The nexus between FDI and Total Factor Productivity Growth in Sub Saharan Africa

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ABSTRACT In this study we construct an alternative analytical framework aimed at investigating the nexus between FDI inflow and productivity growth within the externalities type endogenous growth theory. The competitive equilibrium of our model indicates that a technological spillover from FDI has positive effect on the total factor productivity of the host economy. To empirically test the model, we employed panel data for 22 Sub-Saharan African countries covering the period 1970-2000. We estimated the fixed effect and the dynamic panel models and the results from both models, inline with the solution of analytical model and empirical results of some of the recent studies, show that FDI inflow has negative short-term effects and positive long-run effects on total factor productivity.

Keywords: Foreign Direct Investment, Total Factor productivity, growth, Panel data, Sub Saharan Africa

JEL Classification code: C33, F21, F23, F43, O55

1. INTRODUCTION

Though the study of the impact of Foreign Direct Investment (FDI) on the performance of the host economy is an old research area, there has been a growing interest in this topic in recent years. This can be seen from the staggering number of both theoretical and empirical research reports. Though there could be various reasons behind this revival of research interest, the performance of the economies of East and South East Asian countries seems to be one of the most important. Many results suggest that these countries attracted and significantly benefited from FDI in the process of their fast economic transformation.

One channel through which FDI is expected to enhance economic growth in host countries is its contribution towards increasing the productivity of host economies; the other being via increasing capital stock. Theoretically, the productivity gain from the

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technological spillovers in the host economy arises in various ways, such as labour turn-over resulting in movement of trained labour from foreign owned firms to local firms, learning-by-watching/demonstration effect, and linkages through supply of inputs. If this technological spillover exists, it should be reflected in its impact on the productivity of the host economy that can be captured by different measures of productivity, one of which is total factor productivity (TFP). Though there are attempts to investigate the impact of FDI inflows on productivity, they are mainly concentrated on firm level or industry level studies. There are few, if any, studies conducted to investigate the nexus between FDI inflows and productivity growth using aggregate data.

It is almost a stylized fact, at least since Solow (1957), that sustainable growth in per capita GDP of a nation can be achieved only via growth in technological progress. In the Solow-Swan type neoclassical growth model, however, this technological progress is exogenously determined just like "manna from heaven" (Jones, 1998: 33). The new growth theories successfully indicate that technological progress, or the discovery of new ideas, is the outcome of intentional economic activities of profit maximizing firms (see for example, Romer, 1990; Jones, 1998 ch. 4; Grossman and Helpman, 1994) that requires huge investment in both physical and human capital, both of which are of dire shortage in developing countries.

Fortunately, the developing countries need not recreate the technology that has already been created in advanced countries since they can benefit from technological diffusion. The most effective and less costly channel through which technology transfers from developed to developing countries is via Foreign Direct investment (FDI). Some three decades back, in a widely cited work, Findlay (1978) developed a model in which FDI flows from advanced countries act as an agent of technology transmission to developing countries. According to this model, one expects the presence of foreign capital with better technology in a poor country to be of paramount importance for its economic development.

The technological diffusion via FDI is also behind the "catch-up" hypothesis which claims that developing countries (followers) tend to grow faster and hence catch up with developed countries (leaders) thereby resulting in economic convergence of countries (Barro and Sala-i-Martin, 2004). This view has gained revival in recent

years mainly due to the claim that East and South East Asian countries, in particular China and India, attracted and benefited from FDI (Yao and Wei, 2007).

Cognizant of this, developing countries, including those in Sub Saharan Africa, have been trying hard to attract the global capital flow from advanced countries. This can be seen from the stiff competition among these countries, through fiscal and financial incentives (tax exemption on import of physical capital, tax holidays, provision of investment land free of lease fee or at a very low fee, easy access to commercial loan for investment, easy profit repatriation, etc). In many ways these countries started to see FDI as a panacea to their problems: it brings new technologies, increases their capital stock, creates market opportunities abroad, etc. The implication of which is higher job opportunities in the short to medium term and faster economic growth in the long-run.

The discussion so far poses questions such as: Is there a technological spillover from FDI in Africa? If so, how significant is this effect? If not, what are the country and region specific characteristic features explaining poor performance of FDI in enhancing productivity in this part of the world?

In this study, we try to develop an alternative analytical model within the Barro (1990) type endogenous growth framework in which spillovers from FDI generate growth in total factor productivity, and hence a positive endogenous growth rate in per capita GDP. This theoretical framework shows not only that FDI affects the growth of productivity of the economy (hence, the long run growth rate of the economy) through the technological spillovers associated with it; but also that the magnitude of these spillovers converted into input of production is endogenously determined by the overall economic environment. The overall economic environment, on the other hand, depends on the decisions that the households, firms and mainly the public sectors make in the process of the attraction of FDI and absorption of the technological spillover that comes with it. This model will be tested using aggregate data on productivity for a sample of Sub-Saharan African Countries.

The main contribution of this study is that it tries to model the technological spillover from FDI and its impact on the long run growth of the economy within a dynamic general equilibrium framework. On the empirical side, the measure of aggregate

productivity has been one of the constraints to undertake such a study for previous studies. Consequently, there is concentration of research examining the link between growth rate of GDP and FDI and/or the firm level investigation of the nexus between productivity growth and FDI. As far as our knowledge is concerned, this study is the first to investigate the impact of FDI on productivity using the new database on the productivity performance of countries- World Productivity Database of UNIDO- at least for Sub Saharan Africa.

The rest of the paper proceeds as follows. Section 2 reviews both theoretical and empirical literature. Section 3 presents a model of endogenous growth where the rate of growth of technological spillover from FDI determines the rate of growth of the economy. Section 4 deals with the description of the data, the main variables, and specification and estimation procedure. The results will be discussed in Section 5 and Section 6 gives concluding remarks.

