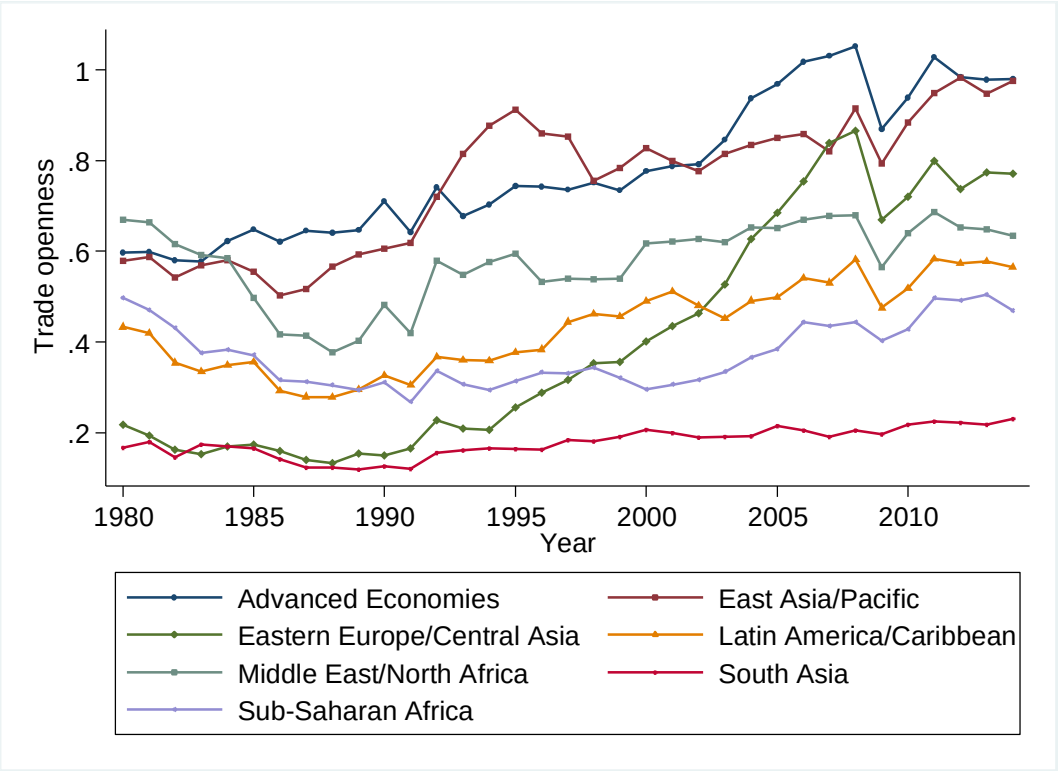
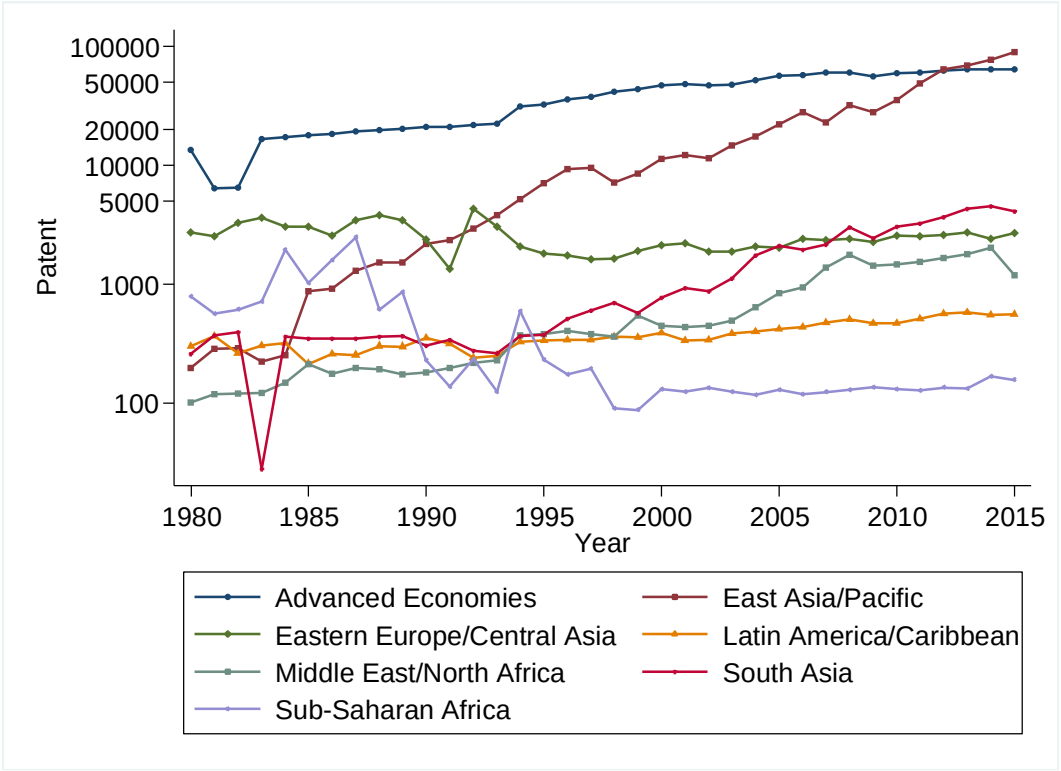


