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Inequality and Economic Growth: Do Natural Resources Matter?

by

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Abstract

This paper is intended to demonstrate, in theory as well as empirically, how increased dependence on natural resources tends to go along with less rapid economic growth and greater inequality in the distribution of income across countries. On the other hand, public policy in support of education can simultaneously enhance equality and growth by raising the return to working in higher technology (that is, nonprimary) industries and thus counter some of the potentially adverse effects of excessive natural resource dependence. Together, these two variables – natural resources and education – can help account for the inverse relationship between inequality and growth observed in cross-country data. Moreover, the analysis highlights the role of public revenue policy. Taxes and fees can be used to reduce the attractiveness of primary-sector employment, lift the marginal productivity of capital in higher technology industries and thus increase the rate of interest and economic growth, while reducing the inequality of income and wealth.

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1. Introduction

For a long time, many economists were of the view that economic efficiency and social equality were essentially incompatible, almost like oil and water. The perceived but poorly documented trade-off between efficiency and equality was commonly regarded as one of the main tenets of modern welfare economics. One of the key ideas behind this perception was that increased inequality could increase private as well as social returns to investing in education and exerting effort in the hope of attaining a higher standard of life. Redistributive policies were supposed to thwart these tendencies and blunt incentives by penalizing the well off through taxation and by rewarding the poor. Economic efficiency – both static and dynamic – was bound to suffer in the process, or so the argument went.

More often than not in recent empirical work, measures of income inequality have turned out to have a negative effect on economic growth across countries. Thus Alesina and Rodrik (1994), Persson and Tabellini (1994) and Perotti (1996) report that inequality hurts growth. Barro (2000) assesses the relationship between economic growth and inequality in a panel of countries over the period from 1965 to 1995 and finds – by studying the interaction of the Gini index and the initial level of income in a growth regression – that increased inequality tends to retard growth in poor countries and boost growth in richer countries.[1] However, Barro finds no support for a relationship between inequality and growth in his sample as a whole. Forbes (2000) finds that the relationship between inequality and growth becomes positive in a pooled regression when country effects are included. She claims that country-specific, time-invariant, omitted variables generate a significant negative bias in the estimated coefficients reflecting the effects of inequality on growth in pure cross sections and mentions corruption and the level of public education as two candidates in this regard. Banerjee and Duflo (2000b) claim that this result is misleading, and arises from imposing a linear structure on highly nonlinear data.

The above-mentioned empirical results – showing, by and large, that rapid economic growth tends to go along with less, not more, inequality – call for an explanation. Thus far, the explanations on offer involve showing how inequality

[1] This empirical finding does not support the claim of Garcia-Peñalosa (1995) that in rich countries increased inequality discourages education and growth by increasing the number of poor people who cannot afford education whereas in poor countries increased inequality encourages education and growth by increasing the number of rich people who can afford education.

affects growth either directly or indirectly through its effects on public policy, including taxes and transfers and education expenditures. We will now briefly describe some of these theories before returning to our proposed thesis, which involves natural resources as a joint determinant of both inequality and growth.

First, large inequalities of income and wealth may trigger political demands for transfers and redistributive taxation. To the extent that transfers and taxation distort incentives to work, save and invest, inequality may impede growth. It is not clear, however, that this type of political-cum-fiscal explanation necessarily implies an inverse relationship between inequality and growth, for it is possible that during the redistribution phase increased equality and a drop in growth go hand in hand, especially in panel data that reflect developments over time country by country as well as cross-sectional patterns. Perotti (1996) finds little empirical support for this type of explanation. Moreover, in democratic countries with an unequal distribution of income and with many poor people, the electorate may vote for more and better education as well as higher taxes and transfers (Saint-Paul and Verdier, 1993, 1996), thus obscuring the relationship between inequality and growth. Absent democracy, dictators may still find it in their own interest to redistribute incomes and reform education in order to promote social peace and strengthen their own hold on political power (Alesina and Rodrik, 1994). Easterly and Rebelo (1993) report empirical results that suggest that increased inequality is associated with both higher taxes and more public expenditure on education in a large sample of countries in the period 1970-1988.

In second place, the initial extent of inequality probably makes a difference. An equalization of incomes and wealth in countries with gross inequities, such as Brazil where the Gini index is 60, would seem likely to foster social cohesion and peace and thus to strengthen incentives rather than weaken them, whereas in places like Denmark and Sweden, where the Gini index is 25 and incomes and wealth are thus already quite equitably distributed by world standards, further equalization might well have the opposite effect. Excessive inequality may be socially divisive and hence inefficient: it may motivate the poor to engage in illegal activities and riots, or at least to divert resources from productive uses, both the resources of the poor and those of the state. Social conflict over the distribution of income, land or other assets can take place through labor unrest, for instance, or rent seeking which can hinder investment and growth (Benhabib and Rustichini, 1996).[2] Alesina and Perotti (1996) report empirical evidence of an inverse relationship between inequality and growth through socio-political instability.[3]

Third, national saving may be affected by inequality if the rich have a higher propensity to save than the poor (Kaldor, 1956). In this case inequality may be good for growth in that the greater the level of inequality, the higher is the saving rate and hence also investment and economic growth. Against this Todaro (1997) suggests that the rich may invest in an unproductive manner – count their yachts and expensive cars. Barro (2000) finds no empirical evidence of a link between inequality and investment.

Fourth, increased inequality may hurt education rather than helping it as suggested by the political-economy literature referred to at the beginning of this brief discussion. If so, increased inequality may hinder economic growth through education. Galor and Zeira (1993) and Aghion (1998) argue that this outcome is likely in the presence of imperfect capital markets. If each member of society has a fixed number of investment opportunities, imperfect access to credit and a different endowment of inherited wealth, the rich would end up using many of their investment opportunities while the poor could only use a few. Therefore, the marginal return from the last investment opportunity of the rich would be much lower than the marginal return of the last investment opportunity of the poor. Redistribution of wealth from the rich to the poor would increase output because the poor would then invest in more productive projects at the margin. This argument can also be applied to investment in human capital if we assume diminishing returns to education. In this case, taking away the last few quarters of the university education of the elite and adding time to the more elementary education of the poor would raise output and perhaps also long-run growth, other things being the same. Income redistribution would reverse the decline in investment in human capital resulting from the credit-market failure.[4]

The distribution of income and wealth may also affect the amount of public and private investment in education. When a large part of the population is poor, it may be more likely that the majority of voters will support expenditures on public education

[2] Further, Aghion (1998) suggests that excessive inequality may be associated with macroeconomic volatility through credit cycles because of unequal access to credit and thus to investment opportunities, and that this may hurt investment and growth.
[3] See also Aghion, Caroli and Garcia-Peñalosa (1999).
[4] For a further discussion of recent empirical literature on inequality and growth, see Bénabou (1996).

aimed at the poor, as argued by Saint-Paul and Verdier (1993, 1996) and corroborated empirically by Easterly and Rebelo (1993), but the effect could also, in principle, go the other way. If so, the more deprived and detached from the mainstream population is the poorer segment, the less likely the poor are to participate in or affect the outcome of elections. As a result the general level of education may suffer – the more so, the more capital-constrained is the poorer segment of the population. A virtuous circle may arise when redistribution of income leads to an increase or improvement in human capital, which then induces voters to prefer higher expenditures on education, which again pulls more workers out of poverty, and so on. At an empirical level, we would expect increased equality to enhance economic growth through its effect on education, and vice versa. That is, more and better general education may be expected to reduce public tolerance against extreme inequality and thus to reduce inequality through the political process, thereby stimulating economic growth. These processes can be mutually reinforcing; that is, if increased social equality encourages education and economic growth, this does not mean that more and better education cannot similarly, and simultaneously, enhance equality and growth.

The models reviewed above all have the same basic structure: inequality affects some unknown intermediate variable X which, in turn, makes a difference for economic growth. In this paper we take a different approach: we view both economic growth and inequality of incomes as well as of educational attainment and of land as endogenous variables and argue that the inverse relationship between inequality and growth does not imply causality one way or the other. We propose an explanation which, in contrast to the ones surveyed in the literature reviewed briefly above, involves a variable that is exogenous to most economic models. This variable is the abundance of, or rather dependence on, natural resources, which we measure by the amount of natural capital per person and the share of natural capital in national wealth, respectively. We will argue, on theoretical grounds as well as empirically, that a direct relationship between natural resource intensity and inequality, on the one hand, and between natural resource intensity and growth, on the other hand, can help account for the inverse cross-sectional relationship between inequality and growth that is observed in the data, assuming that natural resources are given. The first relationship – between natural resource intensity and inequality – was documented by Bourguignon and Morrison (1990) in a sample of 35 developing countries in 1970, while the second relationship – between natural resource intensity and growth – has been scrutinized by a number of authors in recent years, beginning with Sachs and Warner (1995). Moreover, we assume that the ownership of natural resources tends to be less equally distributed than other assets within as well as across countries. To the extent that this is not the case at the outset, we assume that rent seeking and other forces, frequently compounded by a lack of democracy, will see to it that the natural resources end up in the hands of a relatively small minority – a military regime, say, or a royal family.

The paper proceeds as follows. In Section 2, we set out our view of the way in which natural resources can affect inequality and growth. In Section 3, we describe the data that we use to measure income inequality and also gender inequality in education; we also discuss inequality in the distribution of land. In Section 4, we present simple cross-country correlations between three different measures of education, three different measures of inequality and economic growth, and thus allow the data to speak for themselves. In Section 5, we attempt to dig a little deeper and report the results of cross-sectional multiple regression analysis where growth is traced to natural resource intensity, education and inequality as well as to other factors commonly used in growth regression analysis (investment and initial income), and where some of the determinants of growth, including education and inequality, are explicitly modeled as endogenous variables. Section 6 concludes the discussion.

