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Foreign Direct Investment, Inequality and Growth

by

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Abstract

This paper examines the interactions between Foreign Direct Investment (FDI), inequality, and growth, both from an empirical and a theoretical point of view. Using a panel of 119 developing countries, we observe that FDI promotes both inequality and growth, and tends to reduce the share of agriculture to GDP in the recipient country. We then 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. The main predictions of the model are consistent with the stylized facts observed in the data.

JEL Classification: O1, F43.

Keywords: Foreign direct investment, inequality, growth.

Outline

Non-technical summary

This paper examines the interactions between Foreign Direct Investment (FDI), inequality, and growth, both from an empirical and a theoretical point of view.

We first present some stylized facts relative to the interactions between FDI, inequality, growth, and the share of agriculture to GDP in the recipient country. These stylized facts are based on a panel of 119 developing countries over the period 1970 to 1999. We find that there is a positive association between FDI and educational and income inequality, as well as between FDI and growth, and a negative relationship between FDI and the share of agriculture to GDP in the recipient country. These findings suggest that, in developing countries, FDI induced growth exacerbates economic inequality

The paper then develops a growth model aimed at explaining these stylized facts. The model is based on 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 (entrepreneurs) with a high initial human capital. In this world, foreign capital benefits the rich who have enough human capital to operate modern manufacturing enterprises. It does not benefit the poor, unless they are able to accumulate sufficient human capital to operate the modern technologies by becoming entrepreneurs. The ability of the poor to become entrepreneurs depends on the productivity of agriculture and on their initial level of human capital.

In accordance with our stylized facts, the main predictions of our model can be summarized 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.

The upshot of our analysis is that FDI could exacerbate inequality, particularly in an environment where the poor are unable to access the modern FDI-based technology because of low initial human capital. The problem could be 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 to become entrepreneurs. In the long-run, such policies could allow the poor to catch-up with the rich.

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 emphasizes 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.

A growing literature is attempting to integrate these two disjoint branches. A number of studies have analyzed the effects of FDI on income and wage inequality, reaching mixed conclusions[3]. Focusing on income inequality in Less Developed Countries (LDCs), Tsai (1995) finds that the relationship between FDI and inequality tends to vary significantly across geographical areas, and is generally positive only in East and South Asian countries[4]. Along similar lines, analyzing a panel of 119 countries over the period 1993-2003, Choi (2004) concludes that income inequality and FDI are positively related. Finally, Mah (2002) shows that FDI tends to deteriorate income distribution in Korea.

Focusing on wage inequality in both developed and developing countries, other authors conclude that capital inflows generally increase the demand for skilled workers, causing their relative wages to rise, and wage inequality to deteriorate (see for instance, Aitken et al., 1996; Feenstra and Hanson, 1995, 1997; Figini and Görg, 1999; Lipsey and Sjöholm, 2001; Matsuoka, 2001; Velde and Morrisey, 2003; and Taylor and Driffield, 2005)[5].

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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 (1997) 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 (2005) show that the growth-inequality relationship depends on the structural parameters of the model.

[3] See Cooper (2001) for a survey on the influence of foreign trade and investment on inequality in developing countries.

[4] Unobserved country-specific heterogeneity is, however, not taken into account in Tsai's (1995) analysis. Also see Bornschier and Chase-Dunn (1985) for a survey of early empirical studies that looked at the FDI-inequality relationship.

[5] Also see Wang (1997) and Aghion and Howitt (1998) for theoretical contributions. It should be noted that an FDI-induced increase in wage inequality is not necessarily associated with an increase in income inequality. FDI is in fact most likely to affect the middle income groups within the host country. These income groups will be made better off as a consequence of higher wages, and will therefore move closer to the top income groups

Yet, Blonigen and Slaughter (2001) show that multinational activity is not significantly correlated with skill upgrading within US manufacturing sectors, and Freeman et al. (2001) find no evidence for a consistent relationship between FDI and wage inequality in a large panel of developing countries. Focusing on five East Asian countries, Velde and Morrissey (2002) reach similar conclusions. Wu (2001) distinguishes FDI characterized by relatively skill-biased technology, from FDI with relatively labor based technology, and, using Chinese data, shows that the former raises wage inequality, while the latter does not. Finally, Li and Xu (2003) show that the increase in wage inequality that follows from FDI in China, is much lower in state-owned firms, compared to non-state owned firms[6].

To the best of our knowledge, no study has focused on the direct effects of FDI on educational inequality. Blomström and Kokko (2003) have presented indirect evidence related to the issue, focusing on the interactions between FDI and human capital. They show that technology-intensive FDI will flow essentially towards those economies with high educational levels, further contributing to the development of human capital in these economies[7]. On the other hand, economies with low levels of initial human capital will attract less technology-intensive FDI, and this type of FDI will play a smaller role in the future development of these economies (also see Blomström et al., 1994; Aitken and Harrison, 1999; and Monge-Naranjo, 2002).

In this paper, we try to bridge this gap by looking at how FDI impacts educational inequality, both from an empirical and a theoretical 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 in the level of access to technology in different countries is widening[8].

