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Foreign Direct Investment, Inequality, and Growth

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Abstract

This paper examines the interactions between Foreign Direct Investment (FDI), inequality, and growth, both from a theoretical and an empirical point of view. We set up a growth model of a dual economy in which the traditional (agricultural) sector uses a diminishing returns technology, while FDI is the engine of growth in the modern (industrial) sector. Using a panel of 119 developing countries, we test the main predictions of our model. We find that FDI promotes both inequality and growth, and tends to reduce the share of agriculture to GDP in the recipient country.

JEL Classification: O1, F43
Keywords: Foreign direct investment, inequality, growth

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1. INTRODUCTION

Two distinct branches in the growth literature focus on how growth relates with inequality on the one hand, and with FDI, on the other. Within the first branch, there is no clear empirical consensus yet on how growth and inequality are related.[1] From a theoretical point of view, a recent stream of non-ergodic growth papers emphasise that initial inequality of human capital can have permanent effects on a country's growth.[2] The second branch of the literature investigates the effects that FDI has on growth for developing countries. There is a wave of papers on this theme, and a near consensus is now reached that FDI is an engine of growth in developing countries (see De Mello, 1997, for a survey). The positive growth effects of FDI can arise from factors such as knowledge spillovers or technological upgrading.

Relatively little effort has been made to integrate these two disjoint branches of the literature.[3] In this paper, we try to bridge this gap by looking at how FDI impacts human

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[1] For instance, Forbes (2000) finds a positive correlation between growth and inequality; Barro (2000) reports that the growth-inequality relationship varies significantly between rich and poor countries; and Castelló and Doménech (2002) find a negative correlation between the two variables.

[2] Even from a theoretical point of view, however, the exact long-run effect of inequality on growth is not clear. Aghion and Bolton (1993) argue that inequality due to credit market imperfections may hurt growth, and that a redistribution of wealth from the rich to the poor would thus promote growth. Banerjee and Newman (1993) construct examples where initial wealth inequality may lead to either stagnation or prosperity. Bandyopadhyay (1993) and Bandyopadhyay and Basu (2002) show that the growth-inequality relationship depends on the structural parameters of the model.

[3] Tsai (1995) considers the relationship between FDI and income inequality in LDCs. His econometric analysis suggests that the relationship is generally positive, but varies across geographical areas. However, unobserved country-specific heterogeneity is not taken into account in his analysis. Also see Bornschier and Chase-Dunn (1985) for a survey of other mainly empirical studies that looked at the FDI-inequality relationship. A recent paper by Monge-Naranjo (2002) explores the relationship between FDI and human capital accumulation, both

capital and income inequality, both from a theoretical and an empirical point of view. The issue is important: a recent United Nations Human Development Report (1999) suggests in fact that in an era where there is massive infusion of modern technology, the inequality between rich and poor countries is widening.[4] If FDI were contributing to the widening of this inequality, it may be associated with negative welfare effects, which could offset some of its positive effects on growth.

We develop a growth model of a dual economy in which the traditional (agricultural) sector uses a diminishing returns technology, while FDI is the engine of growth in the modern (industrial) sector. There are two types of altruistic agents in this economy: the poor with a low initial human capital, and the rich with a high initial human capital. Depending on the initial distribution of human capital and the state of agricultural productivity, several possibilities can arise during the transitional phase. First is the most optimistic scenario, where the poor may become entrepreneurs at some point in the future.[5] Here, inequality would decline to zero once the poor become entrepreneurs, but the short-run correlation between FDI and inequality could be positive or negative depending on the parameter configurations. This scenario can only take place if the initial endowment of human capital of the poor and the state of agricultural productivity are high.

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theoretically and empirically, and makes the point that FDI speeds up the accumulation of human capital in developing economies. However, his paper does not explore the effect of FDI on the inequality of human capital.

[4] According to the United Nations Human Development Report (1999): "…the disparities are […] stark. In mid-1998, industrial countries – home to less of 15% of people - had 88% of Internet users. North America alone – with 5% of all people – had 50% of Internet users. By contrast, South Asia is home to over 20% of all people, but had less than 1% of the world's Internet users." This shows that a very small proportion of people have access to modern technologies.

[5] See Gollin et al. (2002) for a similar scenario.

A second scenario may arise when the poor produce and consume food below the saturation level[6], and remain isolated from the modern sector. This is likely to happen when the agricultural productivity and the initial endowment of human capital of the poor are both low. This scenario is akin to an enclave economy, where the traditional sector remains in a poverty trap, and the modern sector, with FDI-based technology, grows. Here, inequality widens as FDI propels growth in the modern sector.

A third intermediate scenario may arise when the poor produce food above the saturation level and trade with the rich by exchanging their surplus food for manufacturing goods. This gives the poor some room for growth in the short-run. However, the human capital of the poor soon reaches a steady-state: trade has no long-run effect on the human capital of the poor. In the short-run, one could observe either a positive or a negative relationship between FDI and inequality, but as soon as the human capital of the poor stops growing, this relationship would become positive. Contrary to the enclave economy environment, in this scenario, inequality is not accompanied by poverty.

In all three scenarios, FDI and growth are positively correlated, and FDI and the share of agriculture to GDP are negatively related.

We test our model using a panel of 119 developing countries over the period 1970-99. Our regressions provide empirical support for a positive relationship between FDI and human capital as well as income inequality. We also find a strong positive association between FDI and growth, and a negative association between FDI and the share of agriculture to GDP in the recipient country. These findings are consistent with the model's predictions, and suggest that FDI induced growth exacerbates economic inequality in developing countries.

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[6] The utility function that we use in our model assumes a level of saturation for food. Before that level is reached, all agents care about is food. Once that level is reached, agents do not derive any more utility from additional food and start caring about manufacturing goods (see Section 2.1 below).

The rest of the paper is organised as follows. Section 2 lays out the theoretical model. Section 3 describes the data. Section 4 presents the empirical results, and Section 5 concludes.

2. A MODEL OF FDI AND INEQUALITY

2.1 Environment

Production

Consider a dual economy with two sectors: traditional (indexed with a) and modern (indexed with m).[7] The traditional sector (agriculture) produces output (food) with raw labor (l_a), capital (h_a), and land. Since land is fixed in supply (normalized at unit level), the traditional sector is subject to diminishing returns. The modern (industrial) sector produces output with raw labor (l_m), human capital (h_m), and foreign capital (f). To start production in sector m, one needs a minimum amount of human capital, h_{min}. The production functions in these two sectors are, therefore,

(1) $$y_{at} = z(l_{at}h_{at})^{\alpha} \quad \text{with } 0<\alpha<1;$$

(2) $$y_{mt} = (l_{mt}h_{mt})^{\nu} f_t^{1-\nu} \quad \text{for } h_{mt} \geq h_{\min}$$

$$= 0 \quad \text{otherwise,}$$

where $0<\alpha<1$ and $0<\nu<1$. $l_{at}h_{at}$ and $l_{mt}h_{mt}$ represent effective labor supplied in the two sectors, and z is the total factor productivity (TFP) in the traditional sector. Raw labor l_{at} and l_{mt} are inelastically supplied and therefore normalized at unit levels.

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[7] Bandyopadhyay and Basu (2001, 2002) analyze issues of growth, inequality, and optimal redistributive taxes in a model similar in spirit to ours. However, they do not deal with the issue of the linkage between foreign direct investment, inequality, and growth, which is our central concern in this paper.

Initial distribution of human capital

Agents are altruistic and live for two periods: in the first period as offsprings of their parents and in the second period as adults accompanying their child. Only adults make decisions. There are two types of adults in this economy: the poor (type 1) and the rich (type 2). The population is constant and normalized to unity. Let ϕ be the proportion of poor who own $h_0^{(1)}$ ($<h_{min}$) units of human capital and one unit of land to start with. The rich own $h_0^{(2)}$ ($>h_{min}$) units of human capital and one unit of land. Because of the initial distribution of human capital, the poor only have access to the production technology (1). The rich, on the other hand, have access to both technologies (1) and (2).

Investment

There are two types of investment technologies for the creation of human capital. An adult can invest in the traditional sector or in the modern sector. Investment in the traditional sector can be thought of as educating one's child in a village primary school. Investment in the modern sector could be interpreted as sending one's child to a big city for secondary and more advanced education. Regardless of the form of schooling, the child can become an entrepreneur only if he/she acquires the minimum skill h_{min}.