2. Resources, distribution and growth

An important potential weakness of the many stories purporting to explain the relationship between inequality and growth is that both of these variables are endogenous. This leaves open the possibility that a third, exogenous variable is affecting both, thus giving rise to the inverse correlation between the two. Specifically, a country's abundance of, or dependence on, natural resources can under many circumstances be viewed as exogenous to models of economic growth and also to models attempting to explain the extent of income inequality. But even if we treat natural resources as exogenous, we are aware that both natural resource extraction and reserves can respond to economic forces; for example, oil prices can influence oil production as well as oil exploration. We do not address this problem in this paper, but we acknowledge its potential importance; at some point, this problem will need to be addressed. Here we want to let it suffice to explore the possibility that natural resource ownership impinges on both inequality and growth and thus illuminates the inverse relationship between inequality and growth that has been observed in cross-sectional data.

We will now show how natural resource dependence is inversely related to both equality and growth in a standard growth model. Thereafter, we will test this prediction empirically in a sample of 87 industrial and developing countries in the period 1965-1998. Our theoretical model can be summarized as follows: workers can earn a living by either working in the primary sector extracting natural resources from the soil or the sea or through paid employment in the manufacturing sector, including services. Because human capital is equally spread across the population, wage income in manufacturing is the same for all workers. However, due to the whims of nature, or the competition for the rent generated by the natural resource, earnings in the primary sector are unequal at each point in time. It follows that the more time workers devote to natural resource extraction, the more unequal the distribution of income. And growth is also affected. If we assume, quite plausibly, that the manufacturing industry provides greater opportunities for learning and innovation, it follows that the more time workers spend in the primary sector, the lower will be the rate of growth. Hence, abundant natural resources cause both inequality and slow growth by tempting workers away from industries where technology and output are more likely to progress and grow and where earnings are more equally shared. Elsewhere (Gylfason and Zoega, 2001b) we show how saving and investment – and hence also growth – can depend inversely on natural resources. The intuition is again straightforward: when physical capital is less important in the production technology, the optimal rate of saving is lower. Therefore, the optimal level of steady-state capital is lower. If we now postulate learning-by-investing (as in Romer, 1986), the rate of technological progress and the rate of growth of output per capita will consequently both be lower.

Our hypothesis has the advantage that here we have an exogenous variable that affects the two endogenous variables in a predictable way, and this makes any empirical testing of the theory more robust. We will show how the relationship between inequality and growth can arise in the presence of natural resources. If natural resources affect both inequality and growth, then this could shed new light on the statistical relationship between inequality and growth. But to do this we need to identify, on theoretical grounds as well as empirically, the relationship between natural resources and inequality, on the one hand, and between natural resources and growth, on the other hand. It is to this task that we now turn.

2.1 Allocation of time

Imagine a world in which natural resources generate a constant flow of riches. All one has to do is go out and pick the fruits of nature, be they diamonds, fish or oil. This could involve passively standing beneath an apple tree or a coconut palm and picking up the fruits that fall to the ground or one could have to exert oneself looking for fruits, diamonds or fish, to take a few examples. The value of each bundle of the natural resource is equal to R and the likelihood of finding a bundle increases with the time spent searching. Now imagine that amidst the bounties of nature there is a manufacturing industry that uses labor and capital to produce output without using or depending in any way on the natural resource. Assume, crucially for our argument, that workers face a more challenging and stimulating work environment in the manufacturing industry, because manufacturing is more likely to foster learning and innovation. In particular, assume that there is learning-by-investing in manufacturing.

Workers have a choice when it comes to their work effort: they can spend part of or all of their time trying their luck picking fruits or they can take a paid job in industry. Each individual has to decide how much time to spend picking fruits and how much time to spend in paid employment. We denote the fraction of time spent in productive employment by β and the fraction spent picking fruits by $1-\beta$.

Now assume that the discovery of a bundle of natural resources valued R is a random event and follows a Poisson distribution. Denote the number of such discoveries by the random variable N. The random event is then defined as "a worker finds a bundle of the natural resource during a unit of time" and has the following density:

$$f(N)=\frac{e^{-\gamma(1-\beta)}[\gamma(1-\beta)]^{N}}{N!} \qquad \text{for } N = 0, 1, 2 \ldots \tag{1}$$

where the mean arrival rate – that is, the expected number of discoveries by a given worker or, equivalently, the probability that a discovery will be made by the worker within a unit of time – is $E(N)=\gamma(1-\beta)$. The expected number of discoveries for the representative individual is thus a linear function of the fraction of time spent searching. The larger the share of time spent in nature, the more bundles will be discovered. The parameter γ measures search effectiveness.

There are L individuals (identical by assumption) spending part of their time searching. The aggregate income from the natural resource is then

(2) $$Y^n = NLR$$

The expected value and the variance of N given by the Poisson distribution are both equal to $\gamma(1- \beta)$. Since all individuals are identical, it follows that the variance across the population in the number of discoveries of the natural resource bundles per unit of time is also equal to $\gamma(1- \beta)$. We now have the following result: the variance of the distribution of income emanating from the natural resource is an increasing function of the time devoted by each worker to the natural-resource-based sector – primary sector, for short. Define income per capita by lower case letters. We then have

(3) $$E(y^n) = \gamma(1-\beta)R, \quad \text{var}(y^n) = \gamma(1-\beta)R$$

The expected per capita income or rent from the natural resource as well as the variance of this per capita income across the population of workers is an increasing function of the abundance of the resource R and also an increasing function of the time spent procuring it 1-β.

We now turn to the manufacturing industry, which offers workers an alternative to wandering around nature. This industry uses capital and labor to produce output and offers opportunities for learning and innovation. The production function is

(4) $$Y_i = (qK_i)^{\alpha} (K\beta L_i)^{1-\alpha}$$

Here q denotes the quality of capital and takes a value between zero and one,[5] K_i and L_i denote the capital and labor used by firm i and K is the aggregate capital stock in

[5] Like Scott (1989), we distinguish between quantity and quality. If some investment projects miss the mark and fail to add commensurately to the capital stock, we have $q < 1$. There are three ways to interpret q: (a) as an indicator of distortions in the allocation of installed capital due to a poorly developed financial system, trade restrictions or government subsidies that attract capital to unproductive uses in protected industries or in state-owned enterprises where capital may be less productive than in the private sector (Gylfason, Herbertsson and Zoega, 2001); (b) as the ratio of the economic cost (i.e., minimum achievable cost) of creating new capital to the actual cost of investment (Pritchett, 2000) – that is, K is then measured on the basis of actual costs, which may overstate its productivity; or (c) as a consequence of aging: the larger the share of old capital in the capital stock currently in operation, i.e., the higher the average age of capital in use, the lower is its overall quality (Gylfason and Zoega, 2001a). For our purposes, the three interpretations are analytically equivalent. However, we assume that the quality of capital has remained constant in the past, which means that all units of capital are of the same quality. In other words, we are not interested here in the implications of

the manufacturing sector. As in Romer (1986) the aggregate capital stock is a proxy for the accumulated knowledge that has been generated in the past through investment at all firms. This is what sets manufacturing apart from the primary sector; it uses capital and the installation of new units of capital generates a flow of ideas that raises productivity in a labor-augmenting fashion. In contrast, the primary sector does not offer similar opportunities for learning and innovation.

We assume a perfectly competitive market for labor and capital. Assuming symmetric equilibrium, so that $K=kL$, gives the following first-order conditions for maximum profit, and also for equilibrium in the two factor markets:

$$\frac{dY_i}{dL_i} = (1-\alpha)kq^{\alpha}(\beta L)^{1-\alpha} = \beta w \tag{5}$$

$$\frac{dY_i}{dK_i} = \alpha q^{\alpha}(\beta L)^{1-\alpha} = r + \delta \tag{6}$$

where w is the real wage, r is the real interest rate and δ is the rate at which installed capital loses its usefulness over time, as a result of economic obsolescence as well as physical wear and tear (Scott, 1989).[6]

The representative worker/consumer has to make two decisions each moment of his infinite life. He has to decide how much to consume and save and how much time to spend working in the manufacturing sector rather than trying his luck in the primary sector. We assume that he cannot do both at the same time. Hence a decision to spend more time in the primary sector causes him to spend less time in paid employment making manufactures. Moreover, we assume that time spent in the primary sector is costly: a direct cost η is incurred for each moment spent. Finally, there is a tax on wages t_w and also a tax on income from the natural resources t_n.

The worker maximizes the discounted sum of future utility from consumption:

$$\max_{\beta, c} \int_0^{\infty} \log(c_t) e^{-\rho t} dt \tag{7}$$

where ρ is the discount rate, subject to

having different vintages of capital.

[6] The parameters q and δ can both be modeled as endogenous choice parameters (as in Gylfason and Zoega, 2001a), but here we treat them as exogenous magnitudes for simplicity, even if we acknowledge that depreciation may depend on quality, through obsolescence.

$$\dot{a}_t = ra_t + \beta w(1-t_w) + \gamma(1-\beta)R(1-t_n) - \gamma(1-\beta)\eta - c_t$$

By assumption, the worker does not gain any utility (or suffer disutility) in the primary sector, nor from being employed. The worker has assets *a*, which he accumulates if his earnings exceed expenditures (henceforth, we omit time subscripts). His earnings come from three sources: There is interest income on assets *ra* which is tax-free, there is wage income from employment βw, taxed at t_W, and there is the value of the primary goods he picks or produces $(1-\beta)R$, taxed at t_n. The worker then incurs the direct cost η and consumes *c* per unit of time. A necessary condition for optimal consumption is

$$c = \frac{1}{\lambda} \tag{8}$$

where λ denotes the shadow price of wealth. Consumption is at an optimum when the marginal utility of consumption is equal to the shadow price of wealth at each instant. More interesting is equation (9), which helps determine the optimal allocation of time:

$$w(1-t_w) = \gamma R(1-t_n) - \eta \tag{9}$$

The left-hand side of equation (9) shows the marginal benefit from working longer in manufacturing net of taxes, while the right-hand side shows the marginal benefit from fruit picking, also net of taxes. While each worker takes wages *w* as given, wages do nevertheless respond to market forces. Combining equations (5) and (9) gives the following equation:

$$(1-\alpha)kq^{\alpha}L^{1-\alpha}\beta^{-\alpha}(1-t_w) = \gamma R(1-t_n) - \eta \tag{10}$$

Solving for β gives

$$\beta = \left[\frac{(1-\alpha)kq^{\alpha}L^{1-\alpha}(1-t_w)}{\gamma R(1-t_n)-\eta}\right]^{\frac{1}{\alpha}} \tag{11}$$

The time spent in industrial employment β is decreasing in the value of the natural resource *R* and search effectiveness γ as well as in taxes on wage income t_W, and increasing in the accumulated knowledge in the manufacturing industry *kL (=K)*, the productivity of capital *q*, taxes on natural resources t_n and the cost of utilizing the natural resource η

2.2 Work and growth

We can now describe the various ways in which natural resources affect the allocation of labor in our model.