Figure 13. Trends of Technology by Region, Unbalanced Sample

(a) Number of Patents (log scale)



(b) High-Technology Exports (Ratio to Manufacturing Exports)

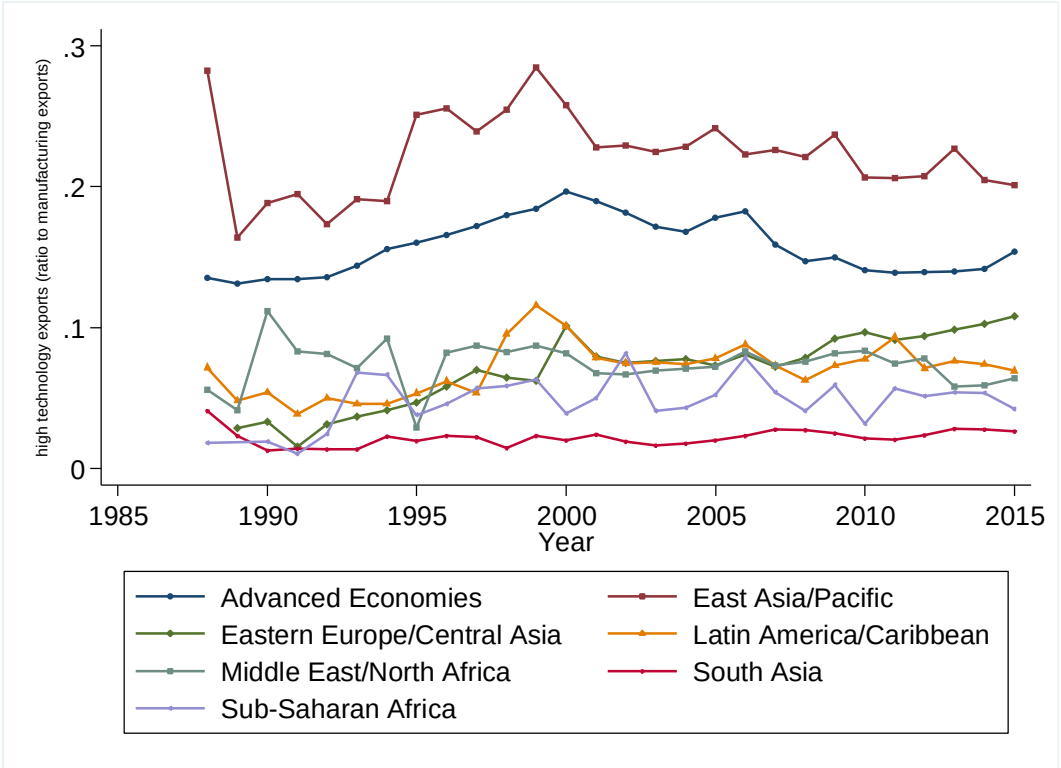


Figure 14. Relationship between Intergenerational Earnings Elasticity and Income Gini