We thus have the following technology for updating human capital in each sector over generations:

(3) $$h_{jt+1} - (1-\delta)h_{jt} = I_{jt}\text{, where } j=a, m.$$

I_{jt} is the investment in sector *j*. If the adult does not invest in schooling, the child only inherits a fraction (1-δ) of his/her parent's human capital. Benabou (1996), Mankiw et al. (1992), and Bandyopadhyay (1993) model the intergenerational knowledge transfer process in a similar way. We also assume that there is a fixed cost, F (which exceeds h_{min}), for investing resources abroad. This precludes the poor from investing abroad.

Foreign capital

We assume that the home country is a small open economy, which faces an exogenously given constant world interest rate r^*, and can access an unlimited amount of foreign capital at a fixed rental price, r^*. The profit maximization condition requires that the marginal product of foreign capital equals its rental price, r^*. This gives rise to the following demand function for foreign capital:

(4) $$f_t = \left[\frac{1-\nu}{r^*}\right]^{1/\nu} h_{mt}.$$

Since the supply of foreign capital is infinitely elastic at r^*, (4) gives the time path of f_t, which depends on the endogenous time path of h_{mt}. The FDI at date t (call it fdi_t) is defined as:

(5) $$fdi_t = f_{t+1} - (1 - \delta) f_t,$$

where δ is the rate of depreciation of foreign capital. For simplicity, we assume that all types of capital depreciate at the same rate, δ.

Using (4) and (5) yields the following equation for the FDI rate:

(6) $$\frac{fdi_t}{h_{mt}} = \left[\frac{1-\nu}{r^*}\right]^{1/\nu} \left[\frac{h_{mt+1}}{h_{mt}} - (1-\delta)\right].$$

Not surprisingly because of technological complementarities, the FDI rate increases as human capital grows in the modern sector[8].

[8] Note that the explicit modelling of FDI behaviour is beyond the scope of this paper. For a model of FDI behaviour, see Rob and Vettas (2003).

Plugging (4) into (2) gives rise to the familiar Rebelo (1991)-type linear production function in the modern sector:

(7) $y_{mt} = A.h_{mt}$,

where $A = \left[\frac{1-\nu}{r^*}\right]^{\frac{1-\nu}{\nu}}$. We assume that the technology is such that A-δ>r^*, which means that the rich never invest abroad.[9] Foreign capital is thus the critical engine of growth in this model. If there were any restrictions on the inflow of foreign capital, the production in the modern sector would be subject to diminishing returns and growth would stop.[10]

Preferences

Following Gollin et al. (2002), the instantaneous utility function for the two types of agents is given by:

(8) $U(c_a, c_m) = c_a$ when $\omega \leq c_a < \bar{a}$

$= \bar{a} + \log c_m$ when $c_a \geq \bar{a}$,

where c_a and c_m denote consumption of agricultural (food) and manufacturing goods respectively; ω represents the minimum subsistence level of consumption below which the agent fails to survive; and $\bar{a}$ is a saturation level of consumption of food.[11] Until that level is

[9] If δ=0, such a restriction means that $(1-\nu)^{1-\nu}>r^*$.

[10] This feature of the model is similar to De Mello (1997).

[11] We assume that $\bar{a}$ is less than the initial start up cost of launching a modern enterprise, $h_{\min}$.

reached, all agents care about is food. Once that level is reached, agents do not derive any more utility from additional food, and start caring about manufacturing goods.[12]

Both types of agents are altruistic, and thus maximize the utility function,

$$\sum_{t=0}^{\infty} \beta^t U(c_{at}, c_{mt}), \tag{9}$$

where β is the degree of altruism.

Resource constraints

Since their initial capital stock is less than the start-up cost of running a modern enterprise (h_{min}), the poor produce food with the technology illustrated in (1). If they produce more than the saturation level, $\bar{a}$, they trade $x_{at}^{(1)}$ units of food with the rich for manufacturing goods, which are priced at p_t. If the poor produce less than $\bar{a}$, they cannot trade with the rich. In both cases, the poor only invest $I_{at}^{(1)}$ in agriculture. In other words, the poor face the following constraints:

when $y_{at}^{(1)} \geq \bar{a}$,

$$\bar{a} + I_{at}^{(1)} + x_{at}^{(1)} = y_{at}^{(1)}, \tag{10}$$

$$h_{at+1}^{(1)} - (1-\delta) h_{at}^{(1)} = I_{at}^{(1)}, \tag{11}$$

$$x_{at}^{(1)} = p_t c_{mt}^{(1)}; \tag{12}$$

when $y_{at}^{(1)} < \bar{a}$,

[12]To avoid any discontinuity in the utility function, the logarithmic part of (8) should be written as $\ln(\varepsilon + c_m)$ where ε is very small number. This is equivalent to assuming that all agents have a small endowment of manufacturing goods. As in Gollin et al. (2002), without any loss of generality, we avoid this complication.

(13) $c_{at}^{(1)} + I_{at}^{(1)} = y_{at}^{(1)}$,

(14) $h_{at+1}^{(1)} - (1-\delta)h_{at}^{(1)} = I_{at}^{(1)}$.

Combining (1) and (10) through (14), we get the following sequential resource constraints for the poor:

(15) $\bar{a} + p_t c_{mt}^{(1)} + h_{at+1}^{(1)} - (1-\delta)h_{at}^{(1)} = z h_{at}^{(1)\alpha}$ when $y_{at}^{(1)} \geq \bar{a}$;

(16) $c_{at}^{(1)} + h_{at+1}^{(1)} - (1-\delta)h_{at}^{(1)} = z h_{at}^{(1)\alpha}$ when $y_{at}^{(1)} < \bar{a}$.

The rich produce food and manufacturing goods because they can operate both technologies (1) and (2). Given the utility function (8), the rich just consume $\bar{a}$ units of food. They will not produce more food than $\bar{a}$ because having a greater production of food (above $\bar{a}$) would be wasteful. They would neither be able to consume that surplus food because of the preference structure (8), nor to trade it with the poor for manufacturing goods, because the poor do not produce manufacturing goods. The rich can, however, produce less food than $\bar{a}$, and buy the rest from the poor in exchange for manufacturing goods.

At any date *t*, the rich first allocate their human capital between the traditional and modern sectors. They produce $y_{at}^{(2)}$ units of food and $y_{mt}^{(2)}$ units of manufacturing goods, and consume $\bar{a}$ units of food and $c_{mt}^{(2)}$ units of manufacturing goods. They also invest $I_{mt}^{(2)}$ of their human capital in the modern sector, $I_{at}^{(2)}$, in the traditional sector, sell $x_{mt}^{(2)}$ units of manufacturing goods at the price p_t; and buy $x_{at}^{(2)}$ units of food from the poor[13]. The resource and market constraints facing the rich are as follows:

[13] Obviously, if $y_{at}^{(1)} < \bar{a}$, the poor would not be able to sell agricultural goods to the rich in exchange for manufacturing goods. In such case, both $x_{mt}^{(2)}$ and $x_{at}^{(2)}$ would be equal to 0.

(17) $h_{at}^{(2)} + h_{mt}^{(2)} = h_t^{(2)}$,

(18) $\bar{a} + I_{at}^{(2)} - x_{at}^{(2)} = y_{at}^{(2)}$,

(19) $h_{at+1}^{(2)} - (1-\delta)\, h_{at}^{(2)} = I_{at}^{(2)}$,

(20) $c_{mt}^{(2)} + I_{mt}^{(2)} + x_{mt}^{(2)} = y_{mt}^{(2)}$,

(21) $h_{mt+1}^{(2)} - (1-\delta)\, h_{mt}^{(2)} = I_{mt}^{(2)}$,

(22) $p_t x_{mt}^{(2)} = x_{at}^{(2)}$.

Using (1), (2), (7), and (17) through (22), one obtains the following sequential resource constraint for the rich:

(23) $\bar{a} + p_t c_{mt}^{(2)} + p_t[h_{mt+1}^{(2)} - (1-\delta)h_{mt}^{(2)}] + I_{at}^{(2)} = Ap_t h_{mt}^{(2)} + z h_{at}^{(2)\alpha}$.

2.2 Can the poor become entrepreneurs?

Since FDI is the engine of growth in the modern sector, an immediate issue arises whether the poor can someday become entrepreneurs. In order to do so, the poor need to reach the minimum human capital, $h_{\min}$. How can they achieve this? Because of credit market imperfections, it is assumed that they cannot access the credit market to finance schooling (see Appendix 1 for a justification of this issue). They, therefore, have the option to consume just the subsistence level, ω, for several generations, and accumulate an amount of human capital sufficient for them to become entrepreneurs. The following proposition examines the feasibility of such a plan.