- The discovery of natural resources R raises the reward to producing primary output and reduces the optimal time spent in manufacturing.
- A decrease in the cost of producing primary output η and an increase in search effectiveness γ have an effect identical to that of a resource discovery: labor leaves manufacturing for the primary sector.
- The structure of the tax system affects the allocation of time. The higher are taxes on wages t_w and the lower are taxes on income or rent from natural resource extraction t_n, the more time is devoted to producing primary goods.
- History matters because past learning-by-investing in the industrial sector determines current knowledge as reflected by k and hence also real wages. The more advanced the manufacturing sector, the higher the wages it can afford to pay and the more time workers spend in manufacturing.

The last point explains why natural resource abundance and dependence do not have to go together. Abundance of natural resources is a significant impediment to growth only if productivity and wages in the manufacturing sector are low, that is, if there is little accumulated knowledge and expertise in the sector. But the presence of abundant natural resources can prevent manufacturing from "taking off", thereby preventing innovation and learning from taking place:

- When R is sufficiently high, or when productivity in the manufacturing sector is sufficiently low, it can be optimal not to spend any time in manufacturing. In this case, growth never takes off.

Education provides a possible solution to this dilemma by increasing labor productivity in manufacturing:

- Education can increase knowledge, and thereby also labor productivity which, like past learning-by-doing, lifts wages and draws workers to the manufacturing industry from the primary sector.

We now turn to the remaining necessary condition for maximum utility, the Euler equation giving optimal growth of consumption:

$$\frac{\dot{c}}{c} = r - \rho \tag{12}$$

Equations (6) and (12) give the optimal rate of growth of consumption and output:

(13) $$g = \alpha q^{\alpha} \left(\beta L \right)^{1-\alpha} - \delta - \rho$$

Growth is an increasing function of β, the share of time spent producing manufactures rather than primary goods.

There are two market failures in the model. The first is the standard one that firms, when investing, neglect the gains from learning and knowledge spillovers to other firms. In contrast, a social planner uses the average product of capital – not the private marginal product – to measure the cost of capital. Second, workers compare the current benefit from spending time in the two sectors but ignore the growth effect of industrial employment: by spending more time in the manufacturing industry they, collectively, would raise the marginal product of capital, the interest rate and economic growth. This makes their wages grow more rapidly. By withdrawing labor from the primary sector, workers would invest in a higher future wage. However, each worker has only a very small effect on growth imparting an external benefit to others.

We can now summarize the relationship between natural resources and growth.

- A rise in the natural resource rent R attracts more people to the primary sector in the hope of securing a piece of the action. These people leave the manufacturing sector, thereby lowering the private marginal product of capital, the rate of interest and the rate of growth of consumption and output. This is the Dutch disease working through the labor market (Paldam, 1997).
- When abundant natural resources reduce the incentive to provide good education (Gylfason, 2001), this reduces labor productivity and wages, hence reinforcing the incentive to stay in the natural resource sector. An abundant natural resource – a high value of R – attracts workers and this effect is reinforced by bad education which drives people away from industrial employment.
- If natural resources reduce the quality of society's institutions, this could manifest itself in a reduction in the private cost of rent seeking η Moreover, less developed capital markets are likely to generate a lower quality capital stock q, which depreciates at a higher rate δ (Gylfason and Zoega, 2001a, 2001b).

We can now combine these insights with the earlier result showing that the variance of income or rent emanating from the natural resource sector is

$$\text{var}(y^n) = \gamma(1-\beta)R \tag{14}$$

Equations (13) and (14) show that while economic growth is increasing in β, inequality – measured by the variance of income – is decreasing in β. According to our thesis, any variable that increases the value of β is likely to stimulate growth and reduce inequality. Equation (11) shows that an abundance of natural resources – relative to the level of technological know-how – will lower the value of β. In contrast, any variable that raises labor productivity and wages in the manufacturing sector will raise β, increase growth and reduce inequality. The knowledge that has been generated through past investment and production is one such factor. Another factor is the level of education. Education that raises productivity and wages in industry will discourage workers from spending time in the natural resource sector and hence raise growth and reduce inequality. At last, the tax system can affect growth and equality: a high tax on natural resource rents and a low tax on wages increases the value of β, hence raising growth and reducing inequality.

3. Measuring inequality

In what follows, we make use of three different measures of inequality. Take income inequality first. The Gini index measures the extent to which income (or, in some cases, consumption) among individuals or households within an economy deviates from a perfectly equal distribution. A Gini index of zero represents perfect equality, while a Gini index of 100 means perfect inequality. As Figure 1 shows, the Gini index is closely correlated with the log of the ratio of the income or consumption of the 20 percent of households with the highest incomes to the income or consumption of the 20 percent of households with the lowest incomes (the "20/20 ratio"). In our sample, the 20/20 ratio is lowest (2.6, Gini = 19.5) in the Slovak Republic and highest in Sierra Leone (57.6, Gini = 62.9). The regression line through the scatter in Figure 1 shows that each ten-point increase in the Gini index goes along with roughly a doubling of the 20/20 ratio. Thus, for example, the Nordic countries have a Gini index of 25 and a 20/20 ratio of 3 whereas the United Kingdom has a Gini index of 35 and a 20/20 ratio of 6. The corresponding figures are 30 and 4 for Germany and 40 and 8 for the United States as well as for China and Russia. The data come from nationally representative household surveys and refer to different years between 1983-85 and

1998-99 (World Bank, 2000, Table 2.8). The data refer to either (a) personal or household incomes before taxes and transfers or (b) consumption expenditures and, hence, implicitly incomes after taxes and transfers. Whenever possible, consumption was used rather than income (same source). The Gini index of income inequality is available for 75 of the 87 countries in our sample.

Our second inequality measure is intended to reflect one aspect of social inequality, that is, the unequal access of males and females to education. We take the difference between the average secondary-school enrolment rates of males and females in 1980-1997 to represent gender inequality in education. In a majority of cases where the rates are different, more males than females go to secondary school. In some cases, however, more females than males attend secondary schools. Even so, we use the arithmetic rather than absolute difference between male and female enrolment rates as our inequality measure. This means that we view a change from a situation where, say, the secondary-school enrolment rate for males is 17 percentage points higher than that for females (as in Egypt) to a situation where the secondary-school enrolment rate for females is 17 percentage points higher than that for males (as in Finland) as a decrease in gender inequality. Surprisingly, Figure 2 shows that there is in our sample no discernible correlation between income inequality as measured by the Gini index and gender inequality of education as measured by the excess of male over female secondary-school enrolment. Thus economic and social inequality, as measured here, do not necessarily go hand in hand.

Our cross-country data support the notion of a Kuznets curve: income inequality tends to increase with income at low levels of income and to decrease with income at higher levels of income, as shown in Figure 3. Galor and Moav (1999) suggest the following interpretation of the Kuznets curve: in early stages of development, when investment in physical capital is the main engine of economic growth, inequality spurs growth by directing resources towards those who save and invest the most, whereas in more mature economies human capital accumulation takes the place of physical capital accumulation as the main source of growth, and inequality impedes growth by hurting education because poor people cannot fully finance their education in imperfect credit markets. On the other hand, the gender inequality of education varies inversely and linearly with initial income, without any visible tendency for gender inequality to increase with income at low levels of income (Figure 4).

The third measure of inequality that we will use is the Gini index for the distribution of land. This measure is taken from Deininger and Olinto (2000), and covers 50 of the 87 countries in our sample. Figure 5 shows that, almost without exception, land is less equally distributed than income in our sample. Spearman's rank correlation between the two measures is 0.57.

4. Cross-country patterns in the data

In this section, we allow the data to speak for themselves in the form of a series of bivariate cross-sectional correlations. We first take a look at the correlations between our three measures of inequality and economic growth, all of which are unambiguously negative in our data: greater inequality in the distribution of income and land as well as in access to education tends to go together with lower rates of growth. We then move on to show that two of the three measures of inequality increase from country to country in tandem with the share of natural capital in national wealth. This opens up the possibility that it is the variation in natural capital in the sample that generates the apparent relationship between inequality and growth: when natural resources become more important, inequality rises and growth recedes. This was the prediction of our model in Section 2. At last, we also show that income inequality and three different measures of education are inversely related, while education and growth are positively correlated. This finding accords with earlier research indicating that education, by reducing inequality and fostering growth, can help clarify the inverse relationship between inequality and growth that is observed in the data. Unlike natural resource abundance, however, education is probably best viewed as an endogenous variable, a possibility that we address explicitly in the regression analysis presented in Section 5.