2. LITERATURE REVIEW

There has been a growing interest in research on the link between the inflow of FDI and economic growth in developing countries. This is partly attributable to the development of endogenous growth models and partly due to the claim that the fast growth of the economies of East, South and South East Asian countries, in particular China and India, is due mainly to their success in attracting and benefiting from FDI (Yao and Wei, 2007).

The existing body of literature on the effect of FDI on growth of production and productivity can be summarized by the following four observations. First, there is a lack of a unified analytical framework though there are various pieces of attempts in constructing a model to explain the effects of FDI. Second, those who attempt to investigate the effect of FDI on the economy of the host country mainly focused on the link between FDI and the growth rate of per capita income, though even conceptually, that link is bidirectional. If FDI is really an engine of growth through spillovers effects, its effect should be on the productivity of the economy of the recipient country that can be seen from its effect on Total Factor Productivity (what is commonly referred to as the “Solow-residual”). In their influential work on the effect of FDI on growth, Borensztein et al. (1998: 134), suggest that the effect of FDI may

better be captured through Total Factor Productivity than growth in per capita GDP. However, the studies that attempt to see the link between FDI and productivity are concentrated on the firm level study of such a link. Third, the results on the effect of FDI on the growth of per capita GDP are mixed and hence inconclusive, implying that there is a need for a new approach to this investigation. Fourth, the studies, so far, tend to be concentrated in two regions: East and South East Asia and Latin America. To our knowledge there are only two case (country) studies conducted in Sub Saharan Africa (Akinlo, 2004, and Bwalya, 2006).

2.1. Theoretical Literature

The neoclassical growth model pioneered by Solow (1956) attributes the sustainable growth of income of economies to technological progress that is exogenously determined, as Jones (1998: 33) states, just given as "Manna from Heaven". In this framework, the FDI inflow increases the per capita (per worker) capital stock of an economy and leads to a higher growth rate of per capita income, but only during the transition of the economy to the new steady state (Barro and Sala-i-Martin, 2004; Jones, 1998).

However, after the influential work of Romer (1986) and continued research on that line (Barro, 1990; Rebelo, 1990; Lucas, 1988), the view that exogenously determined technological progress dictates economic growth has been changed. According to this new line of thought, referred to as endogenous growth theory, the rate of economic growth is endogenously determined by various forms of imperfections that result into spillovers or externalities. These theories, according to Lai et al. (2006), can be categorized into two broad classes: investment-based and R&D-based. The former argue that economic growth can be achieved, without assuming exogenous technological progress, due to various types of imperfections that give rise to positive externalities from different types of investments. That is, there are external benefits that are not internalized by the investors and hence benefit others. In this model, FDI can serve as engine of growth since there are various ways through which the non-tangible assets possessed by foreign firms benefit domestic firms in the form of spillovers effects or externalities. These various ways include, among others, learning-

by-watching/demonstration effect, labour turn-over, business relationship (both vertical and horizontal) between foreign firms and local firms.

This argument is based on the assumption that FDI "generates externalities in the form of technology transfer, including advanced technology, management method, new products and new processes" (Liu, 2008:177). One of the early theoretical works on the productivity spillovers effect from FDI is Findlay (1978) showing that FDI plays the role of technology transfer from developed countries to developing countries. Findlay argues that the presence of better technology employing foreign firms in the economy increases the productivity of local firms not only by serving as a source of improved technology but also through imposing competitive pressure and forcing domestic firms to improve their efficiency. This is clearly posed in his argument:

> Contact with firms of a higher level of efficiency enables the relatively backward ones to improve not only by copying or imitating but also by inducing them to "try harder," as in the well-known Avis motto. As in many fields of human endeavour, the visible example of a high standard can inspire those with a lower level of achievement to perform better. (Findlay, 1978: 4-5)

This implies that the stiff competition generated due to the presence of foreign firms improves the efficiency of the economy as firms struggle for survival by enhancing their productivity, since those that failed to cope with it will be forced to exit. However, this pro-competitive effect has been seen as a negative effect on the host economy, because the domestic firms equipped with less advanced technology will lose their market shares and be driven out of the market before they grow and compete with foreign firms. This was one of the reasons behind the anti-Multinational Corporations arguments advanced by dependency theory scholars in the developing world, in particular those in Latin America in the 1970s (see the discussion in Bengoa and Sanchez-Robles, 2003).

In recent years, studies conducted since the development of the various strands of endogenous growth models, attempt to model different ways through which FDI could enhance the growth of the domestic economy (see Bengoa and Sanchez-Robles, 2003; 2005; Borensztein et al., 1998; among others).

Some of these models, for instance Borensztein et al. (1998) employed the assumption that technological progress in an economy is determined by the number of varieties of capital goods that is available in the economy (following Romer, 1990). In this model, FDI enhances economic growth in two ways. First, FDI might bring new varieties of capital from the country of origin. Second, FDI reduces the fixed setup cost required to produce new varieties of capital as such cost is assumed to depend negatively on the ratio of foreign firms operating in the economy to the total number of firms (Borensztein et al., 1998: 119). However, the assumption that entry of foreign firms increases the variety of capital in the economy faces difficulty as the aforementioned pro-competitive argument indicates.

Others considered FDI as a source of physical capital exhibiting decreasing returns just like domestic physical capital, but argued that the combination of foreign and domestic capital exhibits non-diminishing returns (Bengoa and Sanchez-Robles, 2005). In their model it is the policy shock that plays the role of generating positive endogenous rates of growth through cost reduction of doing business in the host country and keeping the domestic rate of return on capital higher than the world interest rate, entailing a continuous inflow of FDI. The continuous inflow of FDI, in turn, leads to increasing growth, since when combined with domestic physical capital, it results in non-decreasing returns.