We first present some stylized facts relative to the interactions between FDI, inequality, growth, and the share of agriculture to GDP in the recipient country, based on a panel of 119 developing countries over the period 1970 to 1999. According to these stylized facts, there is a positive association between FDI and educational and income inequality, as

(which would reduce income inequality), but further apart from the bottom income groups (which would increase income inequality).

[6] All the above mentioned studies focus on the effects of FDI on wage inequality in the recipient country. See Freeman (1995) for an analysis of the effects of FDI on wage inequality in the home country.

[7] Multinational companies can raise the human capital of the host country by providing training or sponsoring the formal education of individual employees, or by supporting the development of universities and related institutions in the host country (see Blomström and Kokko, 2003, for more details).

[8] 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.

well as between FDI and growth, and a negative relationship between FDI and the share of agriculture to GDP in the recipient country. These findings suggest that, in developing countries, FDI induced growth exacerbates economic inequality

We then develop a growth model aimed at explaining these stylized facts. Our model is based on 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 (entrepreneurs) with a high initial human capital. In this world, foreign capital benefits the rich who have enough human capital to operate modern manufacturing enterprises. It does not benefit the poor, unless they are able to accumulate sufficient human capital to operate the modern technologies by becoming entrepreneurs. Their ability to become entrepreneurs depends on the productivity of agriculture and on their initial level of human capital. Depending on the parameterization of the model, the relationship between FDI and inequality may be positive or negative, but, in accordance with our stylized facts, FDI is always positively associated with growth.

The rest of the paper is organised as follows. Section 2 presents the stylized facts aimed at motivating our theoretical analysis. In Section 3, we lay out the theoretical model. In Section 4, we discuss the model's predictions regarding the interactions between FDI, inequality, and growth in three scenarios, namely an enclave economy scenario, where the poor can neither become entrepreneurs, nor trade with the rich; a scenario where the poor cannot become entrepreneurs, but can trade with the rich; and a scenario in which it is feasible for the poor to actually become entrepreneurs. Section 5 concludes the paper.

2. Stylized facts

In this section, we report some stylized facts about the interactions between FDI, inequality, growth, and the share of agriculture to GDP in the recipient country. This exercise is aimed at motivating the theoretical analysis that follows.

2.1. Data description

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 to GDP in the recipient country.

Except for the human capital and inequality variables, our data is taken from the Word Development Indicators (World Bank, 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 (educational) 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):

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

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[9].

We average our data over non-overlapping five-year periods, so that data permitting, there are six observations per country (1970-74, 1975-79, 1980-84, 1985-89, 1990-94, 1995-99). 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 developing countries over six time periods[10]. A full list of the 119 countries can be found in Appendix 1. Descriptive statistics are presented in Table 1.

[9] 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).

[10] It is however 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 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.

2.2 Interactions between FDI, inequality, growth, and the share of agriculture to GDP in the recipient country

Relationship between FDI and inequality

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

(2) $Inequality_{it} = a_0 + a_1 * FDI_{it} + u_i + u_t + u_{it}$,

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 (2) is made up of three components: u_i, which is a country-specific component; u_t, which is a time-specific component; and u_{it}, which is an idiosyncratic component. We control for u_t by including time dummies in all our specifications. We estimate Equation (2) 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 based on the human capital of the population aged 25 and over (*Gini25*), and the Gini coefficient based on income (*Gininc*)[11]. We can see that the coefficient associated with FDI is positive and statistically significant in all our specifications. This suggests that once unobserved country-specific heterogeneity is taken into account, inequality and FDI are positively related[12]. 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; the black market premium; the rate of growth

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[11] 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*.

[12] 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).

of population; and a measure of trade openness[13]. From the results, it appears that with the exception of trade openness, these additional variables do not play a statistically significant effect on inequality. 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*[14].

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 possible endogeneity problems by using the model variables lagged two or more periods as instruments[15]. 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 (2). 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[16]. 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 related[17].

[13] The ratio of *M2* to GDP can be seen as a measure of financial development. The black market premium is calculated as follows: (black market exchange rate / official exchange rate) – 1. Openness is calculated as (imports+exports)/GDP.

[14] 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.

[15] 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.

[16] 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.

[17] 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.

Relationship between FDI and growth

We now turn to the relationship between FDI and growth. The fact that FDI promotes growth in developing countries is well documented in the literature (see De Mello, 1997, for a survey). To see whether such a relationship holds in our data, we estimate an equation of the following type:

(3) $Growth_{it} = b_0 + b_1 * GDPC_{i(t-1)} + b_2 * FDI_{it} + v_i + v_t + v_{it}$,

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[18]. The results obtained by estimating Equation (3) using a fixed-effects specification are reported in column 1 of Table 3. We can see that there is a strong positive association between FDI and growth.

Estimating Equation (3) 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 (3) using a system-GMM estimator. This technique combines in a system the relevant regression expressed in first-differences and in levels (Arellano and Bover, 1995; Blundell and Bond, 1998). We use the system-GMM estimator rather than the simple first-difference estimator because in growth equations the latter estimator is particularly likely to suffer from a weak instrument bias[19]. 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.