4.1 Inequality and growth

Let us now begin by looking at the cross-country pattern of income inequality and economic growth. Figure 6 shows a scatterplot of the annual rate of growth of gross national product (GNP) per capita from 1965 to 1998 (World Bank, 2000, Table 1.4) and the inequality of income or consumption as measured by the Gini index (same source, Table 2.8). The growth rate has been adjusted for initial income: the variable on the vertical axis is that part of economic growth that is not explained by the country's initial stage of development, obtained as a residual from a regression of growth during 1965-1998 on initial GNP per head (i.e., in 1965) as well as the share of natural capital in national wealth, taken from World Bank (1997). The 75 countries shown in the figure are represented by one observation each.[7] The regression line through the scatterplot suggests that an increase of about 12 points on the Gini scale from one country to another is associated with a decrease in per capita growth by one percentage point per year on average. Twelve points on the Gini scale correspond roughly to the difference between income inequality in the United Kingdom (Gini = 36) and in Sweden and Japan (Gini = 25). The relationship in Figure 6 is statistically significant (Spearman's rank correlation is -0.50). If rich countries and poor are viewed separately, a similar pattern is observed in both groups (not shown). Shaving one percentage point off any country's annual growth rate is a serious matter because the (weighted) average rate of per capita growth in the world economy since 1965 has been about 1½ percent per year. We see no signs of the positive cross-sectional relationship between inequality and growth in rich countries reported by Barro (2000), nor do we see any evidence of the nonlinearity in the panel relationship documented by Banerjee and Duflo (2000a, 2000b).

Figures 7 and 8 tell a similar story. Here we see the cross-country pattern of per capita growth as measured in Figure 6 and gender inequality of education (Figure 7) and land inequality (Figure 8). The pattern is not as clear as in Figure 6, but it is still statistically significant (Spearman's rank correlation is -0.32 and -0.37, respectively). The number of countries is 75 and 50 in the two figures. All countries for which the requisite data are available are included in all the figures in the paper, without exception.

4.2 Natural resources, inequality and growth

In Figure 9, we measure natural resource dependence by the share of natural capital in national wealth in 1994 – i.e., the share of natural capital in total capital, which comprises physical, human and natural capital (though not social capital; see World Bank, 1997). The natural capital variable is intended to come closer to a direct measurement of the intensity of natural resources across countries than the various

[7] All countries for which the requisite data are available are included in all the figures in the paper, without exception.

proxies that have been used in earlier studies, mainly the share of primary (i.e., non-manufacturing) exports in total exports or in gross domestic product (GDP) and the share of the primary sector in employment or the labor force. The latter proxies may be prone to bias due to product and labor market distortions.

Figure 9 shows that the share of natural capital in national wealth is positively correlated with income inequality as measured by the Gini index. Spearman's rank correlation is 0.41. Notice the cluster of five countries (Niger, Guinea-Bissau, Madagascar, Mali, and Zambia, in descending order) in the northeast corner of the figure with a natural capital share above 35 and Gini above 45. Even if this cluster is removed from the sample, the pattern remains statistically significant. Notice, further, the two countries (Sierra Leone and the Central African Republic) with a natural capital share of around 30 and Gini above 60. If this pair of observations is omitted, the pattern remains significant. If, however, both clusters (i.e., all seven countries) are removed from the sample, the remaining pattern becomes insignificant in a statistical sense. In this sense, this group of seven African countries in the northeast corner of the figure explains the inverse correlation. Even so, we are inclined to keep these African countries in our sample. We find it instructive that no country with a natural capital share above 25 has a Gini coefficient below 45.

Figure 10 shows that the natural capital share is also positively correlated with gender inequality as measured by the male minus female secondary-school enrolment rate. Spearman's rank correlation is 0.32. The pattern observed is statistically significant with or without the seven African countries mentioned above. Moreover, there is a positive albeit insignificant correlation between land inequality and natural capital in our sample (not shown); Spearman's rank correlation is 0.19.

From Figures 9 and 10 combined with Figure 11, which shows that the natural capital share varies inversely with per capita economic growth from 1965 to 1998 across the same group of countries, we conclude that these findings may help explain the inverse cross-sectional relationship between inequality and growth shown in Figures 6 and 7. In Figure 11, the rank correlation between natural capital and growth ($r = -0.64$) is statistically significant, and remains so even if the two clusters in the southwest corner and the northeast corner of the figure are excluded from the sample (see Gylfason and Zoega, 2001b).

At last, Figure 12 shows that, in our sample, natural capital is also inversely and significantly correlated with public expenditure on education ($r = -0.32$). Natural capital is also inversely and significantly related to years of schooling for girls and secondary-school enrolment for both genders (not shown).

4.3 Inequality and education

Let us now consider the three above-mentioned measures of education inputs, outcomes and participation and how they vary with inequality and economic growth. Figure 13 shows a scatterplot of public expenditure on education from 1980 to 1997 as reported by UNESCO (see World Bank, 2000, Table 2.9) and income inequality. Public expenditure on education varies a great deal from country to country. In the 1990s, some countries spent as little as 1 percent of their GNP on education (Haiti, Indonesia, Myanmar, Nigeria and Sudan). Others have spent between 8 percent and 10 percent of their GNP on education, including St. Lucia, Namibia, Botswana and Jordan, in descending order. Public expenditure is admittedly an imperfect measure of a nation's commitment to education, not least because some nations spend more on private education than others. Moreover, public expenditure on education may be supply-led and of mediocre quality, and may thus fail to foster efficiency, equality and growth, in contrast to private expenditure on education, which is generally demand-led and thus, perhaps, likely to be of a higher quality. Even so, this yardstick should reflect at least to some extent the government's commitment to education. The regression line through the 74 observations in Figure 13 suggests that an increase in public expenditure on education by one percent of GNP from one country to the next is associated with a decrease of 2.3 points in the Gini index. The relationship is statistically significant ($r = -0.36$).

Figure 14 shows scatterplots of the expected number of years of schooling for females from 1980 to 1997 and income inequality. This indicator of schooling is intended to reflect the total education resources, measured in school years, that a girl will acquire over her lifetime in school or as an indicator of an education system's overall state of development. In Figure 14, the regression line through the 46 observations, one per country, suggests that an increase by one year of the schooling that an average girl at the age of school entry can expect to receive is associated with a decrease in the Gini index, i.e., increased equality, by almost one point. The relationship is statistically significant ($r = -0.49$). Unlike the relationship in Figure 13, the one in Figure 14 is significantly nonlinear (not shown), suggesting that the marginal effect of increased education on equality is rising in the level of education –

that is, there may be increasing returns to schooling in terms of equality. Sen (1999), among others, emphasizes the importance of educating girls in developing countries. The corresponding relationship for males (not shown) is virtually the same as for females.

In Figure 15, we present a scatterplot of secondary-school enrolment and income inequality. The pattern is clear: an increase in secondary-school enrolment by five percent of each cohort goes hand in hand with a decrease in the Gini index by one point. The data exhibit a similar, albeit not quite as strong, relationship between secondary-school enrolment and gender inequality (not shown). The same applies to Figures 13 and 14: public expenditure on education and years of schooling for girls are also inversely related to gender inequality (not shown). All three measure of education are positively correlated with economic growth (not shown).

These patterns seem to suggest that more and better education goes along with less inequality as well as more rapid growth and that human capital, like natural capital, thus can perhaps help explain the inverse relationship between inequality and growth that we observe in the data. To find out, we need to dig a little deeper.

5. Regression analysis

Table 1 reports seemingly unrelated regression (SUR) estimates of a system of five equations for the 87 countries in our sample for the years 1965-1998. The equations reveal how natural capital intensity can affect growth through various channels: through investment, education and inequality, as well as directly.

5.1 The model and estimation

The first equation shows how economic growth depends on (a) the logarithm of initial per capita income (i.e., in 1965), defined as income in 1998 divided by an appropriate growth factor, (b) the share of natural capital in national wealth (which comprises physical, human and natural capital), (c) the share of gross domestic investment in GDP in 1965-1998, (d) the log of the secondary-school enrolment rate (the log in order to capture diminishing returns to education), (e) the Gini index and (f) gender inequality of education as measured by the difference between male and female secondary-school enrolment rates in 1980-1997. This equation can be interpreted either as a description of endogenous long-run growth or of medium-term growth in the neoclassical model where economic growth is exogenous in the long run. Initial income is intended to capture conditional convergence. Natural capital is another exogenous determinant of growth. Investment and education are intended to capture the contribution of physical and human capital accumulation to growth. The inequality measures reflect the hypothesized effects of income and gender inequality on growth.

The second equation shows the relationship between the investment rate and the natural capital share (as spelled out in Gylfason and Zoega, 2001b; the underlying explanation is that increased dependence on natural resources reduces the share of physical capital in GDP and thereby weakens the incentive to save and invest by our extension of the Golden Rule).

The third equation shows how the enrolment rate depends on initial income (because wealthy countries can afford to spend more on education) as well as on natural capital (as in Gylfason, 2001, and Gylfason and Zoega, 2001b; the idea behind this formulation is that the natural-resource-intensive sector may find it profitable to use workers with fewer skills than the manufacturing sector).

The fourth equation shows the relationship between the Gini index, initial income (i.e., the Kuznets curve) and the natural capital share that we documented in Section 4. The fifth and last equation shows the relationship between gender inequality and the natural capital share. To recapitulate, our hypothesis from Section 2 is that because natural resource ownership tends to be less equally distributed than other assets, countries that depend heavily on their natural resources tend to have a less equal distribution of income, education and land than countries that are less dependent on their natural wealth.

The recursive nature of the system and the conceivable correlation of the error terms in the four equations make SUR an appropriate estimation procedure (Lahiri and Schmidt, 1978). However, the fact that ordinary least squares (OLS) estimates of the system (not shown) are almost identical to the SUR estimates shown in Table 1 indicates that the correlation of error terms across equations is of minor consequence. In our data, each country is represented by a single observation. This is because our data on natural resources are limited to a single year, 1994. In view of this, our analysis is confined to a cross section of countries, even if panel data on income distribution have recently become available (Deininger and Squire, 1996). An extension of our analysis to panels must await richer data on natural capital. This may be important because some writers (e.g., Forbes, 2000) have reported panel regression results on inequality and growth that seem to go against some of the results that have been obtained from cross-sectional studies (but see Banerjee and Duflo, 2000b, who disagree with Forbes, and also Bénabou, 1996).