Many of the recent studies, following Findlay (1978), recognized that the most important channel through which FDI affects the host economy is its role as conduit of technology diffusion (Lai et al., 2006; Pessoa, 2005; Liu, 2008; Markusen and Venables, 1999; Hale and Long, 2007; Girma and Wakelin, 2007; Baldwin et al., 2005; Cheung and Lin, 2004). The common ground of this group of literature, whether the unit of analysis is the firm or the aggregate economy, is that FDI has technological spillovers that can be captured by domestic firms and employed as a special type of input of production. It assumes that these spillovers can be converted into firm specific capital input either freely or at a cost less than the benefit obtained from them. This assumption underlies the argument that the technological spillover results in sustained long-run economic growth as the spillover leads to productivity growth.

Other researches emphasized the importance of identifying the channels through which such FDI spillovers transfer into the host economy. These channels are identified as demonstration/imitation, labour mobility, exports, competition, and backward and forward linkages with domestic firms (Crespo and Fonoura, 2006).

A closely related theoretical issue addressed by the recent literature is what determines the FDI spillovers. This is very important since empirical evidence shows that the benefit from FDI varies across countries, which requires conceptual explanation. Though this issue occupied a central point in recent years, Findlay (1978) argues that the larger the difference in development level among countries the larger the effect of the technology transfer due to FDI. He writes:

> … the greater the backlog of available opportunities to exploit, measured by the distance between the advanced and backward region's current levels of development, the greater the pressure for change within the backward region, and the faster its rate of growth. (Findlay, 1978: 3)

However, Findlay (1978) emphasized that the technological difference should not be huge arguing that if the gaps are so wide the negative impact of the transfer of technology outweighs the benefit to the developing countries. Crespo and Fontoura (2006) expound these determinants by including others and they summarize that the main factors are absorptive capacity and technological gap, regional effect, domestic firm characteristics and FDI characteristics.

One new insight about the technology spillovers from FDI is that the effect of the spillovers could be negative or positive. Liu (2008) builds a model that is based on the assumption that the engine of growth is firm specific organization capital. Part of the magnitude of this capital is dependent on the spillovers from FDI that can be captured and used by the firm. This model is the externalities based endogenous growth model of the Barro (1990) type. The growth of the firm specific organization capital is modeled as a function of the existing stock of such capital and technology spillovers from FDI converted into firm specific capital. The main argument is that technological spillovers from FDI are public goods but require investment of scarce resources, mainly managerial time. Hence, the firm faces an ordinary constrained optimization problem where it maximizes the present value of profits; the constraint being the growth of firm specific capital as a function of existing stock of such capital

and managerial time. Intuitively, the allocation of more managerial time to conversion of the spillovers into firm specific capital leads to the long-term growth rate of productivity of the firm. This implies that the allocation of less managerial time to the current production process leads towards reducing the short-term productivity level of the firm.

The Liu (2008) model discussed in the previous paragraph seems sufficient to its objective of investigating the link between FDI and productivity spillovers at firm level. But the productivity spillovers from FDI are influenced more by the overall economic environment created by both formal institutions (mainly policies, rules and regulations) and informal institutions (such as culture, norms, social networks, etc) than mere managerial time. We argue that modeling the technology spillovers from FDI as a function of the aggregate economic environment, upon which the efficiency of managerial-time of firms itself depends, is more enlightening. Liu (2008), however, has made a significant contribution towards understanding inter-firm differences of the impact of technological spillovers from FDI on firm productivity. The results from the model by Liu (2008) that technological spillovers from FDI can have both negative and positive effects on the productivity of an economy is intuitively understandable. This is so since the managerial-time that must be invested on the conversion of the spillovers/externalities from FDI may have opposite effects on the level of productivity and long-term growth rate of productivity. The more managerial time is invested in the conversion process of such externalities, the larger the long run positive effect on the growth rate of productivity. But the same decision implies less time available for management of current production process and hence a negative effect on the level of current productivity. The overall effect being dependent on the magnitudes of these two opposite effects: short-term level effects and long-term growth rate effects.

The survey of the literature in this section attempts to show that the theoretical modeling regarding the effect of FDI on the performance of the host economy is still at its infancy and there is no single analytical framework within which the effect of FDI can be analyzed. Furthermore, we tried to show the shift from direct analysis of the link between GDP growth and FDI inflow to the investigation of the link between FDI inflow and productivity growth. In this paper we try to contribute towards

improving the theoretical framework to analyze the link between growth of productivity of the host economy and the FDI inflow.

2.2. Empirical literature

A close examination of the empirical literature indicates two approaches commonly employed to investigate the effect of FDI on economic growth of the host country. On the one hand, there is an attempt to understand the link by looking at the effect of FDI on the growth of GDP per capita (Akinlo, 2004; Bengoa and Sanchez-Robles, 2003, and 2005; Yao and Wei, 2007; Li and Liu, 2004; Borensztein et al., 1998). On the other hand, we have those employing the approach of assessing the impact of FDI on the productivity of factors of production in the recipient country. In a well cited work on the link between growth and FDI, Borensztein et al., (1998: 134) proposed this approach to be promising; stating "The results suggest that the beneficial effects on growth of FDI come through higher efficiency rather than simply from higher capital accumulation. This suggests the possibility of testing the effect of FDI on the rate of total factor productivity growth in recipient countries." However, so far only few tried to follow this approach (Pessoa, 2007; Liu and Wang, 2003; Liu, 2008).