The estimates of Equation (3) 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

[18] The latter variable takes conditional convergence into account.

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

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[20].

Relationship between FDI and the share of agriculture to GDP in the recipient country

The final relationship that we investigate is that between FDI and the share of agriculture to GDP in the recipient country. In column 1 of Table 4, we therefore present the fixed-effects estimates of the following regression:

(4) $$Agric_{it} = c_0 + c_1 * FDI_{it} + \varepsilon_i + \varepsilon_t + \varepsilon_{it},$$

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, suggesting that FDI flows are associated with a decline in the share of agriculture to GDP in the recipient country. 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[21]. 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[22].

Summary

The stylized facts that emerge from Tables 2 to 4 can be summarized as follows:

(i) There is a positive relationship between FDI and educational inequality, as well as between FDI and income inequality.

(ii) FDI is positively associated with growth.

(iii) FDI flows are associated with a decline in the share of agriculture to GDP in the recipient country.

In the section that follows, we develop a model which attempts to explain these stylized facts.

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[20] 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.

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

[22] 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.

3. A model of FDI and inequality

3.1 Production

Consider a dual economy with two sectors: traditional (indexed with a) and modern (indexed with m)[23]. At time t, the traditional sector (agriculture) produces output (food, y_{at}) with raw labor (l_{at}), human capital (h_{at}), 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 (y_{mt}) with raw labor (l_{mt}), human capital (h_{mt}), and foreign capital (f_t)[24]. To start production in sector m, one needs a minimum amount of human capital, h_{min}. The production functions in these two sectors are:

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

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

$= 0$ 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.

3.2 Initial distribution of human capital

There are two types of agents in this economy: the poor and the rich. 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 to start with. Because of the initial distribution of human capital, the poor only have access to the production technology (5). The rich, on the other hand, have access to both technologies (5) and (6).

3.3 Investment

There are two types of investment technologies for the creation of human capital. An agent can invest in the traditional sector or in the modern sector. Regardless of the form of human

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[23] Bandyopadhyay and Basu (2001, 2005) 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 FDI, inequality, and growth, which is our central concern in this paper.

[24] We label the traditional sector “agriculture” and the modern sector “industrial” for simplicity. Alternatively, we could label the traditional sector “low-tech sector” (which would include agriculture as well as the manufacture of low-tech goods) and the modern sector “high-tech sector”.

capital investment, the agent 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:

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

I_{jt} is the human capital investment in sector j at time t. If the agent does not invest in schooling, his/her 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.

3.4 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:

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

Since the supply of foreign capital is infinitely elastic at r^*, (8) gives the time path of f_t, which depends on the endogenous time path of h_{mt}[25]. The FDI at date t (call it fdi_t) is defined as:

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

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.

Plugging (8) into (6) gives rise to a familiar Rebelo (1991)-type linear production function in the modern sector:

(10) $y_{mt} = Qh_{mt}$,

[25] 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).

where $Q = \left[\frac{1-\nu}{r^*}\right]^{\frac{1-\nu}{\nu}}$. We assume that the technology is such that Q-δ>r^*, which means that the rich never invest abroad[26].

Foreign capital is thus the critical engine of growth in this model, as it generates technological externalities[27]. 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.

3.5 Preferences

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

(11) $U(c_{at}, c_{mt}) = c_{at}$ when $\omega \leq c_{at} < \bar{a}$

$= \bar{a} + \log c_{mt}$ when $c_{at} \geq \bar{a}$,

where c_{at} and c_{mt} 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[28]. Until 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[29].

Agents are connected across generations by altruistic bequest motives. Thus, they maximize the utility function:

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

where β is the degree of altruism.

3.6 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 specified in (5). If they produce more than

[26] If δ=0, such a restriction means that $(1-\nu)^{1-\nu}>r^*$.
[27] Domestic human capital and foreign capital are therefore assumed to be technological complements (not substitutes). See De Mello (1997) for a similar setup.

[28] We assume that $\bar{a}$ is less than the initial start up cost of launching a modern enterprise, $h_{\min}$.
[29] To avoid any discontinuity in the utility function, the logarithmic part of (11) 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), we avoid this complication as all the results in the paper would remain largely unaffected if we introduced it.