5.2 Empirical results

All the coefficient estimates shown in Table 1 are economically and statistically significant, with one exception (see below). The coefficient on initial income in the growth equation indicates a conditional convergence speed of 1.3 percent per year. The direct effect of the natural capital share on growth is -0.05 and the indirect effects through investment and education are -0.20*0.11 = -0.022 and -(0.03)*1.08 = -0.032. The additional indirect effect of the natural capital share on growth via the Gini index is 0.30*(-0.04) = -0.012. The total effect of natural capital on growth is, therefore, about -0.12 (for given initial income). Hence, the income distribution channel accounts for about one-tenth of the total effect of natural capital intensity on growth.

Of additional interest here are the effects of education and inequality on growth. The first equation in the table shows the direct effect of education on growth to be 1.08/E = 0.025, evaluated at the mean value of the secondary-school enrolment rate, E = 0.43; this means that an increase in the enrolment rate by ten percentage points from one country to another increases growth by one-fourth of a percentage point. The direct effect of increased income inequality on growth is also rather strong: an increase in the Gini index by 15 points, which corresponds to the difference between Norway (Gini = 26) and the United States (Gini = 41), from one place to another is associated with a decrease in growth by 0.6 percentage points which, in turn, is about a half of the average per capita growth in our sample over the period under review. On the other hand, we do not find significant evidence of a negative effect of increased gender inequality of education and economic growth; the coefficient reported in the top line of Table 1 is negative, true, but small and insignificant. Even so, an increase in the natural capital share increases both types of inequality significantly and substantially. Thus, an increase in the natural capital share by ten percentage points from one country to another increases the Gini index by three points and the difference between male and female secondary-school enrolment rates by two and a half percentage points; the latter type of increased inequality, however, does not significantly hamper growth.

It is interesting to note that the inclusion of the natural capital share and the secondary-school enrolment rate in the growth equation does not reverse the sign of the estimated coefficient of the Gini index. In particular, the relationship between growth and inequality remains negative, in contrast to the results of Forbes (2000). However, the size of the income distribution effect is reduced by about a half by the inclusion of the natural capital and school enrolment variables. This seems to suggest that in growth equations without natural capital and education, the income distribution variable picks up a good part of the influence of the omitted variables. Our cross-sectional results bear out a long-term relationship between inequality and growth while the pooled estimation of Forbes (2000) reflects short- to medium-term relationships by her own reckoning. It is also possible that the inclusion of omitted, country-specific variables other than natural capital and education could reverse the sign of the coefficient of the Gini index.

Notice, at last, that the data support the notion of a Kuznets curve relating income inequality and initial income. There is, however, no comparable nonlinear relationship between gender inequality and initial income. In our data, initial income has no significant effect on investment across countries.

5.3 Other possibilities

We have experimented with several variations of the model specification in Table 1.

First, we added natural capital per person as a proxy for natural resource abundance in order to distinguish between natural resource abundance and natural resource intensity (as in Gylfason and Zoega, 2001b). By intensity, or dependence, we mean the importance of natural resources to the national economy, while abundance refers to the supply (per capita) of the natural resources. Some countries – Australia, Canada and the United States, to name a few – have abundant natural resources but are not particularly dependent upon them, not any more. Our argument has been that it is natural resource dependence that matters for inequality and growth. We do not expect Australia, Canada or the United States to suffer from their abundance of natural resources, far from it. When we add natural capital per person as an independent explanatory variable to each equation in Table 1, it turns out that natural resource abundance encourages economic growth, investment and education and reduces gender inequality, but has no effect on income inequality. In other respects, the results remain virtually the same as in Table 1. This means that increased dependence on natural resources hurts growth, as we hypothesized, while increased abundance helps (for more, see Gylfason and Zoega, 2001b).

Next, we entered the natural capital share and the Gini index of income inequality multiplicatively rather than additively in our growth equation in order to study the interaction between the two variables. Now the coefficient of the multiple is -0.0011 (with t = 3.72). This means that the negative effect of natural resource dependence on growth varies directly with income inequality: the more unequal the distribution of income, the greater is the adverse effect of natural resource dependence on growth. Evaluated at the mean value of the Gini index in our sample (42), the effect of the natural capital share on growth is -0.05 as in Table 1. This new specification also means that the negative effect of income inequality on growth varies directly with natural resource dependence: the greater the natural capital share, the greater is the adverse effect of income inequality on growth. Evaluated at the mean value of the natural capital share in our sample (12), the effect of income inequality on economic growth is -0.013, which is smaller than the coefficient of the Gini index in the first equation in Table 1. When we replace the Gini index of income inequality in the above experiment with our measure of gender inequality or of land inequality, we obtain the same results: the greater the natural capital share, the greater is the adverse effect of increased inequality on growth.

Third, we replaced our gender inequality measure (the arithmetic difference between male and female secondary-school enrolment rates) by the absolute difference between male and female enrolment rates. The new measure means that a change from a situation where more boys than girls go to school to one where more girls than boys go to school leaves gender inequality unchanged if the numbers are the same. When we re-estimate our system using this new measure, increased gender inequality reduces economic growth directly: the coefficient on gender inequality in the first equation in Table 1 is now -0.05 with t = 2.09. In this case, however, the effect of the natural capital share on gender inequality becomes small and statistically insignificant (the coefficient is 0.08 with t = 1.47). In other respects, the regression results (not shown) are very similar to those reported in Table 1.

Our fourth and last experiment involves Africa and Latin America. When we add a dummy variable for Africa to each equation in our model, in case Africa might be different from other regions, as some studies have shown, the dummy coefficient has the expected sign everywhere, but it is statistically significant only in the equations for education and the Gini index. The annual rate of per capita growth in Africa is thus three quarters of a percentage point smaller than elsewhere according to our results (not shown), but the difference is not significant (t = 1.73). The investment rate is almost two percentage points lower in Africa than elsewhere, but again the difference is insignificant (t = 1.38). The secondary-school enrolment rate is 15 percentage points lower in Africa than elsewhere (evaluated at the sample mean), and this difference is significant (t = 3.23). Gender inequality in education is also significantly greater in Africa than elsewhere, by almost five percentage points (t = 2.15). There is, on the other hand, no significant difference between the Gini index in Africa and the rest of our sample. All the estimates shown in Table 1 remain essentially intact in the presence of the African dummy. When we add a dummy variable for Latin America (with or without Central America) rather than for Africa, the dummy has no effect on growth, investment or education, but it does matter for distribution; specifically, the Latin dummy reduces gender inequality by 7.5 percentage points (t = 2.48) and increases the Gini index of income inequality by ten points (t = 3.20). Again, our estimates in Table 1 remain unchanged. We conclude that the specification of our model in Table 1 is sufficiently broad to render the inclusion of regional dummy variables superfluous.

6. Conclusion

The inverse empirical relationship between inequality and economic growth across countries that has emerged from several recent studies has spurred several authors to suggest various potential theoretical explanations for the relationship. These explanations have generally been of the following kind: inequality is bad for some variable X – for example, education – and X is good for growth, so increased inequality hurts growth by hurting X. We approach this issue from a different angle: we argue that a country's dependence on its natural resources influences both inequality and growth. We show – both theoretically and empirically – how variations in the share of natural resources in national wealth can help explain the inverse relationship between inequality and economic growth across countries.

The essence of our story is this: if the distribution of ownership of natural resources is more unequal than the distribution of other forms of wealth, the inequality of the distribution of income, education or land is directly related to the share of natural resources in national income. Specifically, we show – in the context of an endogenous-growth model of the simplest kind – how natural resources can reduce growth and increase inequality by attracting workers away from higher technology industries. Our data appear to confirm this prediction: they suggest that the Gini index of income inequality as well as gender inequality varies directly with the share of natural capital in national wealth. The data also bear out an inverse relationship between economic growth and the share of natural capital in national wealth.

Differences in human capital across countries appear also to help explain the inverse cross-country correlation between economic growth and inequality. More and better education – measured by secondary-school enrolment, years of schooling or public expenditure on education – is associated with less inequality and more rapid growth in our data. This suggests a clear role for public policy in combating the potentially adverse effects of excessive dependence on natural resources on income inequality and growth. In addition, tax policy can be used to combat the adverse effect of natural resources on inequality and growth. When income or rent from natural resource extraction is taxed at a higher rate than wage income, this discourages workers from spending time in the natural resource sector, raises the marginal product of capital in manufacturing, increases the real rate of interest and thereby also the rate of growth of output and consumption per capita.

Our regression results suggest that natural capital intensity reduces growth directly as well as indirectly by reducing equality, secondary-school enrolment rates and investment rates. This leaves an important role for public policy, which can be used to encourage growth by enhancing equality, among other things. We conclude that the trade-off between equality and (dynamic) efficiency is affected by both natural and human capital, as well as by tax policy.