Those that tried to investigate the link between economic growth and FDI inflow differ in their methodology and come up with mixed results. An excellent survey of the empirical work done in this area is found in de Mello (1997) and Herzer et al. (2008). According to these surveys, the mixed results, in most part, emanate from the methodological differences. Herzer et al. (2008), in particular, critically address the methodological limitations of much of the research work on the subject matter. They uncover the problems associated with econometric methods employed in cross-country, panel, panel cointegration, and time series studies employed so far. Their empirical investigation that accounts for the limitations they uncover indicates that "in the vast majority of countries there is neither a long-term nor a short-term effect; in fact, there is not a single country where a positive uni-directional long-term effect from FDI to GDP is found to exist" (Herzer et al., 2008: 16).

Those that find a positive relationship between FDI and GDP growth qualified the impact of FDI to be determined by some characteristic features of the host economy

such as human capital, openness, economic freedom, the degree of complementarity and substitutability between FDI and domestic investment, level of development, financial deepening, quality of governance, etc. (see Borensztein et al., 1998; de Mello, 1999; Kasuga, 2007; Li and Liu, 2004; Liu et al., 2002; Chang, 2007). For instance, Borensztein et al. (1998: 115) find that "the higher productivity effect of FDI holds only when the host country has a minimum threshold stock of human capital. Thus, FDI contributes to economic growth only when a sufficient absorptive capability of the advanced technologies is available in the host economy".

In light of the endogenous growth theories, estimating the effect of FDI on total factor productivity (TFP) seems preferable to test whether or not FDI can serve as source of endogenous growth. As we discussed in the previous paragraphs, FDI can affect growth of GDP per capita in the framework of both the neoclassical and endogenous growth theories. The main difference is whether the effect is temporary (as in the transition dynamics of neoclassical models) or permanent (as in the endogenous growth models). The latter can happen if FDI increases TFP through the various spillover effects associated with it.

This approach also seems reasonable since if FDI is an engine of growth through enhancing TFP, it is not the quantity of FDI inflows, as de Mello (1999: 134) argues, but its presence which may increase productivity in the host economy serving as a "catalyst for domestic investment and technological progress".

The findings from empirical work on the effect of FDI on the TFP of a firm or of the aggregate economy are not conclusive: the result is mixed. Some studies (see, among others, Blomström, 1986; Liu, 2008; Bwalya, 2006; Bengoa and Sanchez-Robles, 2003) reported the existence of a growth generating effect of FDI.

Blomström (1986) investigated whether the presence and entry of foreign firms had a positive effect on the productivity of Mexican manufacturing. The result from this cross section model is that the presence of foreign firms is correlated with structural efficiency, while the entry of foreign firms leads to structural change only in the relatively advanced part of the industries. The interesting result from Blomström (1986) is that the important source of spillover from FDI is the pro-competitive effect which implies to the competitive pressure that foreign owned firms impose on

domestic firms. The pro-competitive effect, according to Findlay (1978) discussed in page 6 of this paper, is the improvement in productivity of domestic firms achieved when domestic firms exert effort to compete and survive with the firms established via FDI which are assumed to have superior technology.

The theoretical insight on the short-term and long-term effects of spillovers from FDI on productivity by Liu (2008) has addressed the problem of mixed results and hence, inconclusiveness of empirical investigations on the subject matter. According to Liu (2008), the reason behind this problem is failure to recognize the opposing short-term and long-term effects of spillovers from FDI on productivity. This is so since the magnitude of the negative short-term and positive long-term effects depends on the length of the time frame (long-time series versus short-time series) of the samples that could easily lead to misleading conclusion unless this is accounted for.

The result from the panel data of Chinese manufacturing shows that "an increase in FDI in the industry at four digit level lowers the short-term productivity level but raises the long-term rate of productivity growth of domestic firms" (Liu, 2008: 191). The theoretical and empirical methodology employed by Liu (2008), if it holds at the aggregate economy level, may solve the existing inconclusiveness of results from studies on the subject. In this study, we employ a closely related theoretical and empirical approach but the unit of analysis is aggregate economies rather than firms.

3. The Model

The basic idea behind the theoretical model is that FDI helps to enhance the growth of productivity of the host economy through technological spillovers. The level of these spillovers available to and usable by domestic producers depends on various factors affecting the economic environment. In this study, we assume that the largest part of the economic environment that affects the availability of technological spillovers from FDI and its conversion to domestic input by producers can be explained by various public policies. These policies include fiscal and financial policies that serve as an incentive to attract FDI into the economy; creating a highly competitive environment that poses pressure on domestic firms to enhance their productivity through, among others, imitation of know-how from foreign firms. Governments can also invest in

activities that help domestic firms learn about the technology brought in by foreign firms such as training, creating networks through which knowledge sharing can take place, fiscal incentives for domestic firms to invest in R&D activities for foreign technology adoption, etc.

These public policies, among other things, depend on the capacity of the government which, for simplicity, is assumed to be determined by the resources available to the government. This line of argument is not new; it is based on Barro (1990) that develops a theoretical model indicating that endogenous growth of the economy can be explained by the externality from public capital.

However, the model in this study is different from that of Barro (1990) in two ways. First, we recognize that FDI serves as a conduit for diffusion of technology but the diffusion of technology from FDI depends on public policies. The second difference is methodological: while the Barro (1990) model employs a continuous time framework, in this model a discrete time framework is used within the recursive economic method as in Bosi (2007)[3]. Consequently, the growth rate of TFP and, hence, the growth rate of GDP per capita is endogenously determined by the optimization decisions of the economic agents.

The economy is assumed to consist of three types of economic agents: households, firms and the government. For simplicity, we assume that the economy produces a single composite product that consists of both capital and consumption goods. Furthermore, the price of this composite good is normalized at unity.