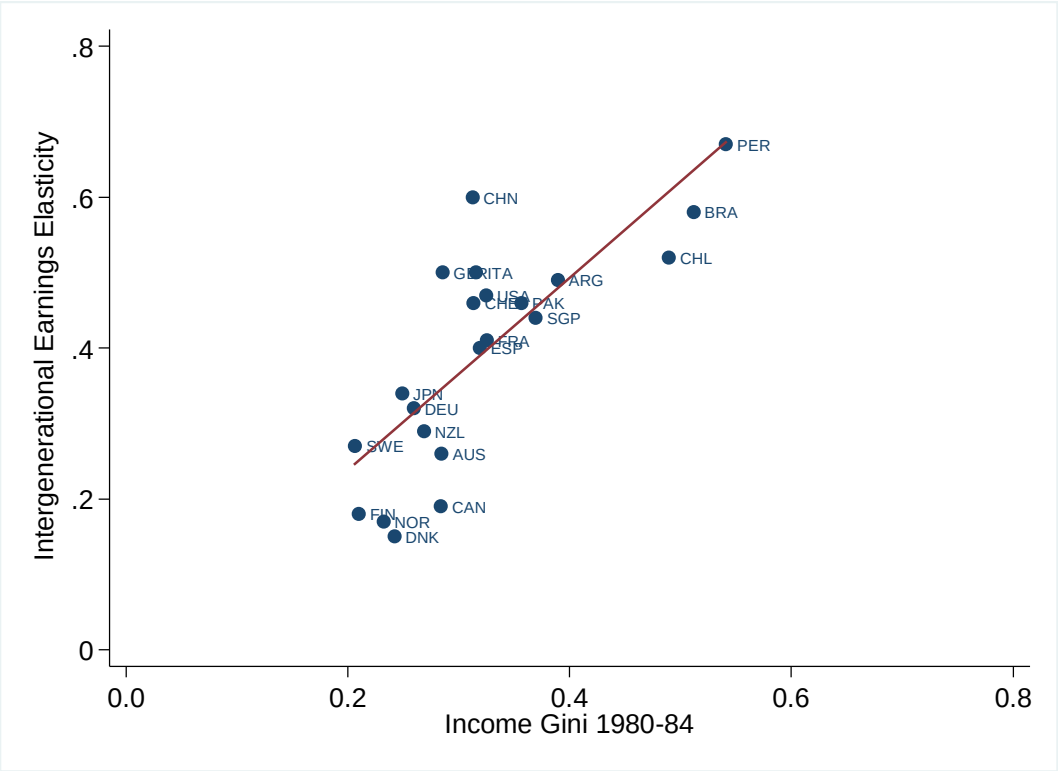


Figure 15. Relationship between Intergenerational Earnings Elasticity and Educational Gini

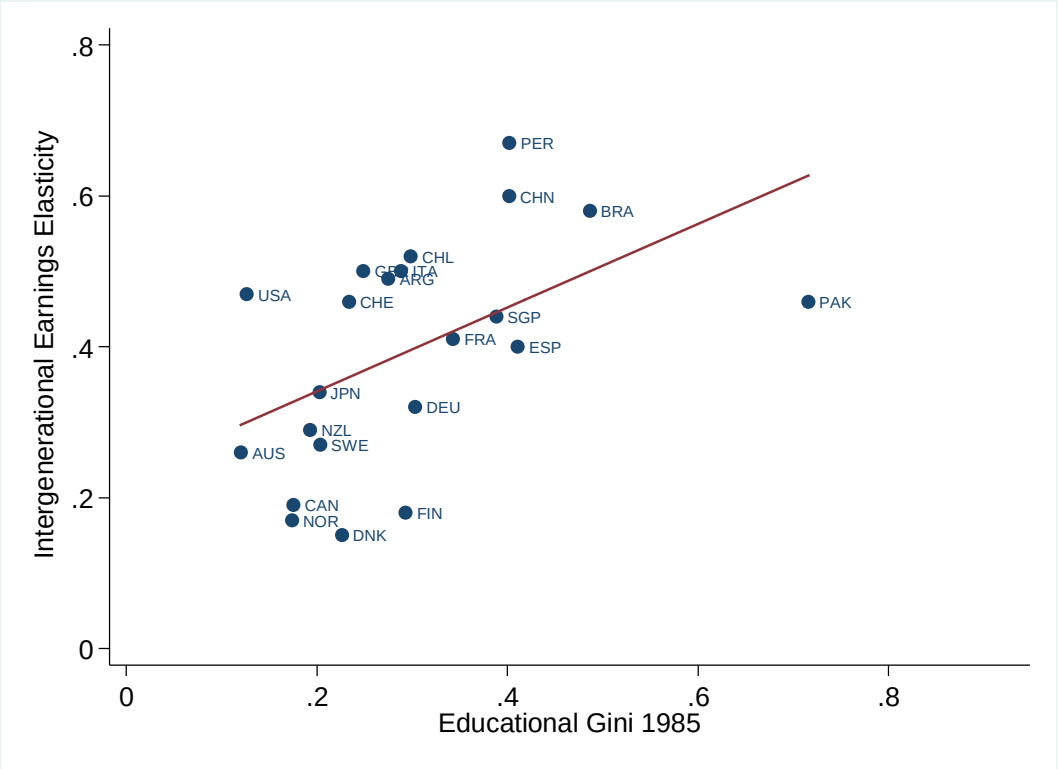


Figure 16. Relationship between Education Gini Coefficient and Intergenerational Schooling Persistence