Proposition 1: Let the poor set a consumption plan $c_{at} = a$. *For sufficiently large values of* $h_0^{(1)}$ *and/or z, or for a sufficiently small* h_{min}*, such a consumption plan will make the poor entrepreneurs.*

Proof: For $c_{at} = a$, the time path of the human capital is given by the following difference equation:

(24) $$h_{at+1}^{(1)} = zh_{at}^{(1)^{\alpha}} + (1-\delta)h_{at}^{(1)} - \omega .$$

Figure 1 plots the phase diagram for (24). There are three steady-states at 0, $\bar{h}$, and $\tilde{h}$. If $h_0^{(1)} > \bar{h}$ and $h_{\min} < \tilde{h}$, the poor can become entrepreneurs[14]. Q.E.D.

To summarize, in order to become entrepreneurs, the poor need to have an initial endowment of human capital, $h_0^{(1)}$, which is above the threshold level, $\bar{h}$. Furthermore, the TFP in agriculture (z) must be large enough for attaining the minimum human capital, $h_{\min}$. Once the poor become entrepreneurs, inequality declines to 0. However, the short-run correlation between FDI and inequality depends on the relative distance between $h_0^{(1)}$ and $h_{\min}$. If the poor make a transition to entrepreneurship starting from a low level of human capital, then inequality may decline in the short-run because the poor may grow faster than the rich[15]. If, on the other hand, the poor transit from a relatively high level of human capital, then inequality may rise temporarily, as the rich may grow faster than the poor. The short-run correlation between FDI and inequality could therefore be positive or negative depending on the parameter configurations.

[14] Note that the 0 steady-state, to which, according to Figure 1, the economy would tend if $h_0^{(1)} < \bar{h}$, is not feasible because at this point, the food consumption of the poor would go to 0, violating Equation (8).

[15] This is because, due to the assumption of diminishing returns, the marginal product of capital is very high at low values of the capital stock.

Furthermore, one would expect a positive correlation between the FDI rate and growth because the economy would continue to grow as FDI flows into the modern sector.[16] Since labor moves from agriculture to industry, the share of agriculture to GDP would decline as growth occurs.

2.3 FDI, growth, and poverty: an enclave economy

The poor

We now consider a scenario where the initial distribution of human capital, and the state of agricultural productivity are not conducive for the poor to become entrepreneurs (i.e. $\tilde{h} < h_{\min}$). What would be, in this case, the optimal investment in human capital of the poor? We have the following proposition:

Proposition 2: If the initial endowment of human capital of the poor is such that $zh_0^{(1)\alpha} < \bar{a}$*, and* $\bar{a}$ *is sufficiently large, the poor consume below the saturation level, and just undertake a breakeven level of investment in human capital in the traditional sector.*

Proof: Given the utility function (8), the first-order condition that the poor face if $\omega \leq c_{at}^{(1)} < \bar{a}$ is given by:

$$(25) \qquad 1 = \beta[\alpha z h_{a\ t+1}^{(1)\ \alpha-1} + 1 - \delta].$$

In this case, the poor instantaneously reach a constant human capital given by: $[\alpha\beta z/(1-\beta(1-\delta)]^{1/(1-\alpha)}$ (which we will call $h_a^{(1)*}$ hereafter). The total income of the poor is, therefore, $zh_a^{(1)*\alpha}$. The poor thus produce $zh_a^{(1)*\alpha}$ units of food and undertake the replacement

[16] This can be easily checked from (6) and (7) by noting that the FDI rate and the growth rate of manufacturing output covary positively.

investment of $\delta h_a^{(1)*}$. If $\bar{a}$ is sufficiently large in the sense that $\bar{a} > z h_a^{(1)*\alpha} - \delta h_a^{(1)*}$, which is equivalent to:

$$(26) \qquad \bar{a} > z^{\frac{1}{1-\alpha}} \left[\frac{\alpha\beta}{1-\beta(1-\delta)} \right]^{\frac{\alpha}{1-\alpha}} \left[1 - \frac{\alpha\beta\delta\, z}{1-\beta(1-\delta)} \right],$$

then the poor consume below the saturation level in the steady state. Q.E.D.

For certain configurations of the parameters, it is therefore possible that the poor end up in a poverty trap where they consume food below the saturation level, $\bar{a}$, and have no access to the modern technology. One should also note that the right hand side of (26) is monotonically increasing in the agricultural TFP term, z. Economies with a high agricultural TFP are, therefore, unlikely to be in this poverty trap. The poverty trap is due to a combination of low agricultural TFP, and low initial endowment of human capital for the poor.[17]

The rich

Since the poor produce food below the saturation level, there is no possibility of trade between the rich and the poor, which means that $x_{mt}^{(2)} = 0$. The rich, therefore, invest in the traditional sector just enough to produce $\bar{a}$ units of food.[18] The rich will therefore allocate a constant amount $\tilde{h}_a^{(2)}$ of human capital to agriculture, which satisfies the following:

[17] One could ask why the rich do not employ the poor. Note that the poor need to have the basic skill h_{min} to produce in manufacturing. Unless they undertake investment in education to acquire this basic skill, they are not employable in manufacturing. Proposition 1 has examined the conditions under which the poor can acquire this basic skill.

[18] In other words, the rich will send their children to the village primary school only to allow them to acquire enough knowledge for being self-sufficient in the production of food in their backyards. Once that basic skill of

(27) $\quad z\tilde{h}_a^{(2)\alpha} = \bar{a} + \delta \overset{\sim(2)}{h_a}$.

The resource constraints facing the rich are thus given by:

(28) $\quad \overset{\sim(2)}{h_a} + h_{mt}^{(2)} = h_t^{(2)}$,

(29) $\quad Ah_{mt}^{(2)} - c_{mt}^{(2)} = I_{mt}^{(2)}$.

Combining (28) and (29), one obtains

(30) $\quad c_{mt}^{(2)} + h_{t+1}^{(2)} - (1-\delta)h_t^{(2)} = Ah_t^{(2)} - \bar{M}$,

where $\bar{M} = (A+\delta)\overset{\sim(2)}{h_a}$.

The rich thus maximize (9) subject to (30).

Given this structure, we have the following proposition:

Proposition 3: For a sufficiently large $h_o^{(2)}$*, the human capital of the rich grows and reaches an asymptotic rate,* $\beta[1+A-\delta]$.

Proof: The intertemporal first-order condition of the rich is given by:

(31) $\quad \dfrac{c_{mt+1}^{(2)}}{c_{mt}^{(2)}} = \beta B$,

where $B = A + 1 - \delta$.

Plugging (30) into (31), we obtain the following second-order difference equation in $h_t^{(2)}$:

(32) $\quad h_{t+2}^{(2)} - B(1+\beta)h_{t+1}^{(2)} + \beta B^2 h_t^{(2)} = \bar{M}(\beta B - 1)$

The general solution to this difference equation is given by:

(33) $\quad h_t^{(2)} = A_1(B)^t + A_2(\beta B)^t + \dfrac{\bar{M}}{B-1}$,

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producing food is reached, the rich take the children out of the village primary school and send them to big cities for advanced schooling.

where A_1 and A_2 are determined by the initial and terminal conditions.[19] The initial condition is characterized by $h_0^{(2)}$. The terminal condition is given by the transversality condition (TVC) as follows:

(34) $$\lim_{T\to\infty} \beta^T \frac{h_{T+1}^{(2)}}{c_{mT}^{(2)}} = 0 .$$

We next show that the TVC requires that A_1 in (33) must equal zero. We prove this by contradiction. If not, then $h_t^{(2)}$ grows at the rate B because $B>\beta B$. On the other hand, $c_{mt}^{(2)}$ grows at the rate βB as in (31). Thus the right hand side of (34) inside the limit operator reduces to:

(35) $$\beta^T \frac{h_0^{(2)} B^{T+1}}{c_{m0}^{(2)} (\beta B)^T} = \frac{h_0^{(2)}}{c_{m0}^{(2)}} B ,$$

which does not converge to zero as T approaches infinity. Consequently, the TVC is violated if $h_t^{(2)}$ grows at the rate B.