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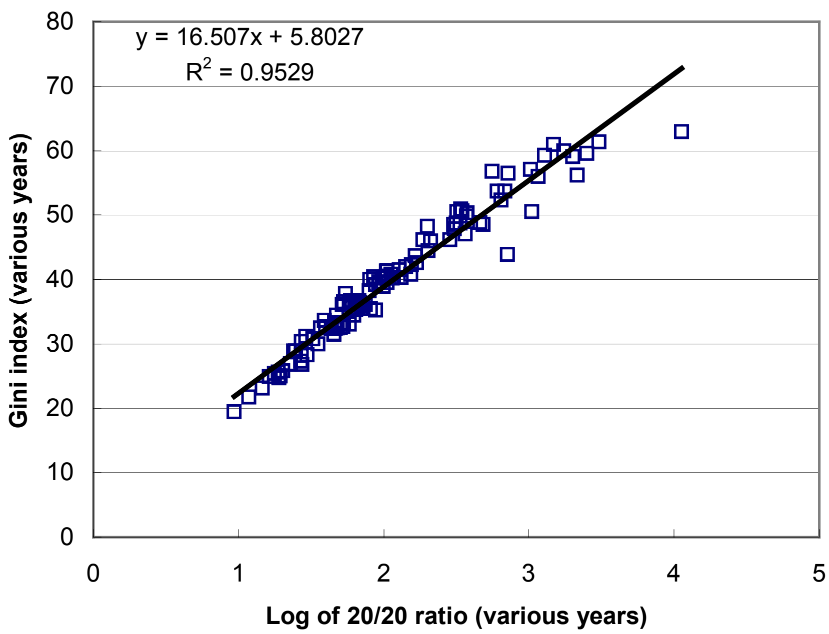
Table 1. Regression Results

Dependen variable	*Initial income*	*Initial income squared*	*Natural capital share*	*Investment rate*	*Enrolment rate (log)*	*Gini index*	*Gender inequality*	*R^2*	*Countries*
Economic growth	-1.26 (6.05)		-0.05 (5.19)	0.11 (3.82)	1.08 (3.88)	-0.04 (2.84)	-0.01 (0.76)	0.68	74
Investment rate			-0.20 (3.98)					0.15	87
Enrolment rate	0.54 (11.31)		-0.03 (6.29)					0.70	87
Gini index	48.88 (3.54)	-3.20 (3.69)	0.30 (2.84)					0.31	74
Gender inequality			0.25 (2.98)					0.09	87

Note: Estimation method: SUR. t-ratios are shown within parentheses. Constant terms are not reported to conserve space.

Figure 1. The Gini Index and the 20/20 Ratio



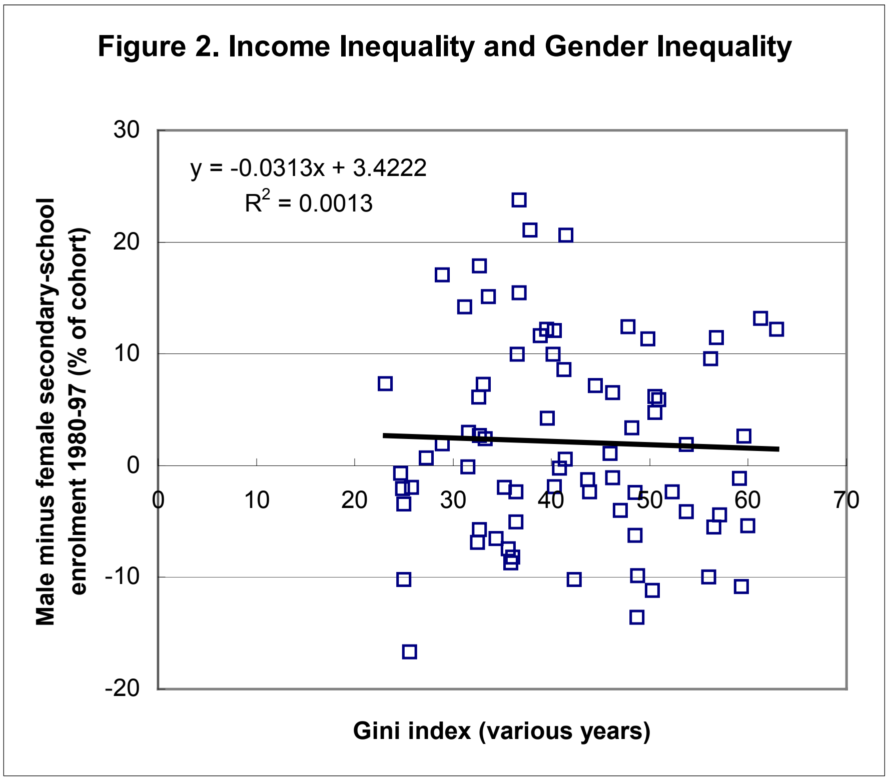


Figure 2. Income Inequality and Gender Inequality
y = -0.0313x + 3.4222
R2 = 0.0013
30
20
10
0
-10
-20
0
10
20
30
40
50
60
70
Male minus female secondary-school enrolment 1980-97 (% of cohort)
Gini index (various years)

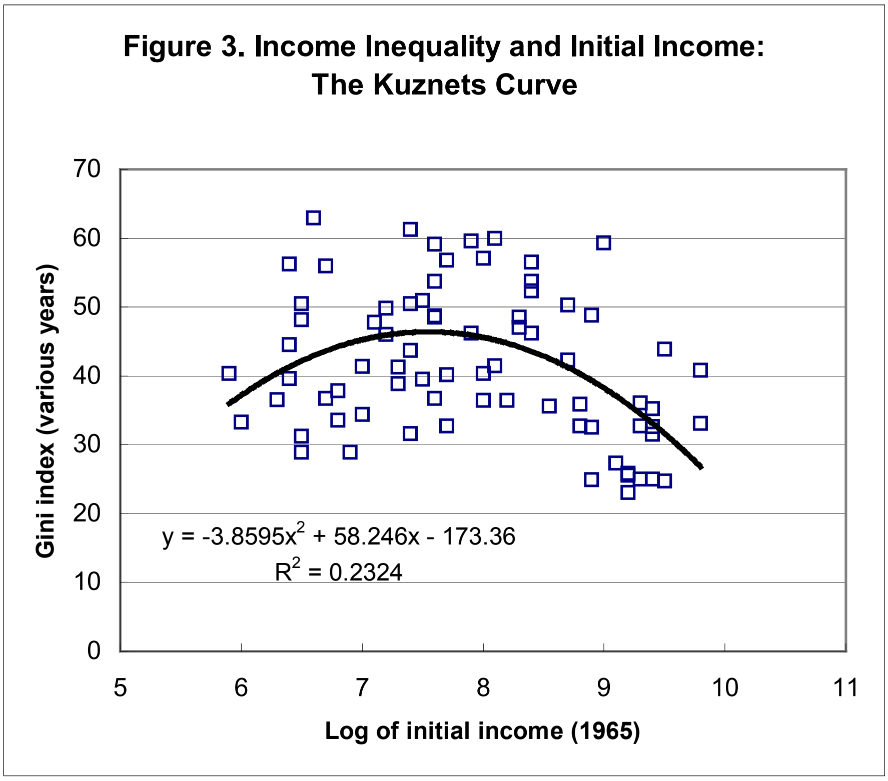


Figure 3. Income Inequality and Initial Income:
The Kuznets Curve
y = -3.8595x2 + 58.246x - 173.36
R2 = 0.2324
70
60
50
40
30
20
10
0
5
6
7
8
9
10
11
Gini index (various years)
Log of initial income (1965)

Figure 4. Gender Inequality and Initial Income

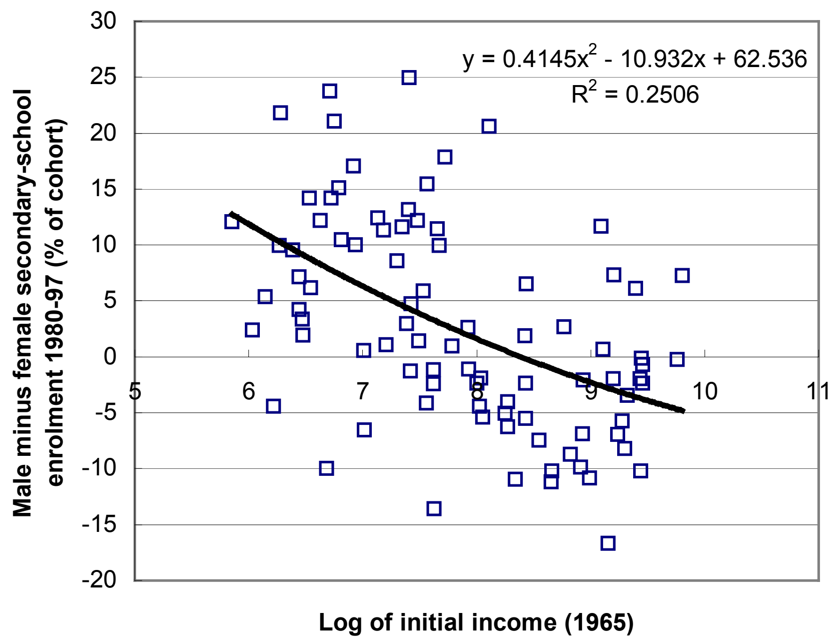


Figure 5. Distribution of Income and Land

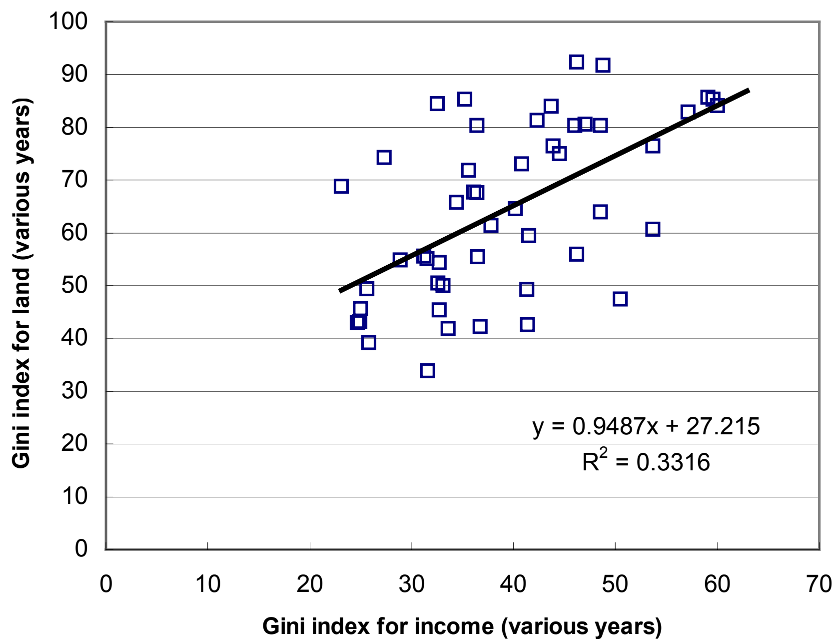


Figure 6. Income Inequality and Economic Growth
y = -0.0842x + 2.1782
R^2 = 0.2088
Per capita economic growth 1965-98, adjusted for initial income (% per year)
Gini index (various years)
4
3
2
1
0
-1
-2
-3
-4
-5
-6
0
10
20
30
40
50
60
70