Households are assumed to be perfectly homogenous and are infinitely-lived over the period of which they maximize utility from consumption. Hence, the problem faced by a representative household can be summarized by the following constrained inter-temporal optimization:

$$\text{Max } U = \sum_{t=0}^{\infty} \beta^t U(C_t) \tag{1}$$

[3] To develop the theoretical model in this paper, the procedure followed is entirely that of Bosi (2007). However, in Bosi (2007) it is assumed that externalities from the public capital bring about endogenous growth rate of GDP. In our model, we explicitly modeled the technological spillovers from FDI affecting the growth rate of total factor productivity in a way that can incorporate Bosi (2007).

Subject to the resource constraint

$$C_t + K_{t+1} - K_t + \delta K_t \leq (1-\tau)(r_t K_t + w_t l_t) \tag{2}$$

where C, K, and l represent consumption, capital stock and labour, respectively while δ, τ, r and w stand for the depreciation rate of capital stock, the tax rate, the real return on capital, and the real wage rate, respectively and β is the discount factor. We assume that the inter-temporal utility function in (1) is well behaving (concave and increasing in its argument, C).

Assuming inelastic labour supply with full employment and normalizing labour supply to unity

$$l_t = 1 \tag{3}$$

the Lagrangian of the problem of the representative household will be given by

$$L = \sum_{t=0}^{\infty} \beta^t U(C_t) + \sum_{t=0}^{\infty} \lambda_t \left[(r_t K_t + w_t) - C_t - K_{t+1} + (1-\delta) K_t \right] \tag{4}$$

Simple rearrangement of the first order condition of this problem yields the Euler Equation that shows the inter-temporal substitution of consumption by the households.

$$\frac{U'(C_t)}{U'(C_{t+1})} = \beta \left[(1-\delta) + (1-\tau) r_{t+1} \right] \tag{5}$$

The Euler Equation in (5) states that the representative household (and hence society), allocates consumption over time in such a way that the marginal utility from one unit of current consumption equals the discounted marginal utility from the same unit if instead it is invested at the rate of r and consumed next period. To clearly understand this, assume that ρ such that $0 < \rho < 1$ is the discount rate or the rate of time preference of the society which implies that

$$\beta = \frac{1}{1+\rho} \tag{6}$$

Substituting for the discount factor, (5) can be expressed as:

$$U'(C_t) = \frac{1+(1+\tau)r_{t+1}-\delta}{1+\rho}U'(C_{t+1}) \tag{7}$$

It is clear from (7) that, other things remaining the same, the larger the discount rate, ρ, the lower is the marginal utility from current consumption. From our assumption of a standard, well behaving concave utility function, lower current marginal utility implies that much is consumed today. Likewise, an increasing rate of interest, r, implies higher marginal utility from current consumption which, given the concave utility function, implies that less is consumed during the current period. The interpretation of the Euler Equation is in line with the intuition that an increasing rate of interest is an incentive for households to postpone their current consumption for more consumption in the future, while a higher discount rate entails that current consumption is valued more than future ones.

Firms in this economy are assumed to be perfectly homogenous and to operate in a perfectly competitive market. They face a production function that exhibits constant returns to scale with respect to the purchased inputs, capital and labour. However, there is technological spillover from FDI, a third type of input, that is publicly available but the magnitude of the spillover captured and used by the firms, depends on the aggregate economic environment. Hence, we can safely assume that it is freely available for firms- or firms take this level of technological spillover as given, when they make production decision. Consequently, the production function of a representative firm can take the following general form[4]:

$$Y_t = F(K_t, l_t, \theta_t) \tag{8}$$

where Y is output and θ represents the technological spillover captured and hence utilized by firms in the economy. The problem faced by the firm is given by:

$$\underset{K_t, l_t}{\text{Max}}\ \pi = F(K_t, l_t, \theta_t) - r_t K_t - w_t l_t \tag{9}$$

[4] The technological term can enter as capital or labour augmenting or as a separate input without changing the final result.

The optimal level of production of this representative firm is given by the equality of the marginal productivity of the purchased inputs with their real returns. That is,

$$\begin{aligned} r_t &= F_K(K_t, l_t, \theta_t) \\ w_t &= F_l(K_t, l_t, \theta_t) \end{aligned} \tag{10}$$

Given the assumption of constant returns to scale production function, the production function can be expressed in output per worker terms as:

$$y_t = f(k_t, \theta_t) \tag{11}$$

where *y* and *k* are output and capital per worker, respectively. This also mean that the real returns for the factors of production expressed in (10) can be conveniently written in intensive form as:

$$\begin{aligned} r_t &= f_k(k_t, \theta_t) \\ w_t &= f(k_t, \theta_t) - k_t f_k(k_t, \theta_t) \end{aligned} \tag{12}$$

yielding

$$r_t k_t + w_t = f(k_t, \theta_t) \tag{13}$$

As discussed earlier, the potential technological spillover is public information though its conversion into input usable in the production process depends on the aggregate policy environment which, in turn, depends on the resource the economy spends on such activity. Let Ω be the potential spillovers effect that is available in the economy which is an increasing function of FDI inflow to the economy. Suppose α is the proportion of public resources allocated to activities creating conducive environment for such transfers, then the equation of motion of spillovers converted into usable input can be given by

$$\theta_{t+1} - \theta_t - \delta_\theta \theta_t = \Omega_t \alpha \tau (r_t k_t + w_t) = \Omega_t \alpha \tau f(k_t, \theta_t) \tag{14}$$

where δ_θ is the rate at which technological spillover that is converted into productive input depreciates or becomes obsolete. For simplicity, we assume that the rate of

depreciation of physical capital and rate at which technological spillover becomes obsolete is equal. That is,

$$\delta_\theta = \delta \tag{15}$$

The equation of motion of technological spillovers from FDI becomes

$$\theta_{t+1} - \theta_t - \delta\theta_t = \Omega_t \alpha \tau f(k_t, \theta_t) \tag{16}$$