We have thus established that the optimal solution for $h_t^{(2)}$ must be:

(36) $$h_t^{(2)} = A_2 (\beta B)^t + \frac{\bar{M}}{B - 1},$$

where A_2 is characterized by the initial stock of human capital as follows:

(37) $$A_2 = h_0^{(2)} - \frac{\bar{M}}{B - 1}$$

As long as $h_0^{(2)} > \frac{\bar{M}}{B - 1}$, human capital in the modern sector will grow and eventually reach an asymptotic rate βB. Q.E.D.

[19] See Appendix 2 for a derivation of Equation (33).

Agricultural production

The total agricultural production (y_a) in the economy is thus a constant both in the short and long-run. It is given by:

$$(38) \quad y_a = \phi z \left[\frac{\alpha \beta z}{1 - \beta(1-\delta)} \right]^{\frac{\alpha}{1-\alpha}} + (1-\phi)\bar{a}.$$

FDI-inequality relationship

In this scenario, the traditional sector stagnates, and the modern sector grows at a rate βB. This means that the traditional sector asymptotically disappears as (y_a/y_m) goes to zero.[20] The home country thus becomes fully industrialized and integrated with the world economy. Along the transition path, the inequality of human capital increases as the modern sector grows, suggesting a positive co-movement between FDI, which is the engine of growth in the modern sector, and inequality.

To formally see this, note that the Gini coefficient for the distribution of human capital (call it *gini*) at any given point in time *t* is given by:[21]

$$(39) \quad gini_t = \phi - \frac{\phi h_a^{(1)*}}{\phi h_a^{(1)*} + (1-\phi) h_t^{(2)}}.$$

Since only $h_t^{(2)}$ grows over time, *gini* increases over time, and, in the long-run, reaches an upper bound ϕ.

[20] This feature is similar to Gollin et al. (2002). y_m represents the total manufacturing production.

[21] See Appendix 3 for the derivation of the Gini coefficient.

Using (6), it is straightforward to verify that the FDI rate also increases as the rich augment human capital. In the long-run, while the modern sector grows at the balanced rate βB, the FDI rate reaches an upper-bound $\bar{\theta}$, given by:

$$(40) \qquad \bar{\theta} = \left[\frac{1-\nu}{r^*}\right]^{1/\nu} [\beta A - (1-\beta)(1-\delta)].$$

FDI-growth relationship

We next analyze the time path of the growth rate of GDP. Denote this growth rate as $1+\gamma_t$, given by:

$$(41) \qquad 1+\gamma_t = \frac{y_{at+1} + \rho(1-\phi)y_{mt+1}}{y_{at} + \rho(1-\phi)y_{mt}},$$

where ρ is the imputed price of manufacturing goods.[22] Next note that the agricultural production in the economy is constant and given by (38). Using (7) and (36), we can rewrite (41) as:

$$(42) \qquad 1+\gamma_t = \frac{y_a + (1-\phi)\rho A[A_2(\beta B)^{t+1} + \overline{M}/(B-1)]}{y_a + (1-\phi)\rho A[A_2(\beta B)^{t} + \overline{M}/(B-1)]},$$

which can also be expressed as:

$$(43) \qquad 1+\gamma_t = \frac{\bar{K} + (1-\phi)AA_2(\beta B)^{t+1}}{\bar{K} + (1-\phi)AA_2(\beta B)^{t}}, \text{ where } \bar{K} = y_a + (1-\phi)A\bar{M}/(B-1).$$

It is now straightforward to verify that $1+\gamma_t$ increases and approaches the upper bound βB. FDI and growth are thus positively related in the short-run.

[22] Since there is no trade in this scenario, the relative price has to be imputed. Note that ρ is the relative marginal cost of producing manufacturing goods evaluated at the steady-state level of agricultural production, y_a, given in (38). In this case, ρ is a constant, equal to $\alpha^{-1} z^{-1/\alpha} A(y_a)^{(1-\alpha)/\alpha}$.

2.4 FDI, inequality, and growth: Case of trade

We next consider a scenario in which the poor have enough initial human capital, and a sufficiently high agricultural TFP to produce more than the saturation level $\bar{a}$ (i.e. $zh_0^{(1)\alpha} > \bar{a}$), but still not enough to become entrepreneurs (i.e. $\tilde{h} < h_{min}$, as per Figure 1). This opens up the possibility of intersectoral trade between the rich and the poor. The first-order condition facing the poor is:

$$(44) \qquad \frac{1}{c_{mt}^{(1)}} = \frac{\beta p_t}{c_{mt+1}^{(1)} p_{t+1}} . \left[\alpha z h_{at+1}^{(1)\ \alpha-1} + 1 - \delta \right],$$

which together with their budget constraint (15), yields:

$$(45) \qquad \frac{1}{zh_{at}^{(1)\alpha} + (1-\delta)h_{at}^{(1)} - \bar{a} - h_{at+1}^{(1)}} = \frac{\beta}{zh_{at+1}^{(1)\ \alpha} + (1-\delta)h_{at+1}^{(1)} - \bar{a} - h_{at+2}^{(1)}} \left[\alpha z h_{at+1}^{(1)\ \alpha-1} + 1 - \delta \right].$$

(45) establishes that the time path of the human capital of the poor is independent of the terms of trade, p_t.[23] It is straightforward to verify that the steady-state capital stock of the poor, which solves (45), satisfies:

$$(46) \qquad h_a^{(1)*} = \left[\frac{\alpha \beta z}{1 - \beta(1-\delta)} \right]^{1/(1-\alpha)}.$$

Because of diminishing returns in agriculture, the poor cease to grow in the long run[24]. However, as evident from (45), there is a transitional dynamics of the capital stock of the

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[23] This model can also be viewed as a model of trade between poor and rich countries, in which case p_t may be interpreted as a real exchange rate.

[24] In order for trade between the poor and the rich to take place both in the short- and long-run, we assume here that $h_a^{(1)*} < h_{\min}$. In other words, the poor cannot become entrepreneurs just by trading with the rich. Also note that although the expression for the steady-state level of human capital reached by the poor is the same as that

poor. Unlike what was happening in the enclave economy, the poor grow in the short-run.[25] Yet, trade has no long-run effect on the human capital of the poor.

The rich, on the other hand, allocate capital between the agricultural and the modern sectors in a way that guarantees the equalization of the net marginal products. This yields:

$$(47) \qquad h_{at}^{(2)} = \left[\frac{\alpha z}{Ap_t}\right]^{1/(1-\alpha)}.$$

Characterization of the intersectoral terms of trade

We next show that in the present setting, the long-run terms of trade are constant. The market clearing condition for agricultural goods requires:

$$(48) \qquad x_a^{(1)}(p_t) = x_a^{(2)}(p_t).$$

Using (15) and (18), we can verify that in such an equilibrium, the following equation holds:

$$(49) \qquad \bar{a} - zh_{at}^{(2)\alpha} + I_{at}^{(2)} = zh_{at}^{(1)\alpha} - I_{at}^{(1)} - \bar{a}.$$

We now characterize the time path of the terms of trade when the poor have reached the steady-state capital stock expressed in (46). Using (45) through (49), one can write:

$$(50) \qquad \left[\frac{\alpha z}{Ap_{t+1}}\right]^{1/(1-\alpha)} = const + (1-\delta)\left[\frac{\alpha z}{Ap_t}\right]^{1/(1-\alpha)} + z\left[\frac{\alpha z}{Ap_t}\right]^{\alpha/(1-\alpha)},$$

where the constant term (*const*) is given by: $zh_a^{(1)*\alpha} - \delta h_a^{(1)*} - 2\bar{a}$. Equation (50) admits a fixed point solution, $p*$, for the terms of trade.[26] In other words, in the steady-state, the terms of trade are constant.

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obtained in the scenario of the enclave economy, the steady-state in the current scenario is higher as the level of agricultural TFP (z) is higher.

[25] Appendix 4 proves the local stability of the steady-state and the properties of the transitional dynamics of the capital stock of the poor. In the enclave economy, since the poor instantaneously reached the steady-state, there was no such short-run dynamics of their capital stock.

FDI-inequality relationship

In the short-run, i.e. in the transition towards their steady-state, one would expect the poor to grow faster than the rich if they start from a very low level of capital stock.[27] In such case, inequality would narrow in the short-run, until the poor reach the steady-state. If on the other hand, the poor started from a somehow higher value of the capital stock, one would expect them to grow slower than the rich: in such case, the inequality would widen in the short-run. The exact nature of the short-run relationship between FDI and inequality depends therefore on whether the poor grow faster or slower than the rich, which in turn depends on their initial human capital.