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

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

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

(15) $x_{at}^{(1)} = p_t c_{mt}^{(1)}$;

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

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

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

Combining (5) and (13) through (17), we get the following sequential resource constraints for the poor:

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

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

The rich produce food and manufacturing goods because they can operate both technologies (5) and (6). Given the utility function (11), 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 of food because of the preference structure specified in (11), 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[30]. The resource and market constraints facing the rich are as follows:

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

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

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

(23) $$c_{mt}^{(2)} + I_{mt}^{(2)} + x_{mt}^{(2)} = y_{mt}^{(2)} - r^* f_t$$

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

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

Using (5), (6), (8), (10), and (20) through (25), one obtains the following sequential resource constraint for the rich:

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

where $A = \nu Q = \nu \left[\dfrac{1-\nu}{r^*}\right]^{(1-\nu)/\nu}$ represents the TFP of the manufacturing sector after netting out the cost of foreign capital.[31]

4. Can the poor become entrepreneurs? Three possible scenarios

Since FDI is the engine of growth in the modern sector, the issue arises whether the poor can someday become entrepreneurs. In order to do so, they 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 2 for a justification of this issue). They, therefore, have the option of undertaking a belt-tightening strategy as follows: consume just the subsistence level, ω, for several generations, and accumulate an amount of human capital sufficient for them to become entrepreneurs[32]. The following proposition examines the feasibility of such a belt-tightening plan.

[30] 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.

[31] We assume that the parameters Q, r^* and ν are such that A is positive.

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

Proposition 1: Let the poor set a consumption plan $c_{at}^{(1)} = \omega$*. 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 $c_{at}^{(1)} = \omega$, the time path of the human capital is given by the following difference equation:

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

Figure 1 plots the phase diagram for (27). 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[33]. 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, $h_{\min}$.

We will next analyze the interactions between FDI, inequality, and growth in three scenarios. In the first one, it is not feasible for the poor to become entrepreneurs, nor to trade with the rich, leading to an enclave economy scenario. In the second scenario, it is still not feasible for the poor to become entrepreneurs, but the poor can trade with the rich. Finally, in the last scenario, it is feasible for the poor to become entrepreneurs.

4.1 Scenario 1: 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 $z h_0^{(1)^{\alpha}} < \bar{a}$*, 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.*

[33] Note that the zero 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 zero, violating Equation (11).

Proof: Given the utility function (11), the first-order condition that the poor face if $\omega \leq c_{at}^{(1)} < \bar{a}$ is given by:

(28) $$1 = \beta[\alpha z h_{a\ t+1}^{(1)\ \alpha-1} + 1 - \delta].$$

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

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

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 (29) 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[34].

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. They will allocate a constant amount $\tilde{h}_a^{(2)}$ of human capital to agriculture, which is sufficient for them to produce the saturation level of food and replacement investment of human capital. In other words:

(30) $$z\tilde{h}_a^{(2)\alpha} = \bar{a} + \delta \tilde{h}_a^{(2)}.$$

[34] 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.

Using (6), (20), (23), and (30), one obtains:

$$(31)\qquad c_{mt}^{(2)} + h_{t+1}^{(2)} - (1-\delta)h_t^{(2)} = Ah_t^{(2)} - (A-\delta)\tilde{h}_a^{(2)}.$$

The rich thus maximize (12) subject to (31).

Given this structure, we have the following proposition:

Proposition 3: For a sufficiently large $h_{\min}$ *(i.e.* $h_{\min} > \tilde{h}_a^{(2)}$ *), the human capital of the rich grows and reaches an asymptotic rate,* $\beta[1+A-\delta]$[35].

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

$$(32)\qquad \frac{c_{mt+1}^{(2)}}{c_{mt}^{(2)}} = \beta B,$$

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

Plugging (31) into (32), we obtain the following second-order difference equation in $h_t^{(2)}$:

$$(33)\qquad h_{t+2}^{(2)} - B(1+\beta)h_{t+1}^{(2)} + \beta B^2 h_t^{(2)} = (A-\delta)\tilde{h}_a^{(2)}(\beta B - 1)$$

The general solution to this difference equation is given by:

$$(34)\qquad h_t^{(2)} = A_1(B)^t + A_2(\beta B)^t + \tilde{h}_a^{(2)},$$

where A_1 and A_2 are determined by the initial and terminal conditions[36]. The initial condition is characterized by $h_0^{(2)}$. The terminal condition is given by the transversality condition (TVC) as follows:

$$(35)\qquad \lim_{T\to\infty} \beta^T \frac{h_{T+1}^{(2)}}{c_{mT}^{(2)}} = 0.$$

We next show that the TVC requires that A_1 in (34) 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 (32). Thus the left hand side of (35) inside the limit operator reduces to:

[35] In our empirical analysis, years of schooling were used as a proxy for human capital. Appendix 3 discusses the relationship between the latter, which according to our model is unbounded in the long-run, and the former, which is a bounded variable.

[36] See Appendix 4 for a derivation of Equation (34).

$$(36)\qquad \beta^{T}\frac{h_0^{(2)}B^{T+1}}{c_{m0}^{(2)}(\beta B)^{T}} = \frac{h_0^{(2)}}{c_{m0}^{(2)}}B \,,$$

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:

$$(37)\qquad h_t^{(2)} = A_2(\beta B)^t + \tilde{h}_a^{(2)} \,,$$

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

$$(38)\qquad A_2 = h_{\min} - \tilde{h}_a^{(2)}$$

As long as $h_{\min} > \tilde{h}_a^{(2)}$, human capital in the modern sector will grow and eventually reach an asymptotic rate βB. Q.E.D.