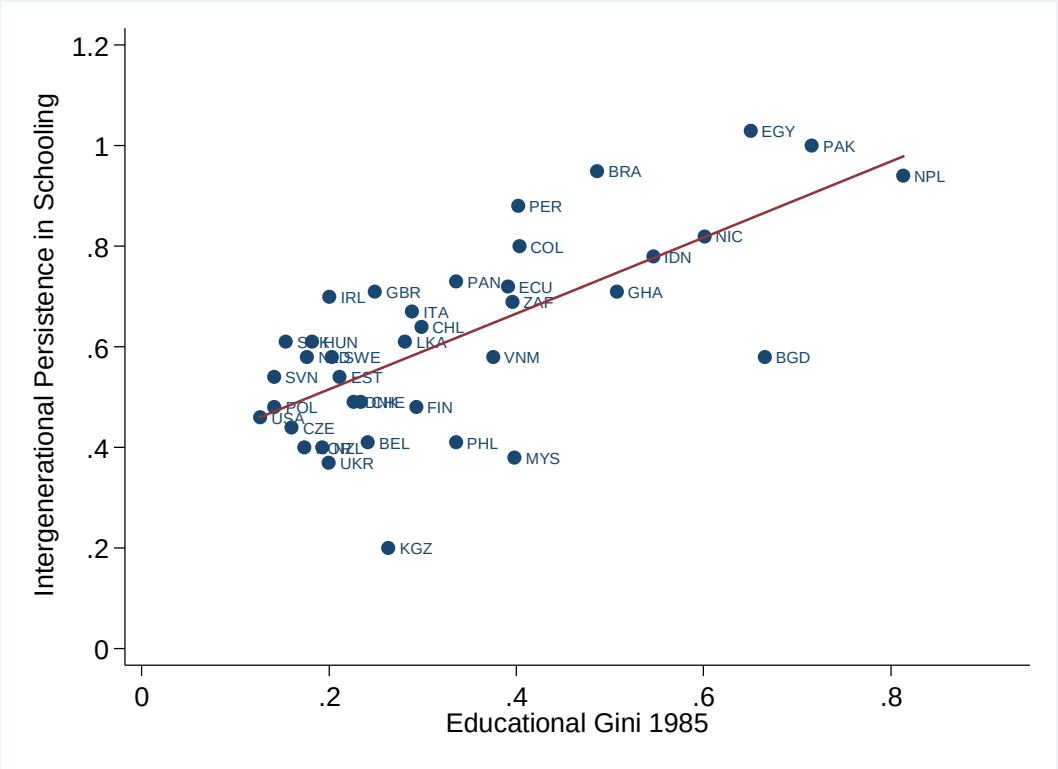
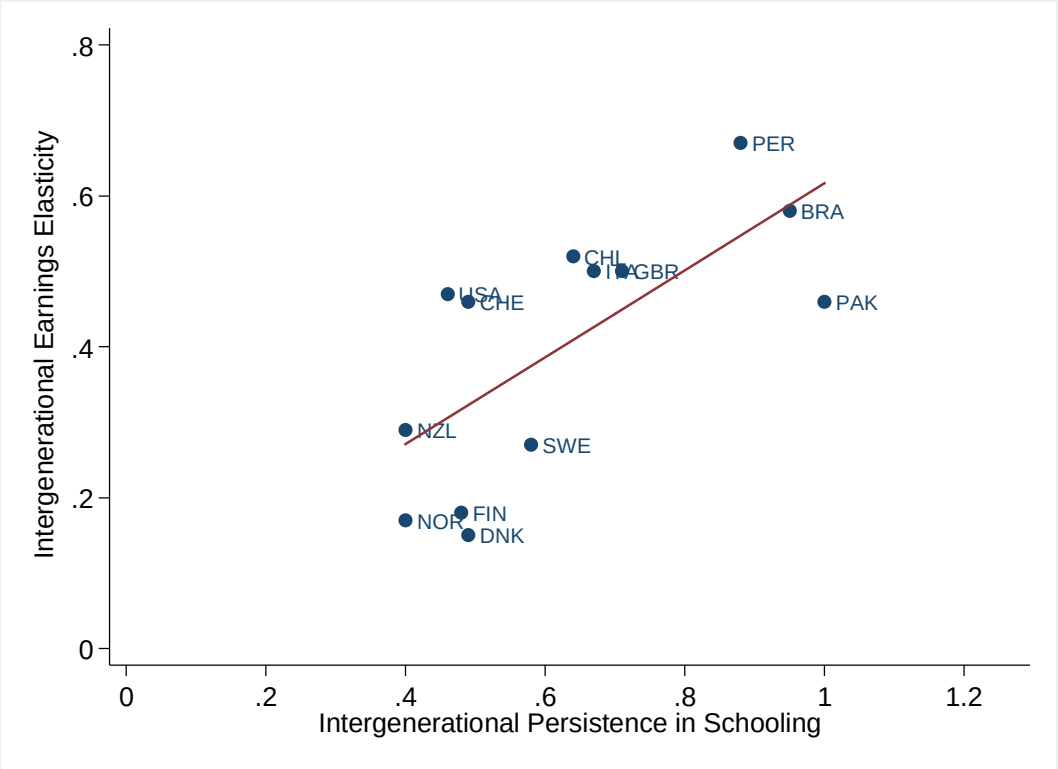