Once the poor have attained the steady-state and the terms of trade have stabilized, the rich continue to grow. Both human capital and income inequalities will therefore widen between the rich and the poor. Using the same line of reasoning as in Proposition 3, one can establish that the human capital of the rich follows the time path:

(51) $$h_t^{(2)} = A_2(\beta B)^t + \frac{\bar{N}}{B - 1},$$

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[26] To see this, let us define $X_t = \left[\frac{\alpha z}{A p_t}\right]^{1/(1-\alpha)}$. Equation (50) can thus be rewritten as: $X_{t+1} = const + (1-\delta)X_t + zX_t^{\alpha}$, which admits a fixed point solution because 0<α<1. Since X_t is monotonically decreasing in p_t, there exists a steady-state value of the terms of trade (p*), which solves the fixed point for (50). Since the agricultural sector ceases to grow and the manufacturing sector keeps growing for ever, the question arises why p_t does not go to zero. As p_t falls, the rich disinvest in manufacturing and increase their investment in agriculture (see Equation 47). This arrests the decline in the price of manufacturing goods. Note that the price process in (50) represents the equilibrium where these tensions are taken into account.

[27] As discussed in footnote 15, this is because the marginal product of capital is very high at low values of the capital stock (due to the assumption of diminishing returns).

where $\bar{N}$ is a constant term, function of the parameters.

The FDI rate and the inequality of human capital thus co-vary positively during this phase of growth in which the agricultural sector has reached the steady-state and the manufacturing sector continues to grow along the path given by (51). In the long-run, the traditional sector asymptotically disappears, the economy grows at the balanced rate βB, the FDI rate reaches the upper bound $\bar{\theta}$ given by (40), and the Gini coefficient reaches the upper bound ϕ.

FDI-growth relationship

In the short-run, both the poor and the rich grow: the relationship between FDI and growth is therefore obviously positive. Once the terms of trade have reached the steady-state level, p^*, the growth rate of GDP is given by:

$$(52) \qquad 1+\gamma_t = \frac{\phi z h_a^{(1)*\alpha} + (1-\phi) z h_a^{(2)*\alpha} + (1-\phi) p^* y_{mt+1}}{\phi z h_a^{(1)*\alpha} + (1-\phi) z h_a^{(2)*\alpha} + (1-\phi) p^* y_{mt}},$$

where $h_a^{(2)*}$ is given by (47) evaluated at p^*. It immediately follows that the growth rate of GDP in (52) increases and approaches the upper bound βB. Growth and FDI remain therefore positively correlated when the human capital of the poor and the terms of trade have reached the steady-state.

Trade and growth

Not surprisingly, trade between the rich and the poor has a positive welfare effect on both groups. Contrary to the autarkic situation, the poor can now buy manufacturing goods from the rich with their surplus food, and grow in the short-run, while the rich can optimally allocate their capital between agriculture and industry. However, trade has no long-run effect on the capital stock of the poor and the balanced growth rate of the economy. As long as the poor cannot become entrepreneurs, trade will not have any long-run effect on their capital stock.

2.5 Testable implications

In light of these various scenarios, one may envisage different types of FDI-inequality relationships depending on the initial distribution of human capital and on the level of agricultural TFP. In a scenario where the poor can someday become entrepreneurs, FDI and inequality may covary positively or negatively in the short-run, until the poor catch up with the rich and inequality disappears. In an enclave economy scenario, there is always a positive association between FDI and inequality. In an economy with trade between the rich and the poor, FDI and inequality may be positively or negatively correlated in the phase in which both the rich and the poor grow, but always covary positively from the stage in which the poor cease to grow onwards. Because the correlation between FDI and inequality largely depends on the degree of the initial inequality of human capital and on the level of agricultural TFP, and because these factors differ significantly from one country to another, the exact nature of the FDI-inequality relationship remains therefore an empirical question to which we turn next[28].

Further predictions of the model are that in all three of the above described scenarios, in the short-run, FDI and growth are positively correlated and FDI and the share of

[28] The issue arises whether our theoretical model explains within-country or cross-country inequality. In fact, the model could explain both. One may think of the model as a two-country scenario where two countries (say rich and poor) differ in terms of their initial endowment of human capital and level of agricultural TFP. These two countries may or may not trade with each other depending on these two factors. As FDI flows into the richer (human capital intensive) developing countries, the cross-country inequality may widen. A similar argument could apply for rich and poor regions within a country.

agriculture to GDP are negatively correlated. We propose to test these additional predictions of the model as well.

3. THE DATA

We use a panel of 119 developing countries for the period 1970 to 1999 to explore the relationship between: (i) FDI and inequality, (ii) FDI and growth, (iii) FDI and the share of agriculture.

Except for the human capital and inequality variables, our data is taken from the Word Development Indicators (2000). Our FDI variable is defined as net inflows of FDI as a percentage of GDP. Our human capital variables are obtained from Barro and Lee's (2001) dataset. Our measures of human capital inequality are taken from Castelló and Doménech (2002), and our measure of income inequality, from Deininger and Squire (1996).

We use two measures of human capital inequality. Both are human capital Gini coefficients, but the first one refers to the population aged 15 and over, whereas the second one refers to the population aged 25 and over. The former Gini coefficient, *Gini15,* is calculated as in Castelló and Doménech (2002, p. C189):

$$(53) \qquad Gini15 = \frac{1}{2\bar{H}}\sum_{i=0}^{3}\sum_{i=0}^{3}\left|\hat{x}_i - \hat{x}_j\right| n_i n_j,$$

where $\bar{H}$ represents the average schooling years of the population aged 15 and over; *i* and *j* stand for different levels of education; n_i and n_j are the shares of population with a given level of education; and $\hat{x}_i$ and $\hat{x}_j$ are the cumulative average schooling years of each educational level. Four levels of education are considered: no schooling, primary, secondary, and higher education. The Gini coefficient relative to the population aged 25 and over, *Gini 25*, is calculated in a similar way. Our measure of income inequality, *Gininc*, is the Gini coefficient relative to income, taken from Deininger and Squire (1996)'s "high-quality" data set[29].

We average our data over non-overlapping five-year periods, so that data permitting, there are six observations per country (1970-75, 1976-80, 1981-85, 1986-90, 1991-95, 1996-99). We take five-year averages of all our variables because the human capital and human capital inequality variables are only available at such intervals. The dataset that we use in estimation is, therefore, an unbalanced panel made up of 119 countries over 6 time periods[30]. A full list of the 119 countries can be found in Appendix 5. Descriptive statistics are presented in Table 1. We can see that all inequality measures are characterized by a low within groups variation and a high between groups variation. For instance the total standard deviation of *Gini15* is 0.22, the between standard deviation is 0.21, and the within standard deviation, only 0.06. This suggests that inequality does not vary too much within countries, but varies significantly across countries. The share of the value added coming from agriculture to GDP also varies significantly between countries, but not too much within countries.

It is also worth noting that not all variables are available for all countries. For instance, *Gini15* is only available for 72 countries. Consequently, the regressions for this

[29] Countries are excluded from the high-quality data set if their income information is derived from national accounts, rather than from direct surveys of incomes; if their surveys are of less than national coverage and/or are limited to the incomes of earning population; and if their data are derived from non-representative tax records. Data are also excluded if there is no clear reference to their primary source. Due to these exclusions, data on income inequality are only available for a relatively small number of observations. Following Deininger and Squire (1996), to reduce any inconsistencies due to the fact that the Gini coefficients for some countries are based on income, while those for others countries are based on expenditure, we have added 6.6 to the Gini coefficients based on expenditure instead of income (also see Forbes, 2000, who adopts this same adjustment).

[30] Note that the last time period only contains four years, namely 1996-99.

variable will only be based on these countries, whereas the regressions for growth and the share of agriculture to GDP will be based on 103-118 countries.