Further simplification can yield the growth factor of the technological spillovers that the economy converts into usable inputs

$$\gamma = \frac{\theta_{t+1}}{\theta_t} = (1-\delta) + \Omega_t \alpha \tau f(\frac{k_t}{\theta_t}, 1) \tag{17}$$

To clearly show how the optimization decisions of the economic agents can be combined in this model to yield an endogenous growth rate in TFP (as in Barro, 1990 and Bosi, 2007), for simplicity, assume the existence of constant elasticities of inter-temporal substitution in consumption. That is,

$$\begin{aligned} u(c) &= \frac{c^{1-\frac{1}{\varepsilon}} - 1}{1 - \frac{1}{\varepsilon}} \quad \text{if } \varepsilon \neq 1 \\ u(c) &= \ln c \qquad\quad \text{if } \varepsilon = 1 \end{aligned} \tag{18}$$

where *u(c)* is the per capita utility function. The above specification of the inter-temporal utility function helps expressing the Euler Equation in (5) as in the following form:

$$\frac{c_{t+1}}{c_t} = \left(\beta\left[(1-\delta) + (1-\tau) f_k(k_t, \theta_t)\right]\right)^{\varepsilon} \tag{19}$$

Assuming that the economy is on its balanced growth path where all *y*, *c*, *k*, and θ grow at the same constant rate (Jones, 1998:33), one can conclude that the growth rate of the economy is given by the growth rate of the technological spillovers from FDI that the economy managed to convert into usable input.

$$\gamma = \frac{\theta_{t+1}}{\theta_t} = \frac{y_{t+1}}{y_t} = \frac{k_{t+1}}{k_t} = \frac{c_{t+1}}{c_t} = (1-\delta) + \Omega_t \alpha \tau f(\frac{k_t}{\theta_t}, 1)$$
$$= \left(\beta\left[(1-\delta) + (1-\tau) f_k(k_t, \theta_t)\right]\right)^{\varepsilon} \quad (20)$$

Now, it is easy to make the proposition that this study set out with; that is, externalities from FDI generate endogenous growth rate in productivity of the economy and thereby the per capita GDP of the economy. From (20) we can see that the growth rate of the economy is endogenous since it is determined by the overall economic environment that can be influenced by the decision of the households, firms and, particularly, the government through its fiscal policy. On the other hand, this growth rate is positively affected by FDI since it is the function of potential spillovers, Ω, which is an increasing function of FDI inflows:

$$\frac{\partial \gamma}{\partial FDI} = \frac{\partial \gamma}{\partial \Omega} \frac{\partial \Omega}{\partial FDI} = \alpha \tau f(\frac{k_t}{\theta_t}, 1) \frac{\partial \Omega}{\partial FDI} \geq 0 \quad (21)$$

The inequality in (21) holds given the assumption that the potential technological spillover in the economy is an increasing function of the FDI inflow into the economy[5].

Though this model is a long-run model of the economy, one can still incorporate other inputs like public capital to implicitly acknowledge the differential short-and long-run effects indicated in Liu (2008). This is so since allocation of more resources to absorb the technological spillovers from FDI (that is, the larger α) the smaller public resource available for accumulation of public capital such as various types infrastructure. This leads to a negative effect on the GDP in the short to medium term while positive long-run effects on the growth rate of productivity and GDP.

[5] The local and global stability of the equilibrium of the system can be assessed as in Bosi (2007).

4. Data, Specification and Estimation procedure

4.1. The Data

The data for this study are collected from various sources. In this sub-section, we describe the data on the two main variables of this study, that is, the data on TFP and data on FDI inflows. This study employs the new dataset for TFP developed by United Nations Industrial Development Organization (UNIDO)-UNIDO World Productivity dataset. Because of the difficulty of measuring the productivity at aggregate economy level, most researchers use the growth accounting methodology whereby the observed growth rate in GDP is decomposed into the growth of factor inputs and changes in production technologies. The measure of productivity obtained in this manner is what is commonly referred to as Solow-residual (following Solow, 1957) since it is the residual after the growth rates of inputs are deducted from the observed growth rate of GDP. However, this exercise suffers from various drawbacks such as problems in measuring labour and capital inputs and the assumption employed with respect to their prices, among others, (for a detailed discussion on theoretical and empirical issues of the method of growth accounting see Barro and Sala-i-Martin (2004: 433-460)).

The World Productivity database of UNIDO is developed in a way that overcomes or at least minimizes the problems associated with the simple growth accounting methodology (for a complete technical description of the database see Isaksson, 2007). For this database four different measures of capital stock and five measures of the labour force are employed instead of single aggregate values used in simple growth accounting. In addition "such secondary inputs as schooling and health, two functional forms, global and regional income shares, measures of technical progress and change in technical efficiency and more than ten measurement methods"(Isaksson, 2007:31) are used to develop the database. It seems obvious that the data on TFP estimated in this way are superior than the ones generated as a Solow-residual. The dataset comprises of 112 countries for which the data on productivity is estimated for the period 1960-2000 and forecasted for the period 2001-2010. For the purpose of this study, a sample of 22 Sub-Saharan African countries and the time frame 1965-2000 are selected. The justification for the selection of both

countries and time frame is the availability of data on other variables, specifically data on FDI inflows.

There are various sources of data on FDI inflows. For the purpose of this study, we initially aimed at employing the gross FDI flows into the sample countries from the IMF Balance of Payments Statistics. It is worth mentioning that IMF reports both the gross FDI inflows (in Balance of Payments Statistics) and net FDI inflows (in International Financial Statistics). The justification for the choice of the gross FDI inflows rather than the net is the purpose of the study. To investigate the impact of FDI on productivity, the interest is on the gross FDI inflows irrespective of the outflow from the host country (for more discussion, see Borensztein et al., 1998).