In order to grow, the rich must have initial human capital in excess of the amount necessary to sustain the agricultural production $\bar{a}$. This explains why $h_{\min}$ must exceed $\tilde{h}_a^{(2)}$.

FDI-growth relationship

We now analyze the time path of the growth rate of GDP, $1+\gamma_t$, which is given by:

$$(39)\qquad 1+\gamma_t = \frac{y_{at+1} + \rho(1-\phi)y_{mt+1}}{y_{at} + \rho(1-\phi)y_{mt}} \,,$$

where ρ is the imputed price of manufacturing goods[37]. The term $(1-\phi)$ appears in (39) as only the rich produce manufacturing goods.

Using (5), (27), and (30), we can see that the agricultural production in the economy is constant both in the short- and long-run, and is given by:

$$(40)\qquad y_{at} = y_a = \phi z\left[\frac{\alpha\beta z}{1-\beta(1-\delta)}\right]^{\frac{\alpha}{1-\alpha}} + (1-\phi)\, z\tilde{h}_a^{(2)\alpha} \,.$$

Using (10), (37), and (40), (39) can be rewritten as follows:

[37] Since there is no trade in this scenario, the relative price has to be imputed. ρ is the relative marginal cost of producing manufacturing goods evaluated at the steady-state level of agricultural production, y_a, given in (40). It is a constant, equal to $\alpha z^{1/\alpha}A^{-1}(y_a)^{(\alpha-1)/\alpha}$.

$$(41)\qquad 1+\gamma_t = \frac{y_a + (1-\phi)\rho Q A_2 (\beta B)^{t+1}}{y_a + (1-\phi)\rho Q A_2 (\beta B)^{t}},$$

It is now straightforward to verify that $1+\gamma_t$ increases over time and approaches the upper bound βB.

We next define the FDI rate, i.e. the ratio of FDI to GDP. Let us denote this FDI rate at date t as $\tilde{fdi}_t$. Combining (39), (40), (8), and (9) yields:

$$(42)\qquad \tilde{fdi}_t = \left[\frac{1-\nu}{r^*}\right]^{1/\nu} \frac{\left[h_{mt+1} - (1-\delta)h_{mt}\right]}{y_a + \rho(1-\phi)y_{mt}}$$

Using (10) and (37), (42) can be rewritten as:

$$(43)\qquad \tilde{fdi}_t = \left[\frac{1-\nu}{r^*}\right]^{1/\nu} \frac{\left[\beta B - (1-\delta)\right]}{(y_a / h_{mt}) + \rho(1-\phi)Q}$$

According to (40), y_{at} is a constant. As h_{mt} grows, the FDI rate ($\tilde{fdi}_t$) will therefore grow over time until it reaches an upper bound $\bar{\theta}$ given by:

$$(44)\qquad \bar{\theta} = \left[\frac{1-\nu}{r^*}\right]^{1/\nu} \frac{\left[\beta B - (1-\delta)\right]}{\rho(1-\phi)Q}$$

The FDI rate and growth are thus positively related in the short-run.

FDI-share of agriculture relationship

In the scenario that we have so far analyzed, 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_{mt}) goes to zero[38]. The share of agriculture to GDP in the recipient country thus gradually declines until the country becomes fully industrialized and integrated with the world economy. The FDI rate and the share of agriculture to GDP will therefore be negatively correlated in the short-run.

FDI-inequality relationship

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.

[38] This feature is similar to Gollin et al. (2002).

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[39]:

$$gini_t = \phi - \frac{\phi h_a^{(1)*}}{\phi h_a^{(1)*} + (1-\phi)h_t^{(2)}} . \tag{45}$$

Since only $h_t^{(2)}$ grows over time, *gini* increases over time. Using (43), it is straightforward to verify that the FDI rate also increases as the rich augment human capital: the FDI rate and inequality are therefore positively related in the short-run.

In the long-run, the traditional sector asymptotically disappears, the modern sector keeps growing at the balanced rate βB, the FDI rate reaches an upper-bound $\bar{\theta}$, given by (44), and *gini* reaches an upper bound given by ϕ.

4.2 Scenario 2: 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. For analytical tractability, we assume hereafter that the rich and the poor trade at a constant terms of trade normalized at unit level[40]. The first-order condition facing the poor is:

$$\frac{1}{c_{mt}^{(1)}} = \frac{\beta}{c_{mt+1}^{(1)}} . \left[\alpha z h_{at+1}^{(1)\ \alpha-1} + 1 - \delta \right], \tag{46}$$

which together with their budget constraint (18), yields:

$$\frac{1}{zh_{at}^{(1)\alpha} + (1-\delta)h_{at}^{(1)} - \bar{a} - h_{at+1}^{(1)}} = \frac{\beta}{zh_{at+1}^{(1)\ \alpha} + (1-\delta)h_{at+1}^{(1)} - \bar{a} - h_{at+2}^{(1)}} \left[\alpha z h_{at+1}^{(1)\ \alpha-1} + 1 - \delta \right]. \tag{47}$$

In contrast with the enclave economy scenario, in this scenario, the poor experience transitional dynamics. Yet, because of diminishing returns in agriculture, they eventually cease to grow. There are thus three phases of FDI-induced industrialization: (i) a short-run

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[39] See Appendix 5 for the derivation of the Gini coefficient.