4. REGRESSION RESULTS

4.1 Inequality regressions

To explore the relationship between FDI and inequality, we estimate specifications of the following type:

(54) $Inequality_{it} = a_0 + a_1 * FDI_{it} + u_i + v_t + e_{it}$,

where i indexes countries, and t, the time period (measured in terms of five-year averages). *Inequality* is our proxy for human capital or income inequality. The error term in Equation (54) is made up of three components: u_i, which is a country-specific component; v_t, which is a time-specific component; and e_{it}, which is an idiosyncratic component. We control for v_t by including time dummies in all our specifications. We estimate Equation (54) using a fixed-effects specification, which allows us to control for unobserved country heterogeneity and the associated omitted variable bias. The results are reported in Table 2. Column 1 refers to the case in which *Gini15* is used as our measure of inequality. Column 2 and 3 refer to the cases in which inequality is measured respectively using the Gini coefficient relative to the human capital of the population aged 25 and over (*Gini25*), and the Gini coefficient relative to income (*Gininc*)[31]. We can see that the coefficient associated with FDI is positive and statistically significant in all our specifications. This suggests that once unobserved country-

[31] The size of the sample used to obtain the estimates in column 3 of Table 2 is much smaller than the sample used in the other columns of the Table. This is due to the fact that *Gininc* is available for fewer observations than *Gini15* and *Gini25*.

specific heterogeneity is taken into account, inequality and FDI are positively related[32]. In terms of elasticities evaluated at sample means, the estimates suggest that if net inflows of FDI as a percentage of GDP increase by 10%, then inequality increases respectively by 0.11%, 0.06%, and 0.28% for the three measures considered. Although not huge, these percentages are sizeable: they can be put into perspective by considering that, on average, over the entire sample period, inequality measured by *Gini15* and *Gini25* only declined by 4.43% and 4.26%, respectively, and inequality measured by *Gininc* only increased by 2.74%.

In column 4 of Table 2, we report the estimates of a regression of *Gini15* on FDI and other controls such as the ratio of M2 to GDP, which can be seen as a measure of financial development; the black market premium; a measure of trade openness[33]; and the rate of growth of population. From the results, it appears that openness and inequality are positively related. The coefficients on the other additional variables are poorly determined. The inclusion of these additional variables in our inequality regressions does not change the sign and significance of the coefficient on FDI. Similar results were obtained by estimating the same extended regressions for *Gini25* and *Gininc*.[34]

In column 5 of Table 2, we estimate a specification identical to that in column 4, using a GMM first-difference estimator. This technique takes unobserved country heterogeneity into account by estimating the equation in first-differences, and controls for

[32] The coefficients on the country dummies are not reported for brevity. They were, however, strongly significant. This is not surprising given that inequality varies significantly across countries, but not too much within countries (see Castelló and Doménech, 2002, for a discussion).

[33] The black market premium is calculated as follows: (black market exchange rate / official exchange rate) – 1. Openness is calculated as (imports+exports)/GDP.

[34] Similar results were also obtained when different additional control variables were included in the regression. These results are not reported for brevity but are available from the authors upon request. See Li et al. (1998) for an analysis of the determinants of income inequality.

possible endogeneity problems by using the model variables lagged two or more periods as instruments[35]. In order to evaluate whether the model is correctly specified, we use two criteria: the Sargan test (also known as *J* test) and the test for second order serial correlation of the residuals in the differenced equation (*m2*). If the model is correctly specified, the variables in the instrument set should be uncorrelated with the error term in Equation (54). The *J* test is the Sargan test for overidentifying restrictions, which, under the null of instrument validity, is asymptotically distributed as a chi-square with degrees of freedom equal to the number of instruments less the number of parameters. The *m2* test is asymptotically distributed as a standard normal under the null of no second-order serial correlation of the differenced residuals, and provides a further check on the specification of the model and on the legitimacy of variables dated *t*-2 as instruments in the differenced equation[36]. According to the results reported in column 5 of Table 2, neither of these tests indicates any problems with the specification of our model. Furthermore, even after controlling for the possible endogeneity of the regressors, FDI and inequality are still positively associated[37].

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[35] See Arellano and Bond (1991) and Blundell and Bond (1998) on the application of the GMM approach to panel data. The program DPD by Arellano and Bond (1998) has been used in estimation. Note that because of first-differencing and using lagged variables as instruments, a number of observations is lost when this method of estimation is used.

[36] If the undifferenced error terms are *i.i.d.*, then the differenced residuals should display first-order, but not second-order serial correlation. Note that neither the *J* test nor the *m2* test allow to discriminate between bad instruments and model specification.

[37] Similar results were obtained when *Gini25* and *Gininc* were used as proxies for inequality, and when other control variables were added to the regression. These results and the ones that follow were also robust to the elimination of an observation characterized by a very high value of FDI (49.8). This observation, which refers to Equatorial Guinea in the period 1996-99, can in fact be considered as an outlier. These additional results are not reported for brevity, but are available from the authors upon request.

4.2 Growth regressions

Our model also predicts a positive relationship between growth and FDI. We now test this prediction by estimating an equation of the following type:

(56) $Growth_{it} = a_0 + a_2*GDPC_{i(t-1)} + a_3*FDI_{it} + u_i + v_t + e_{it}$,

where $Growth_{it}$ represents the growth of real per capita GDP of country i at time t, and $GDPC_{i(t-1)}$ is the logarithm of lagged real GDP per capita. The results obtained by estimating Equation (56) using a fixed-effects specification are reported in column 1 of Table 3. We can see that, as predicted by the model, there is a strong positive association between FDI and growth.

Estimating Equation (56) using a fixed-effects specification, however, is likely to lead to biased estimates as growth and lagged real GDP per capita are simultaneously determined, and more specifically all right-hand side variables might be endogenous. We therefore re-estimate Equation (56) using a system-GMM estimator. This technique combines in a system the relevant regression expressed in first-differences and in levels. We use FDI and GDP per capita variables lagged two and three times as instruments in the differenced equation, and first-differences of the same variables lagged once as instruments in the levels equation. Arellano and Bover (1995) and Blundell and Bond (1998) have shown that where there is persistence in the data such that the lagged levels of a variable are not highly correlated with the first difference, also estimating the levels equation with a lagged difference term as an instrument offers significant gains, countering the bias due to weak instruments. Because growth equations are particularly likely to suffer from the latter bias, we use the system-GMM estimator rather than the simple first-difference estimator.[38]

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[38] See Bond et al. (2001) for a discussion on why the system-GMM estimator is particularly appropriate to estimating growth equations.

The estimates of Equation (56) undertaken using the system-GMM estimator are reported in column 2 of Table 3. We can see that FDI remains positively associated with growth. The Sargan and *m2* tests do not indicate any problems with the specification of the model or the choice of the instruments.

As a robustness check, in column 3 of Table 3, we present the estimates of an extended growth equation, estimated once again using the system-GMM estimator. The additional variables which we include are the average years of secondary education in the population aged 25 and over, the ratio of M2 to GDP, the rate of growth of population, and the gross domestic investment ratio. We instrument all these additional variables using their levels lagged two and three times in the first-differenced equation, and their first-differences lagged once in the level equation. The results suggest once again that FDI and growth are positively related. Focusing on the additional explanatory variables, there is a negative and significant association between the ratio of M2 to GDP and growth, as well as between the rate of population growth and GDP growth, and a positive and significant correlation between the gross domestic investment ratio and growth. The Sargan statistic does not indicate any problems with the specification of the model and the choice of the instruments[39].

4.3 Share of agriculture to GDP regressions

The final prediction of our model is that FDI and the share of agriculture to GDP should be negatively related. In column 1 of Table 4, we therefore present the fixed-effects estimates of the following regression:

(57) $Agric_{it} = a_0 + a_1 * FDI_{it} + u_i + v_t + e_{it},$

[39] Note that, in this specification, the *m2* statistic is not reported because the estimation is only based on two periods, due to missing values characterising the additional regressors. Similar results as in column 3 of Table 3 were obtained when different additional control variables were included in the regression.

where *Agric* represents the share of the value added coming from agriculture to GDP.

We can see that the coefficient associated with the FDI variable is negative and precisely determined. In column 2, we add the rate of population growth, and a measure of openness as additional control variables to our regression, and estimate the extended model using a fixed-effects approach. The coefficient associated with the former variable is statistically insignificant, while the coefficient on the openness variable is precisely determined and negative. The coefficient on the FDI remains highly significant and negative, supporting once again the last prediction of our model[40]. Similar results were obtained in column 3, where we used a GMM first-difference estimator to take into account the possible endogeneity of the regressors. In the latter specification, the *m2* test seems to indicate some problems with the instrument selection and/or the general specification of the model. However, since the Sargan statistic is satisfactory, we do not think this to be a serious problem.