Figure 17. Relationship between Intergenerational Earnings Elasticity and Intergenerational Schooling Persistence



Appendix Table 1. Sample countries

Group/Regions		
Advanced Economies (24)		
Australia	Greece	Norway
Austria	Iceland	Portugal
Belgium	Ireland	Spain
Canada	Italy	Sweden
Denmark	Japan	Switzerland
Finland	Luxembourg	Turkey
France	Netherlands	United Kingdom
Germany	New Zealand	USA
East Asia/Pacific (11)		
China	Lao	Singapore
Fiji	Malaysia	Taiwan
Hong Kong, China	Philippines	Thailand
Indonesia	Republic of Korea	
Eastern Europe/Central Asia (7)		
Bulgaria	Poland	Russian Federation
Czech Republic	Romania	Slovakia
Hungary		
Latin America/Caribbean (20)		
Argentina	Dominican Republic	Panama
Barbados	Ecuador	Paraguay
Bolivia	El Salvador	Peru
Brazil	Guatemala	Trinidad and Tobago
Chile	Honduras	Uruguay
Colombia	Mexico	Venezuela
Costa Rica	Nicaragua	
South Asia (5)		
Bangladesh	Nepal	Sri Lanka
India	Pakistan	
Middle East/North Africa (9)		
Algeria	Iran	Morocco
Cyprus	Israel	Qatar
Egypt	Jordan	Tunisia
Sub-Saharan Africa (19)		
Botswana	Mauritania	South Africa
Cote d'Ivoire	Mauritius	Sudan
Gambia	Niger	Swaziland
Ghana	Rwanda	Tanzania
Kenya	Senegal	Uganda
Lesotho	Sierra Leone	Zambia
Malawi		

Appendix Table 2. Summary Statistics of Variables in the Regression

Description	Data Source	Mean	Std. Dev.	Min	Max
Income Gini	Solt (2016)	0.38	0.09	0.19	0.61
Log of per capita GDP	Feenstra et al. (2015), PWT 9.0	9.03	1.16	6.43	11.71
Educational inequality	Barro and Lee (2013)	0.34	0.18	0.05	0.89
Educational attainment	Barro and Lee (2013)	7.72	2.96	1.04	13.24
Democracy indicator	Freedom House (2017)	0.65	0.33	0.00	1.00
Trade openness (ratio to GDP)	Feenstra et al. (2015), PWT 9.0	0.56	0.56	0.06	4.59
Government consumption (ratio to GDP)	Feenstra et al. (2015), PWT 9.0	0.18	0.07	0.06	0.60
CPI Inflation rate (%)	World Bank (2017), WDI	0.27	1.42	-0.02	20.96
Patents (million)	World Intellectual Property Organization (2016)	0.015	0.063	0.000	0.576
High-technology exports (ratio to manufacturing exports)	World Bank (2017), WDI	0.114	0.121	0.000	0.730
Education spending (ratio to GDP)	World Bank (2017), WDI	0.043	0.016	0.008	0.116
Social spending (ratio to GDP)	International Monetary Fund (2017), GFS	0.100	0.070	0.000	0.254