[40] Implicitly we are assuming here that the model parameters are such that the agricultural market clears at the unit terms of trade, meaning that, in the steady-state, $x_{at}^{(1)} = x_{at}^{(2)}$. Alternatively, one could endogenize the terms of trade. In that case, the equilibrium evolution of the terms of trade would depend on the time path of the distribution of human capital between the rich and the poor. We avoid this complication for the sake of tractability.

phase when both the poor and the rich grow, (ii) a medium-run phase, when the poor reach the steady-state and the rich continue to grow, (iii) a long-run phase, when the agricultural sector asymptotically disappears and there is balanced growth.

It is straightforward to verify that the steady-state capital stock of the poor in the medium-run , which solves (47), satisfies:

$$(48)\qquad h_a^{(1)*} = \left[\frac{\alpha\beta z}{1-\beta(1-\delta)}\right]^{1/(1-\alpha)}.$$

which is identical to the steady-state laid out in Proposition 2[41]: trade has therefore no medium/long-run effect on the human capital of the poor[42].

The rich, on the other hand, allocate capital between the traditional and the modern sectors to maximize (12) subject to (26). This leads to the allocation of a constant amount of capital to the agricultural sector every period, $\bar{h}_a^{(2)}$, which ensures the equality of the marginal products in both sectors, and is given by[43]:

$$(49)\qquad \bar{h}_a^{(2)} = \left[\frac{\alpha z}{A}\right]^{1/(1-\alpha)}.$$

Using the same line of reasoning as in Proposition 3, one can establish that the human capital of the rich follows the time path:

$$(50)\qquad h_t^{(2)} = B_2(\beta B)^t + \bar{h}_a^{(2)},$$

where $B_2 = h_{\min} - \bar{h}_a^{(2)}$.

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 medium/long-

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[41] To distinguish this scenario from Scenario 3 in Section 4.3, we assume here that $h_a^{(1)*} < h_{\min}$. In other words, the poor cannot become entrepreneurs just by trading with the rich.

[42] Appendix 6 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. Moreover, although the expression for the steady-state level of human capital reached by the poor is the same as that 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.

[43] To see this, note that the sequential budget constraint (26) can be rewritten as follows: $\bar{a} + c_{mt}^{(2)} + h_{t+1}^{(2)} - (1-\delta)h_t^{(2)} = A(h_t - h_{at}^{(2)}) + z h_{at}^{(2)\alpha}$. Given h_t, the choice of $h_{at}^{(2)}$ is therefore a temporal decision problem. $h_{at}^{(2)}$ will be chosen to maximize the total output on the right hand side of the equation above, which yields (49).

run effect on the capital stock of the poor and the balanced growth rate of the economy. As long as it is not feasible for the poor to become entrepreneurs, trade will not have any medium/long-run effect on their capital stock.

FDI-growth relationship

In the short-run, since both the poor and the rich grow, the relationship between the FDI rate and growth is evidently positive. In the medium-run, once the human capital allocated to agriculture by the poor reaches $h_a^{(1)*}$, leading to a constant agricultural production, the growth rate of GDP is given by:

(51) $$1+\gamma_t = \frac{\phi z h_a^{(1)*\alpha} + (1-\phi) z \bar{h}_a^{(2)^\alpha} + (1-\phi) y_{mt+1}}{\phi z h_a^{(1)*\alpha} + (1-\phi) z \bar{h}_a^{(2)^\alpha} + (1-\phi) y_{mt}},$$

where $\bar{h}_a^{(2)}$ is given by (49). It follows that the growth rate of GDP in (51) increases over time and approaches the upper bound βB. Following the same line of reasoning as in Section 4.1, we can conclude that growth and the FDI rate are positively correlated in the medium-run. The upshot of this analysis is that the FDI rate and growth are positively correlated both in the short- and medium-run.

FDI-share of agriculture relationship

In the short-run, one would expect the poor to grow faster than the rich if they started from a very low level of human capital, and slower than the rich if they started from a higher level of human capital[44]. In the former case, the share of agriculture to GDP would rise momentarily until the poor cease to grow due to diminishing returns in agriculture[45]. In the latter case, the share of agriculture would decline. The medium-run case is equivalent to the enclave economy short-run scenario: the poor cease to grow while the rich continue to grow, leading to a declining share of agriculture to GDP. Except in the first case, the model therefore predicts a negative correlation between the FDI rate and the share of agriculture.

[44] 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.

[45] Note that the size of the agricultural sector is positively related to the human capital allocated to this sector. As the rich allocate a constant amount of human capital to this sector (see equation 49), when the poor grow relatively faster than the rich, the share of agricultural output in total output also rises.

FDI-inequality relationship

If the poor started from a relatively low level of human capital, thus growing faster than the rich, 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 human capital, 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 the FDI rate and inequality depends therefore on whether the poor grow faster or slower than the rich, which in turn depends on their initial human capital.