However, we could not obtain access to the data on gross FDI inflows and hence used the net FDI inflow data from World Bank Development data (World Bank Africa database 2005). The data for other macroeconomic variables that are expected to determine the growth of TFPsuch as openness of the economy, financial sector development, the share of agriculture in the GDP which is assumed to indicate the level of development of the country, the indebtedness of countries, etc are also taken from the same World Bank Development database.

4.2. Specification and Estimation procedure

The econometric model to be estimated follows the theoretical model specified in Section 3. In equation (17) the growth factor of the technological spillovers from FDI is expressed as a function of the potential spillovers from FDI and the proportion of public resources allocated for the conversion of the potential spillovers into productive inputs. The growth factor of the technological spillovers is captured by the growth of TFP while the potential spillover which is increasing function of FDI is captured by the net FDI inflows. After incorporating other determinants of TFP growth, the general model can be written as:

$$TFP = F(FDI, X) \tag{22}$$

Where FDI stands for net foreign direct investment inflow (for reasons discussed above), and X represents a vector of explanatory variables affecting the growth of TFP.

A review of related literature shows that there are many variables that are possible candidates to be an element of vector X. These include, among others, variables such as openness of the economy, financial sector development, the share of agriculture in the GDP, indebtedness of the nation and debt servicing (see, for example, Akinlo, 2006). With this considerations (22) can be written as

$$TFP = F(FDI, SAG, OPNN, DBT, DSR, CRE) \tag{23}$$

In (23) above, SAG is the share of agriculture in GDP of countries and OPNN stands for the openness of the economy as measured in terms of the ratio of the sum of export and import (trade) to GDP. DBT represents the total debt to export ratio while DSR stands for the debt service to export ratio. CRE is the credit extended to the private sector as a percent of total domestic loan to capture the financial deepening of the economy.

With these considerations and following Liu (2008), to seek for the empirical evidence on the nexus between technology spillovers from FDI and the growth of productivity (as captured by the growth of TFP), we estimate the following econometric model:

$$\ln TFP_{ij} = \beta_0 + \beta_1 FDI_{ij} + \beta_2 TIME + \beta_3 TIME * FDI_{ij} + \beta_4 X_{ij} + u_i + \varepsilon_i \tag{24}$$

where u denotes the unobservable country specific effect and ε denotes the remainder stochastic disturbance. X, as defined previously, represents a vector of variables that determine productivity growth. For the purpose of this study the two most important parameters are β_1 and β_3 where the former measures the short run effect of FDI on TFP while the later measures the long run effect. As in Liu (2008), in estimating the model in (24) we make an implicit assumption that the time trend of total factor productivity can serve as an indicator of the long-run rate of TFP growth.

To estimate the above econometric model, there are two alternatives that must be assessed for appropriateness: micro panel and macro panel. The macro panel method

(panel cointegration) could have been more suitable to investigate the existence of long-run relationship between FDI inflows and TFP growth rate. However, the length of time series over which data for FDI are available is so short that it is inappropriate to apply panel co-integration. Hence, the only option is to employ the micro panel (see Baltagi, 2005) facing the choice between fixed and random effect models; with the choice decision requiring consulting econometric theories and relevant empirical literature.

Provided that the process of including countries into the sample is dictated by the availability of data instead of random sampling procedure, it is difficult to claim that the design of the panel is representative of the population that the study is trying to make inference about. This implies that the individual effect cannot be characterized as random; and hence, inference is conditional on the particular countries included in the sample. According to Baltagi (2005), under such circumstances a fixed effect model is an appropriate specification.

There are additional arguments for the use of the fixed-effects specification for such an analysis. Liu (2008: 181), for example, emphasized two reasons as to why the fixed effect specification is appropriate for the econometric analysis of the technological spillovers from FDI on the growth of firm productivity; these reasons can be adapted to country level analysis. The first reason is that the fixed effects specification avoids the possible reverse causality that countries with higher rates of productivity growth attract more foreign investments. The second reason, which is more important for country level data (national income accounts) than firm level analysis, is that the fixed-effects specification can mitigate the impacts of some forms of non-random measurement errors. This problem is rife in macroeconomic datasets of less developed countries partly due to the fact that the informal sector constitutes a significant proportion of the whole economic activity. With fixed effect specification, this will have no bearing on the estimated effects of spillovers. Furthermore, according to Herzer et al. (2008), the fixed effects model, unlike the random effects model, controlling for unobserved time invariant heterogeneity by treating country specific effects as fixed but unknown constants to be estimated, eliminates a possible source of omitted-variables bias.

The discussion above from theory of panel data econometrics and the experiences of previous studies indicate that fixed effect model is *a priori* a superior specification for the problem at hand.

5. Results

5.1. Descriptive statistics

Before discussing the results of empirical analysis, in this sub section, we examine the descriptive statistics that indicates the characteristic features of the economies in the sample. Table 1 presents the summary statistics of the variables considered.

The variable TFP measures the total factor productivity of the countries in the sample relative to the US total factor productivity. As can be seen from Table 1 above the mean value of the TFP of the sample of countries is 0.25 with small standard deviation. The average net FDI inflow into the sample countries as percentage of their respective GDP is 0.94 with relatively lower standard deviation.

The summary statistics shows that there is great variation among the sample of countries with respect to the share of agriculture in GDP and the financial sector development indicator, i.e., credit dispersed to private sector as a proportion of total domestic loan. The mean value of the share of agriculture in GDP for the sample countries is about 31 percent with the largest value being approximately 74 percent (for Uganda in 1978) and the smallest value is about 3 percent (for South Africa). However, it is important to note that this variation in the share of Agriculture is not entirely the reflection of variation in the level of development of the countries considered. Instead, it is due to the fact that many of the countries in the sample highly rely on mining and other non-Agriculture primary economic activities for their livelihood.