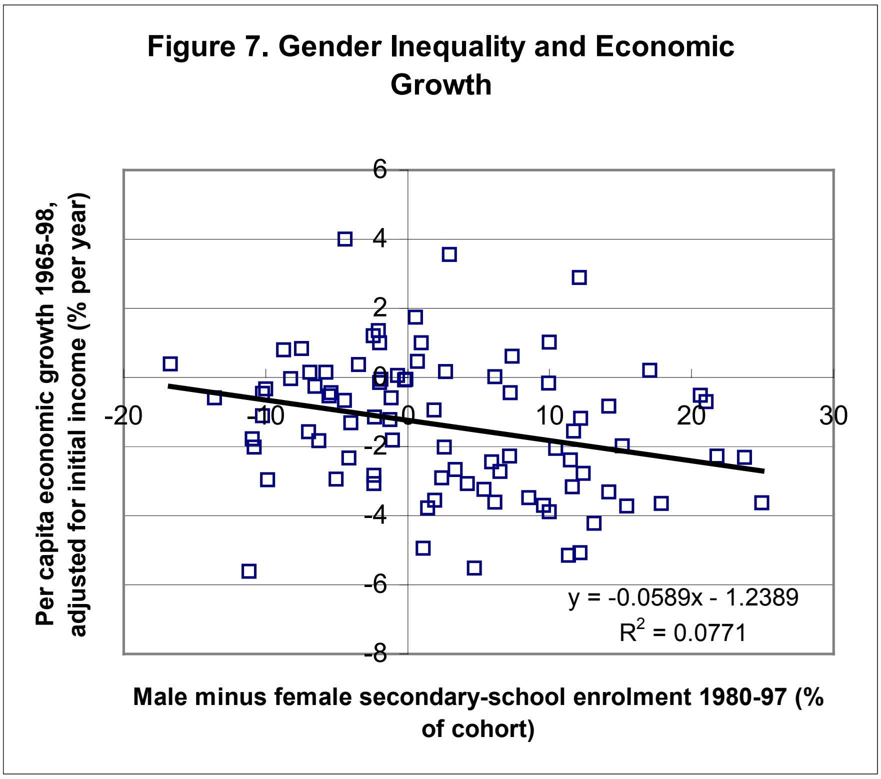


Figure 7. Gender Inequality and Economic Growth
y = -0.0589x - 1.2389
R^2 = 0.0771
Per capita economic growth 1965-98, adjusted for initial income (% per year)
Male minus female secondary-school enrolment 1980-97 (% of cohort)
6
4
2
0
-2
-4
-6
-8
-20
-10
0
10
20
30


Figure 8. Land Inequality and Economic Growth
Per capita economic growth, adjusted for initial income 1965-98 (% per year)
4
3
2
1
0
-1
-2
-3
-4
-5
-6
0
20
40
60
80
100
y = -0.0354x + 1.5092
R2 = 0.1302
Gini index for land (various years)

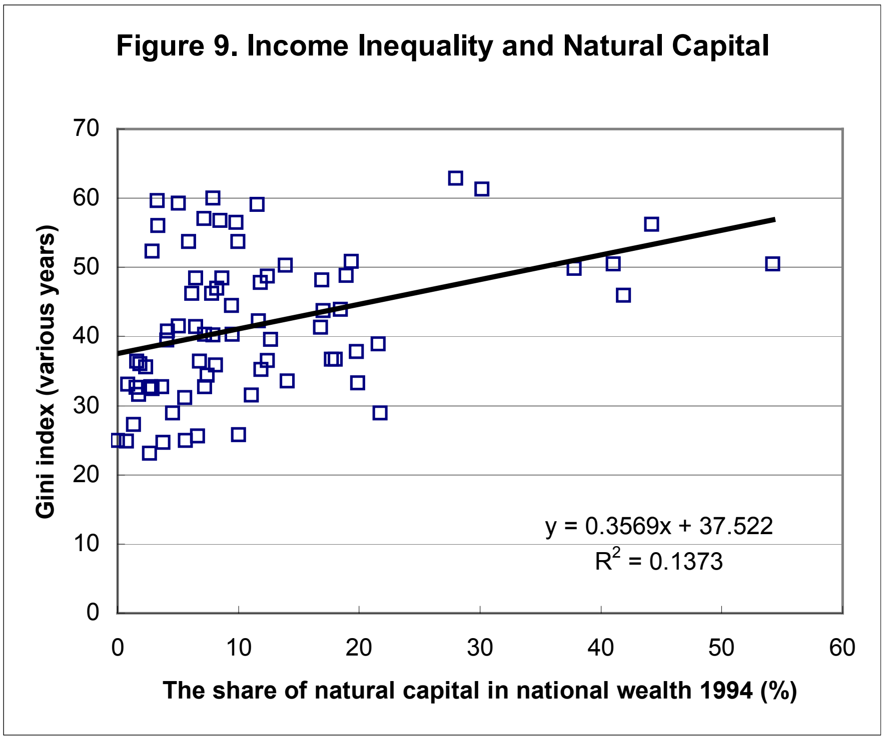


Figure 9. Income Inequality and Natural Capital
Gini index (various years)
70
60
50
40
30
20
10
0
0
10
20
30
40
50
60
y = 0.3569x + 37.522
R2 = 0.1373
The share of natural capital in national wealth 1994 (%)

Figure 10. Gender Inequality and Natural Capital

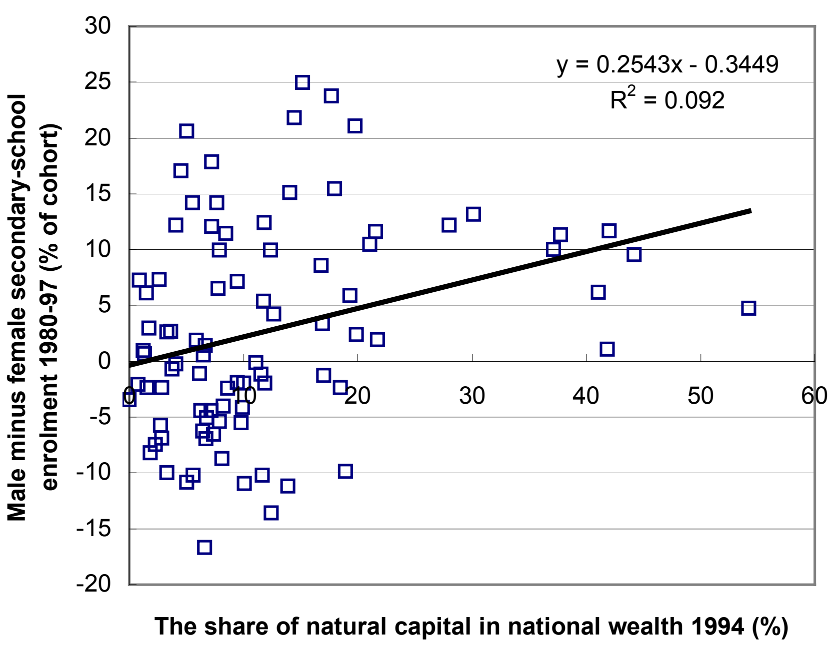
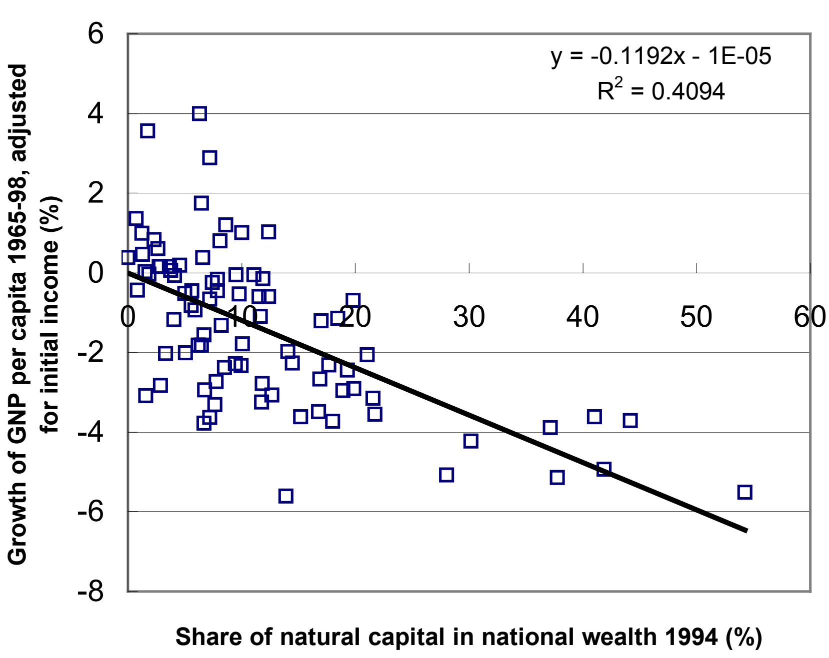