In the medium-run, once the agricultural sector has reached the steady-state and the manufacturing sector continues to grow along the path given by (50), both educational and income inequalities keep widening, leading to a positive correlation between the FDI rate and inequality.

In the long-run, like in the enclave economy scenario, the traditional sector asymptotically disappears; the economy grows at the balanced rate βB; the FDI rate reaches the upper bound $\bar{\theta}$ given by (44) evaluated at ρ equal to one; and the Gini coefficient reaches the upper bound ϕ.

4.3 Scenario 3: case in which it is feasible for the poor to become entrepreneurs

In this Section, we briefly discuss the relationships between FDI, inequality, growth, and the share of agriculture to GDP in the recipient country when it is feasible for the poor to become entrepreneurs (i.e. $\tilde{h} > h_{min}$, as per Figure 1).

In this scenario, like in the previous one, the short-run correlation between the FDI rate 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, because they grow faster than the rich, inequality declines in the short-run making the FDI-inequality correlation negative. If, on the other hand, the poor transit from a relatively high level of human capital, then inequality rises temporarily making the FDI-inequality correlation positive, as the rich grow faster than the poor. The short-run correlation between the FDI rate and inequality could therefore be positive or negative depending on the parameter configurations. Using a similar argument, it follows that the FDI rate and the share of agriculture to GDP will co-vary positively when the poor grow faster than the rich, and negatively when the reverse occurs.

It is also straightforward to verify, using a similar line of reasoning as in Section 4.1, that there is a positive short-run correlation between the FDI rate and growth because the economy will continue to grow as FDI flows in the modern sector.

Like in the two previously analyzed scenarios, in the long-run, the traditional sector asymptotically disappears; the economy keeps growing at a balanced rate; and both the FDI rate and the Gini coefficient reach upper bounds.

4.4 Connecting the model to the stylized facts

In light of the various scenarios analyzed here, one may envisage different types of short/medium-run FDI-inequality relationships depending on the initial distribution of human capital and on the level of agricultural TFP. In an enclave economy scenario, there is always a positive short-run association between FDI and inequality. In an economy with trade between the rich and the poor, FDI and inequality may co-vary positively or negatively in the phase in which both the rich and the poor grow, but always co-vary positively from the stage in which the poor cease to grow onwards. Finally, in a scenario where it is feasible for the poor to become entrepreneurs, FDI and inequality may co-vary positively or negatively in the short-run. Thus, according to the model, the correlation between FDI and inequality is generally positive, except in those transitional phases when the poor grow faster than the rich.

Further predictions of the model about the correlation between FDI and the share of agriculture to GDP suggest that except in those transitional phases when the poor grow faster than the rich, FDI and the share of agriculture co-vary negatively. Moreover, in all three of the above described scenarios, FDI and growth are positively correlated in the short- and medium-run. These predictions are broadly consistent with our stylized facts.

5. Conclusion

In this paper, we investigated how the infusion of foreign capital impacts human capital and income inequality. Using a panel of 119 developing countries over the period 1970-1999, we found that FDI promotes both inequality and growth, and tends to reduce the share of agriculture to GDP in the recipient country. We then developed a growth model aimed at explaining these stylized facts. Our model is characterized by 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. In accordance with our stylized facts, the main predictions of our model can be summarized 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.

The upshot of our analysis is that FDI could exacerbate inequality, particularly in an environment where the poor are unable to access the modern FDI-based technology because of low initial human capital. The problem could be 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 to become entrepreneurs. In the long-run, such policies could allow the poor to catch-up with the rich.

Appendix

1. List of countries used in Section 2

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

2. 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 Galor and Zeira (1993)[46]. 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:

$$(\text{A.1}) \quad r_b b = r^* b + M \ .$$

If the borrower runs away with the loan, the cost of evasion is κM (where $\kappa>1$), 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:

$$(\text{A.2}) \quad b(1+r_b) = \kappa M \ .$$

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

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

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

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 $\lambda>1$. If $b^* < \lambda.h_{min}$, borrowers do not obtain financing. We assume that our model is characterized by such a scenario of imperfect credit markets.

3. Relationship between years of schooling and human capital

We provide here an example to illustrate how the relationship between years of schooling and human capital can be modelled using a production function, which transforms bounded schooling (s_t) to unbounded knowledge (h_t). Such production function could take the following form:

$$(\text{A.5}) \quad h_t = \frac{\bar{s}^{\varphi}}{(\bar{s} - s_t)^{\varphi}}$$

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

where $0 \le s_t \le \bar{s}$, $\bar{s} > 1$, and $\varphi > 0$. $\bar{s}$ is an upper bound for years of schooling, and the parameter φ represents the quality of schooling. A higher φ is associated with a higher quality of schooling, as it makes the technological relationship between h_t and s_t shift upward. Depending on the quality of schooling, the size of φ may differ from country to country. For any nonzero value of φ, as s_t approaches its upper bound, human capital approaches infinity.