5. CONCLUSION

In this paper, we investigated how the infusion of foreign capital impacts human capital and income inequality. We developed a growth model of a dual economy in which the traditional (agricultural) sector uses a diminishing returns technology, while FDI is the engine of growth in the modern (industrial) sector. The main predictions of our model can be summarised as follows: in the most plausible scenarios FDI and inequality are positively correlated; FDI fosters growth; and FDI and the share of agriculture to GDP are negatively related. We tested these predictions using a panel of 119 developing countries over the period 1970-99. Our regressions generally provided support to our model, and suggested that FDI-induced growth promotes economic inequality in developing countries.

[40] Similar results were also obtained when different additional control variables were included in the regression.

FDI-borne technologies are therefore not necessarily welfare improving, particularly in environments where the poor are unable to access the modern technology. The problem is essentially due to imperfect credit markets, which fail to finance the cost of schooling for the poor. Public policies aimed at tackling these circumstances could be of use. For instance, educational subsidies could help the poor to reach the minimum amount of capital necessary for them to become entrepreneurs. In the long-run, such policies could allow the poor to catch-up with the rich. At this stage, instead of widening the gap between the rich and the poor, FDI-borne technologies could become welfare improving. A full understanding of the impact of FDI on welfare needs however careful modelling and is on the agenda for future research.

Appendix

1. A simple model of imperfect credit markets

We outline here a simple model of imperfect credit markets, which deter the poor from obtaining finance. The model draws on Galore and Zeira (1993).[41] International creditors are unable to distinguish between bad and good borrowers, and therefore, incur a fixed monitoring cost M. Let r_b denote the borrowing rate for the poor who borrow b, and r^* denote the world interest rate. The zero profit condition of the creditors implies:

(A.1) $r_b b = r^* b + M$.

If the borrower runs away with the loan, the cost of evasion is κM (where κ>1), which is proportional to the monitoring cost. Banks set the borrowing level and the borrowing rate in such a way that this evasion is not incentive compatible, which yields:

(A.2) $b(1+r_b) = \kappa M$.

Using (A.1) and (A.2) one can easily determine the borrowing rate and the optimal loan size size as follows:

(A.3) $r_b = \dfrac{(1+\kappa r^*)}{\kappa - 1} > r^*$,

(A.4) $b^* = \dfrac{(\kappa - 1)M}{1+r^*}$.

In other words, the borrowing rate exceeds the world interest rate, r^*. As κ approaches infinity, the borrowing rate approaches r^* and the loan size approaches infinity.

To become an entrepreneur, one needs the basic skill h_{min}. Let the schooling cost necessary to attain this basic skill be $\lambda.h_{min}$, where λ>1. If $b^* < \lambda.h_{min}$, borrowers do not obtain

[41] A similar model is also used by Chakrabarty and Chaudhuri (2003).

financing. We assume that our model is characterized by such a scenario of imperfect credit markets.

2. Derivation of Equation (33)

The solution of Equation (32) consists of two parts: the solution for the non-homogenous part (particular integral); and the solution for the homogenous part (complementary solution).

We initially conjecture a solution:

(A.5) $h_t^{(2)} = Q$ for all t .

We then plug (A.5) into (32) and solve for Q to obtain

(A.6) $$Q = \frac{\bar{M}}{B - 1},$$

which solves the particular integral part.

The homogenous part of (32) is given by:

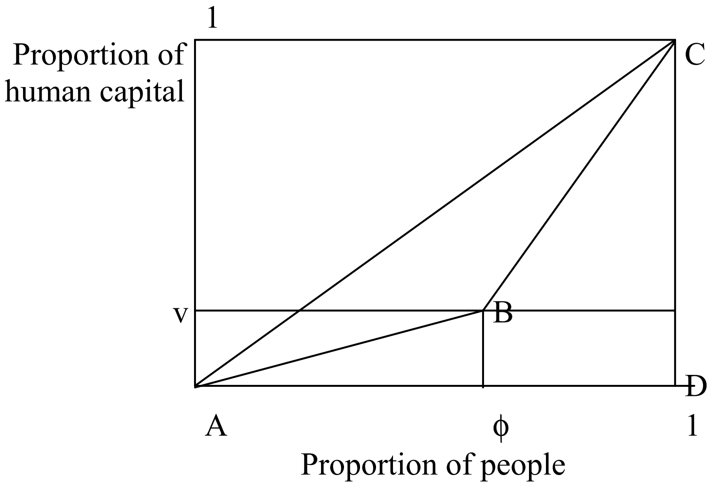
(A.7) $$h_{t+2}^{(2)} - B(1+\beta)h_{t+1}^{(2)} + \beta B^2 h_t^{(2)} = 0 .$$

The two characteristic roots of (A.7) are given by:

(A.8) $$\begin{aligned}\lambda_1, \lambda_2 &= \frac{B(1+\beta) \pm \sqrt{B^2\{(1+\beta)^2 - 4\beta\}}}{2} \\ &= B, \beta B\end{aligned}.$$

The general solution, which is the sum of the solutions for the non-homogenous and homogenous parts, is thus given by (33). Q.E.D.

3. Derivation of the Gini coefficient



In the diagram above, the Gini coefficient ($gini_t$), also known as the Lorenz ratio, is given by the area ABC/ACD, which is equivalent to:

$$\text{(A.9)} \quad gini_t = = \phi - v = \phi - \frac{\phi h_a^{(1)*}}{\phi h_a^{(1)*} + (1-\phi) h_t^{(2)}},$$

where ϕ is the proportion of poor people in the economy, $h_t^{(2)}$ is the human capital of the rich defined in (28), and $h_a^{(1)*}$ is the human capital of the poor defined in the Proof of Proposition 2.

4. Transitional dynamics of the poor

In this Appendix, we establish that in the model with trade, the poor, starting from their initial capital stock, converge to a unique steady-state. The value function for the poor is given by[42]:

$$\text{(A.10)} \quad V(h_t^{(1)}, p_t) = \max_{h_{t+1}^{1}} \left[\bar{a} + U\left(\frac{z h_t^{(1)\alpha} + (1-\delta) h_t^{(1)} - \bar{a} - h_{t+1}^{(1)}}{p_t} \right) + \beta V(h_{t+1}^{(1)}, p_{t+1}) \right],$$

[42] As the poor only produce agricultural goods, $h^{(1)}$ is always equal to $h_a^{(1)}$. For simplicity, we will omit the subscript "*a*".

where $U(c_{mt}^{(1)}) = \ln c_{mt}^{(1)}$.

The first-order condition is:

$$\text{(A.11)}\quad \frac{U'(c_{mt}^{(1)})}{p_t} = \beta V_1(h_{t+1}^{(1)}, p_{t+1}),$$

where V_1 indicates the first derivative of the value function with respect to $h_{t+1}^{(1)}$.

Since the utility and production functions are well behaved, it may be shown that the value function is strictly concave in $h_t^{(1)}$ and twice differentiable (see Stokey et al. 1989). Denoting with V_{11}, the second derivative of the value function with respect to $h_{t+1}^{(1)}$, it is now straightforward to verify that

$$\text{(A.12)}\quad \frac{\partial h_{t+1}^{(1)}}{\partial h_t^{(1)}} = \frac{U''(c_{mt}^{(1)})[\alpha z\, h_t^{(1)\alpha-1} + 1 - \delta]}{U''(c_{mt}^{(1)}) + \beta V_{11}(h_{t+1}^{(1)}, p_{t+1})} > 0$$

The initial endowment of the poor, $h_0^{(1)}$, and their investment policy, $h_{t+1}^{(1)} = \phi(h_t^{(1)})$, which solves (A.11), characterize the time path of their capital stock. In the steady-state, the capital stock $h^{(1)}$ is time invariant, meaning that $h^{(1)} = \phi(h^{(1)})$. Since $\phi(h^{(1)})$ does not depend on the terms of trade, p_t, the steady-state is independent of the terms of trade. From (45), note that the steady-state is $h^{(1)} = h^{(1)*}$, where $h^{(1)*} = [\alpha\beta z/\{1-\beta(1-\delta)\}]^{1/(1-\alpha)}$. Following the same line of reasoning as in Wright (2002), it is straightforward to verify that the strict concavity of the value function ensures that $\frac{\partial h_{t+1}^{(1)}}{\partial h_t^{(1)}} < 1$ at the steady-state level. This proves that for any $h_0^{(1)}$, $h_t^{(1)}$ converges monotonically to $h^{(1)*}$.