Figure 11. Natural Capital and Economic Growth



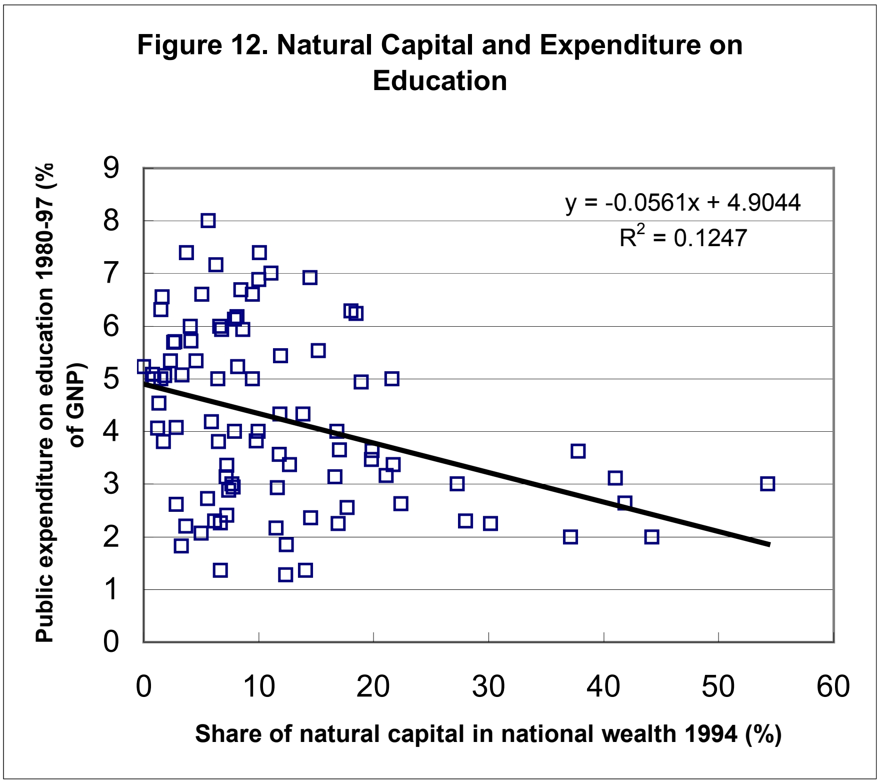


Figure 12. Natural Capital and Expenditure on Education
y = -0.0561x + 4.9044
R2 = 0.1247
Public expenditure on education 1980-97 (% of GNP)
Share of natural capital in national wealth 1994 (%)
0
1
2
3
4
5
6
7
8
9
0
10
20
30
40
50
60

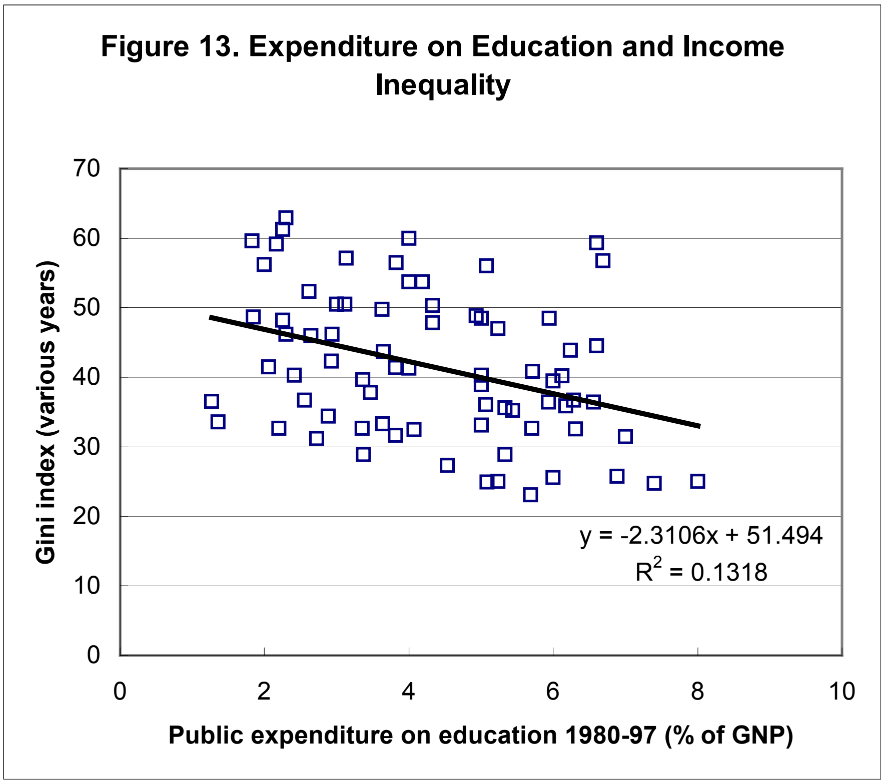


Figure 13. Expenditure on Education and Income Inequality
y = -2.3106x + 51.494
R2 = 0.1318
Gini index (various years)
Public expenditure on education 1980-97 (% of GNP)
0
10
20
30
40
50
60
70
0
2
4
6
8
10

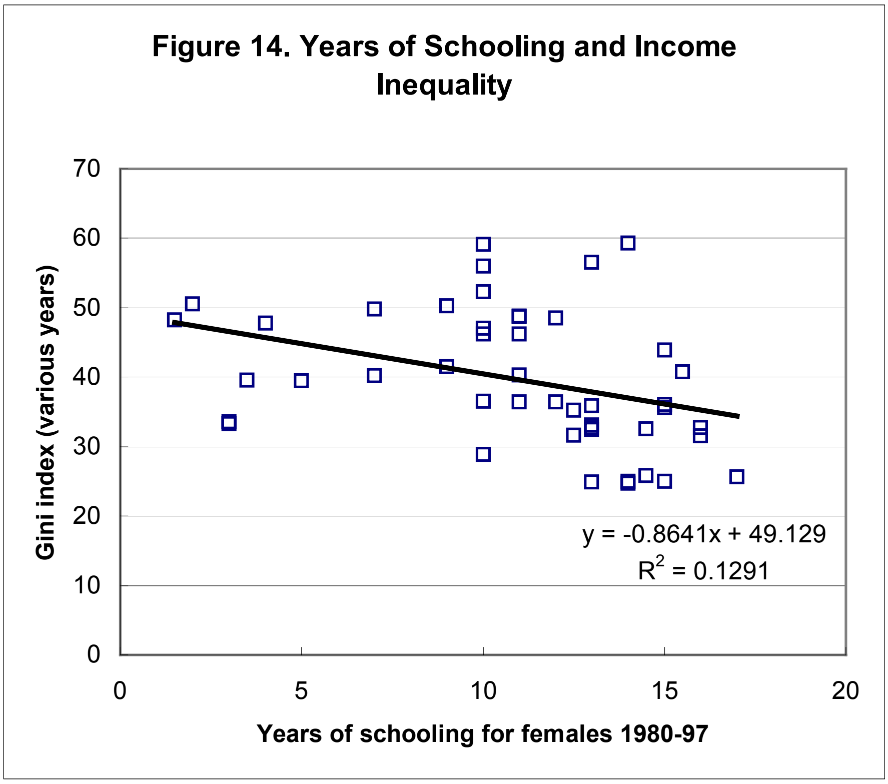


Figure 14. Years of Schooling and Income Inequality
Gini index (various years)
70
60
50
40
30
20
10
0
0
5
10
15
20
Years of schooling for females 1980-97
y = -0.8641x + 49.129
R2 = 0.1291

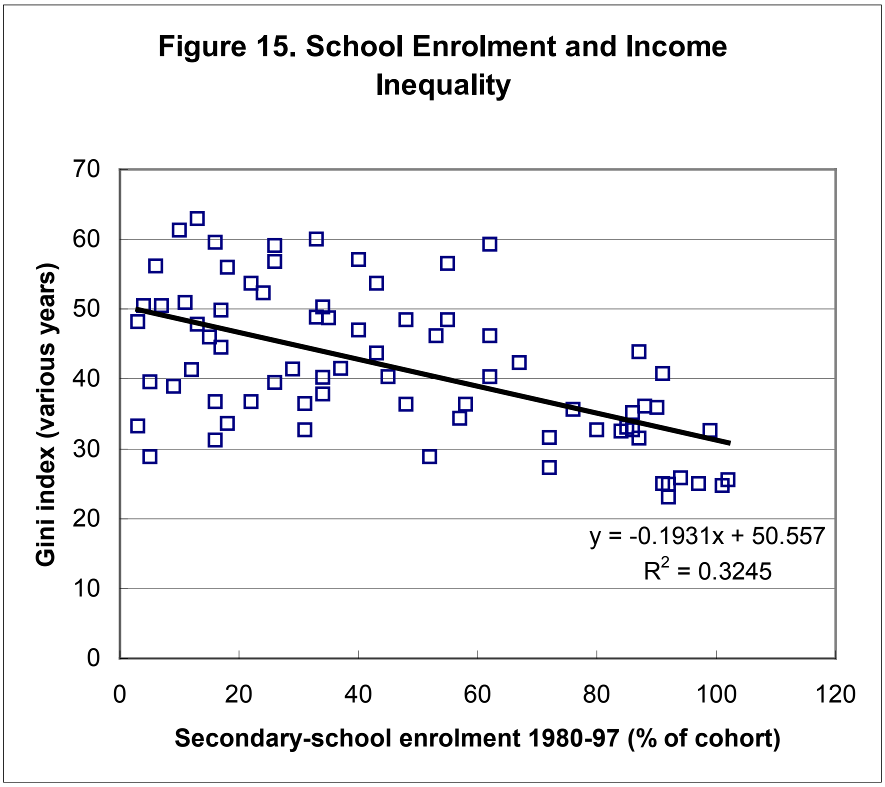


Figure 15. School Enrolment and Income Inequality
Gini index (various years)
70
60
50
40
30
20
10
0
0
20
40
60
80
100
120
Secondary-school enrolment 1980-97 (% of cohort)
y = -0.1931x + 50.557
R2 = 0.3245