All agents in the economy share the same human capital-schooling technology. Since human capital is monotonic in schooling, the time path for human capital optimally chosen either by the rich or the poor pins down a time path of schooling via the technology illustrated in Equation (A.5). An increase in human capital inequality thus translates itself into rising inequality of schooling.

4. Derivation of Equation (34)

The solution of Equation (33) 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.6) $h_t^{(2)} = \Psi$ for all t.

We then plug (A.6) into (33) and solve for Ψ to obtain

(A.7) $\Psi = \tilde{h}_a^{(2)}$,

which solves the particular integral part.

The homogenous part of (33) is given by:

(A.8) $h_{t+2}^{(2)} - B(1+\beta)h_{t+1}^{(2)} + \beta B^2 h_t^{(2)} = 0$.

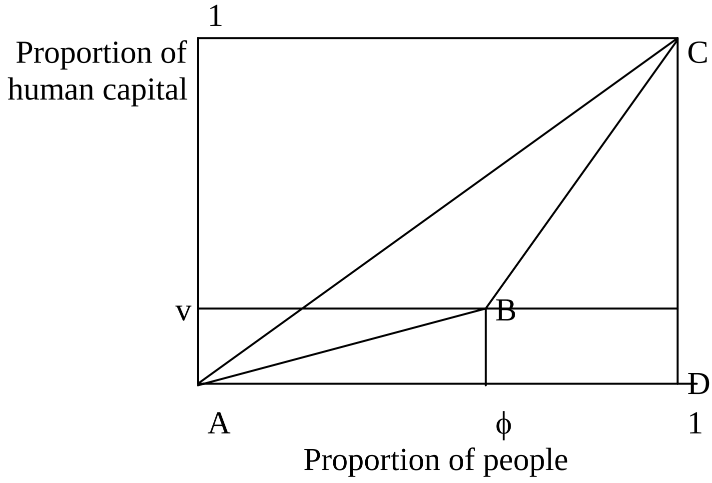
The two characteristic roots of (A.8) are given by:

(A.9) $$\lambda_1, \lambda_2 = \frac{B(1+\beta) \pm \sqrt{B^2\left\{(1+\beta)^2 - 4\beta\right\}}}{2}.$$

$$= B, \beta B$$

The general solution, which is the sum of the solutions for the non-homogenous and homogenous parts, is thus given by (34). Q.E.D.

5. 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:

(A.10) $gini_t = = \phi - v = \phi - \dfrac{\phi h_a^{(1)*}}{\phi h_a^{(1)*} + (1-\phi) h_t^{(2)}}$,

where ϕ is the proportion of poor people in the economy; $h_t^{(2)}$ is the human capital of the rich given by the sum of $\tilde{h}_a^{(2)}$ and $h_{mt}^{(2)}$; and $h_a^{(1)*}$ is the human capital of the poor defined in the Proof of Proposition 2.

6. Transitional dynamics of the poor in the model with trade

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[47]:

(A.11) $V(h_t^{(1)}) = \max\left[\bar{a} + U\left(z\, h_t^{(1)\alpha} + (1-\delta)\, h_t^{(1)} - \bar{a} - h_{t+1}^{(1)}\right) + \beta V(h_{t+1}^{(1)})\right]$,

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

The first-order condition is:

(A.12) $U'(c_{mt}^{(1)}) = \beta V_1(h_{t+1}^{(1)})$,

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

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

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

(A.13) $$\frac{\partial h_{t+1}^{(1)}}{\partial h_t^{(1)}} = \frac{U''(c_{mt}^{(1)})[\alpha z\, h_t^{(1)\alpha-1} + 1 - \delta]}{U''(c_{mt}^{(1)}) + \beta V_{11}(h_{t+1}^{(1)})} > 0$$

The initial endowment of the poor, $h_0^{(1)}$, and their investment policy, $h_{t+1}^{(1)} = \phi(h_t^{(1)})$, which solves (A.12), characterize the time path of their capital stock. In the steady-state, the capital stock $h^{(1)}$ is time invariant, meaning that $h^{(1)} = \phi(h^{(1)})$. From (47), 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 $h^{(1)*}$.

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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*$_{it}$ (measured as indicated in each column)	*(1)*	*(2)*	*(3)*	*(4)*	*(5)*
	Gini15$_{it}$	*Gini25*$_{it}$	*Gininc*$_{it}$	*Gini15*$_{it}$	*Gini15*$_{it}$
	Fixed-effects	*Fixed-effects*	*Fixed-effects*	*Fixed-effects*	*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)
(Black market premium)$_{it}$				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: The subscript i indexes countries, and t, the time period (measured in terms of five-year averages). *Gini15* and *Gini25* represent the human capital inequality in the population aged 15 and over, and 25 and over, respectively. *Gininc* measures income inequality. The B*lack market premium* is calculated as follows: (black market exchange rate/official exchange rate) – 1. *Openness* is calculated as (imports+exports)/GDP. 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$_{it}$*	*(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. *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: $Agric_{it}$	*(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