5. List of countries used in Sections 3 and 4

1. Albania
2. Algeria
3. Angola
4. Argentina
5. Armenia
6. Azerbaijan
7. Bangladesh
8. Barbados
9. Belarus
10. Belize
11. Benin
12. Bolivia
13. Botswana
14. Brazil
15. Bulgaria
16. Burkina Faso
17. Burundi
18. Cambodia
19. Cameroon
20. Cape Verde
21. Central African Republic
22. Chad
23. Chile
24. China
25. Colombia
26. Comoros
27. Congo, Rep.
28. Costa Rica
29. Cote d'Ivoire
30. Croatia
31. Czech Republic
32. Dominica
33. Dominican Republic
34. Ecuador
35. Egypt, Arab Rep.
36. El Salvador
37. Equatorial Guinea
38. Estonia
39. Ethiopia
40. Fiji
41. Gabon
42. Gambia, The
43. Georgia
44. Ghana
45. Grenada
46. Guatemala
47. Guinea
48. Guinea-Bissau
49. Guyana
50. Haiti
51. Honduras
52. Hungary
53. India
54. Indonesia
55. Iran, Islamic Rep.
56. Jamaica
57. Jordan
58. Kazakhstan
59. Kenya
60. Korea, Rep.
61. Kyrgyz Republic
62. Lao PDR
63. Latvia
64. Lesotho
65. Lithuania
66. Macedonia, FYR
67. Madagascar
68. Malawi
69. Malaysia
70. Maldives
71. Mali
72. Mauritania
73. Mauritius
74. Mexico
75. Moldova
76. Mongolia
77. Morocco
78. Mozambique
79. Nepal
80. Nicaragua
81. Niger
82. Nigeria
83. Pakistan
84. Panama
85. Papua New Guinea
86. Paraguay
87. Peru
88. Philippines
89. Poland
90. Romania
91. Russian Federation
92. Rwanda
93. Samoa
94. Senegal
95. Sierra Leone
96. Slovak Republic
97. Solomon Islands
98. South Africa
99. Sri Lanka
100. St. Kitts and Nevis
101. St. Lucia
102. St. Vincent and the Grenadines
103. Swaziland
104. Syrian Arab Republic
105. Tanzania
106. Thailand
107. Togo
108. Trinidad and Tobago
109. Tunisia
110. Turkey
111. Turkmenistan
112. Uganda
113. Ukraine
114. Uruguay
115. Vanuatu
116. Venezuela
117. Yemen, Rep.
118. Zambia
119. Zimbabwe

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Table 1: Descriptive statistics

Variable		Mean	Std. Dev.	Min	Max	Observations	
FDI	*overall*	*1.777242*	*3.556993*	*-2.874619*	*49.82296*	N =	600
	between		2.122877	.0441221	13.26203	n =	119
	within		2.866795	-11.09387	38.78267		
Gini15	overall	.4872761	.2138192	.105	.974	N =	402
	between		.2081789	.1065	.9031667	n =	72
	within		.0650238	.3277761	.6851095		
Gini25	overall	.5391869	.2258534	.107	.997	N =	396
	between		.2191747	.1185	.932	n =	69
	within		.0656532	.3475202	.7570202		
Gininc	overall	44.87217	9.880209	20.69	68.6	N =	172
	between		10.75345	21.498	68.6	n =	80
	within		2.634154	37.4055	53.15016		
Growth							
	overall	1.480221	3.798207	-11.23259	36.27652	N =	551
	between		2.191979	-2.564184	12.35092	n =	103
	within		3.261347	-12.69516	25.40582		
Agric	overall	24.82593	14.23225	2.042201	68.40836	N =	568
	between		13.70805	2.925294	58.63712	n =	118
	within		4.609332	4.814221	43.27827		

Notes: *FDI* is defined as net inflows of FDI as a percentage of GDP. *Gini15* and *Gini25* measure the human capital inequality in the population aged 15 and over, and 25 and over, respectively. *Gininc* measures income inequality. *Growth* represents the growth rate of real GDP per capita. *Agric* represents the share of the value added coming from agriculture to GDP. "*N*" stands for the number of observations, and "*n*", for the number of countries.

Table 2: FDI and inequality

Dep. Var.: *Inequality* (measured as indicated in each column)	*(1)* *Gini15* *Fixed-effects*	*(2)* *Gini25* *Fixed-effects*	*(3)* *Gininc* *Fixed-effects*	*(4)* *Gini15* *Fixed-effects*	*(5)* *Gini15* *GMM first-diff.*
FDI_{it}	0.004	0.003	1.123	0.003	0.005
	(2.59)	(1.89)	(2.99)	(2.27)	(2.37)
$(M2/GDP)_{it}$				0.000	0.000
				(0.06)	(0.36)
$(Bmp)_{it}$				0.000	0.000
				(0.44)	(1.02)
$(Openness)_{it}$				0.001	0.001
				(3.97)	(1.81)
$(Pop.\ Growth)_{it}$				0.003	0.012
				(0.48)	(1.12)
Sargan (p-value)					0.431
m2					0.724
Observations	402	396	172	375	301
Countries	72	69	80	71	66

Notes: *Gini15* and *Gini25* represent the human capital inequality in the population aged 15 and over, and 25 and over, respectively. *Gininc* measures income inequality. *Bmp* stands for "Black Market Premium". Time dummies were included in all specifications. Absolute values of t-statistics are in parentheses. Standard errors and test statistics are asymptotically robust to heteroskedasticity. Instruments in column 5 are two to five lags of FDI_{it}, $(M2/GDP)_{it}$, $(Bmp)_{it}$, $(Openness)_{it}$, and $(Pop.\ Growth)_{it}$. Time dummies were always included in the instrument set. The Sargan statistic is a test of the overidentifying restrictions, distributed as chi-square under the null of instrument validity. *m2* is a test for second-order serial correlation in the first-differenced residuals, asymptotically distributed as N(0,1) under the null of no serial correlation.

Table 3: FDI and growth

Dep. Var.: *Growth rate of real GDP per capita*	*(1)* *Fixed-effects*	*(2)* *System-GMM*	*(3)* *System-GMM*
FDI_{it}	0.433	0.653	1.867
	(7.34)	(5.53)	(2.70)
$(GDP\ p.c)_{i(t-1)}$	-6.450	1.048	-2.991
	(9.00)	(1.32)	(1.31)
$Education_{it}$			0.989
			(0.55)
$(Pop.\ Growth)_{it}$			-2.954
			(2.33)
$(M2/GDP)_{it}$			-0.090
			(2.42)
$(Investment/GDP)_{it}$			23.750
			(1.80)
Sargan (p-value)		0.131	0.148
m2		0.236	
Observations	542	346	118
Countries	103	99	62

Notes: *GDP p.c.* stands for the logarithm of real GDP per capita. *Education* is measured as the average years of secondary education in the population aged 25 and over, and *Investment/GDP* is the gross domestic investment ratio. Instruments in column 2 are $(GDP\ p.c.)_{i(t-2)}$, $(GDP\ p.c.)_{i(t-3)}$, $(FDI)_{i(t-2)}$, $(FDI)_{i(t-3)}$ in the differenced equation, and $\Delta(GDP\ p.c.)_{i(t-1)}$ and $\Delta(FDI)_{i(t-1)}$ in the levels equation. Additional instruments in column 3 are two and three lags of $Education_{it}$, $(Population\ Growth)_{it}$, $(M2/GDP)_{it}$, and $(Investment/GDP)_{it}$ in the differenced equation, and one lag of the first-differences of these same variables in the level equation. Also see Notes to Table 2. In column 3, the *m2* statistic is not reported because the estimation is only based on two periods, due to missing values characterising the additional regressors.

Table 4: FDI and the share of agriculture to GDP

Dep. Var: *Agric*	*(1)* *Fixed-effects*	*(2)* *Fixed-effects*	*(3)* *GMM first-diff.*
FDI_{it}	-0.315	-0.259	-0.578
	(4.21)	(3.36)	(2.40)
$(Pop.\ Growth)_{it}$		0.156	0.875
		(0.36)	(0.50)
$(Openness)_{it}$		-0.060	-0.04
		(3.72)	(0.75)
Sargan (p-value)			0.479
m2			2.390
Observations	568	559	423
Countries	118	118	97

Notes: The dependent variable, *Agric,* represents the share of the value added coming from agriculture to GDP. Instruments in column 3 are two to five lags of FDI_{it}, $(Openness)_{it}$, and $(Pop.\ Growth)_{it}$. Also see Notes to Table 2.

Figure 1: Time path of human capital for the poor if they just consume the subsistence level