Table 1: Summary Statistics

Variable	Mean (standard Deviation)
TFP Total factor productivity	0.2507 (0.2048)
FDI Net FDI inflow	0.9504 (2.3391)
SAG Share of Agriculture in GDP	31.65 (14.01)
CRE Percent of Credit dispersed to Private sector	67.01 (52.08)
DBT Total debt as % of export	265.55 (231.50)
DSR Debt service to export ratio	16.14 (14.26)
OPNN Openness as measured by trade GDP ratio	0.6038 (.3148)

Other characteristic features of the economies in the sample are their indebtedness and openness. As a stylized fact, Sub Saharan Africa is among the highly indebted regions of the world. The average total debt to export ratio over the period 1970-2000 is 266 percent. However, the standard deviation is very large indicating significant variation in the level of indebtedness of the countries. The data also show that the countries in the sample are relatively open on average with mean value of trade to GDP ratio of about 60 percent which is inline with size of the economies.

5.2. Econometric Results

In this sub section we present the results of empirical analysis. To investigate the effect of FDI on the total productivity of the host country we estimated the model in equation (22) using two approaches: fixed effect panel data regression (static panel model) and the dynamic panel model.

As discussed in the theoretical and specification sections, if FDI can serve as an agent of technological diffusion it must be reflected on its effect on the total productivity of the host economy. Furthermore, we argued that (inline with Liu 2008) that FDI can have both negative and positive effects on the productivity of the economy depending

on the time frame considered. To test whether this argument is supported by the data, we first estimated the fixed effect model and the result is reported in Table 2 below.

The results obtained for the sample conforms with the theoretical model and Liu (2008) in that the effect of FDI on total factor productivity is negative in the short run and positive in the long run as can be seen from the coefficients of FDI and the interaction term time*fdi. As has been argued in the literature and the theoretical model sections, the short run effect (level effect) can be negative since some scarce resources must be shifted from current production to conversion of publicly available externality from FDI into productive inputs by firms. In the long-run these converted externalities will increase the growth rate of TFP which is referred to as rate effect of FDI by Liu (2008). The overall significance of the model can also be seen from the observed *F* statistic and the corresponding *p*-value reported in the table.

Though the main objective of the paper is to investigate the link between FDI and TFP, we have also tried to see the effect of other macroeconomic variables for which data are accessible. As reported in Table 2, our result shows that countries with larger share of agriculture in their GDP will experience lower TFP which is inline with what economic theories predict. The other interesting result is the effect of financial deepening of the economy as captured by the credit dispersed to the private sector as percentage of total domestic credit. The result that we obtained proves that the financial sector development has positive and significant effect on the productivity of the economy. This implies that countries with higher financial deepening (developed financial sector) will have higher growth of TFP caused by inflow of FDI.

On the other hand, the effect of total debt as a percent of export on the TFP is negative and statistically significant while effect of the debt service to export ratio turned out to be statistically insignificant and hence was dropped from the model.

The interpretation of the negative and statistically significant effect of total debt as a percent of export is slightly subtle since the effect can go bidirectional: is high total debt as a percent of GDP the result of lower productivity or that high indebtedness as measured in terms total debt as a percent of export the cause of low TFP?

Table 2:

The effect of FDI on total factor productivity Fixed effects model, depen. var, lntfp

Variable	Coefficient
FDI	-0.0084**
	(-2.27)
Lntime*fdi	0.0132**
	(2.06)
lnSAG	-0.2378*
	(-6.73)
lnCRE	0.0378**
	(2.27)
lnDBT	-0.0915*
	(-10.19)
OPNN	-0.1991*
	(-5.65)
constant	-1.8218
	(-11.40)
R-sq: within	0.2886
Between	0.3488
overall	0.2542
F(6, 437)	29.55
Prob > F	0.0000
F test that all u_i=0	
F(21, 437)	251.67
Prob > F	0.0000

Figures in the parenthesis are t-statistic. *significant at 1 percent level. ** significant at 5 percent level

For this study, we tried to check for endogeniety between the two variables and found none. Hence, the second part of the interpretation holds, i.e., the higher the total debt as percentage of GDP, the higher will be debt repayment as percent of GDP and hence lower investment in physical and intangible capital which leads to lower growth of TFP. This is the case since almost all of the countries included in the sample are dependent on imported physical capital and technology which is highly dependent on their export earnings.

Though many theoreticians modeled that the degree of openness of the economy will have positive effect on productivity, our result is opposite to this widely held view. The rationale behind the argument that the degree of openness has positive effect on productivity, as surveyed by Lai et al (2006), is that more open economies will have higher chance of accessing and benefiting from the know-how developed in the rest of the world. However, the negative and statistically significant effect of openness in this paper is not the only result in this line. Lee

(1993) as cited in Lai et al (2006) finds negative and significant relationship between openness and economic growth.

The Dynamic model

Recognizing the dynamic nature of economic variables, in general, and the research question at hand, in particular, we also estimated the dynamic panel model using the two step Arellano-Bond (1991) GMM method by including the lagged values of the total factor productivity. This is important since such specification allows controlling the endogeniety bias and enabling testing the Granger causality test (see Hezer et al 2008). Table 3 presents the Arellano-Bond two step GMM estimator.

Table 3:
Arellano-Bond GMM two step estimators, dependent variable lntfp[6]

Variable	Coeficient
Lntfp L1	0.6552*
(lagged tfp)	(8.01)
fdi	-0.0050*
	(-5.72)
Lntime*fdi	0.0046**
	(2.35)
lnSAG	0.0509**
	(2.35)
lnCRE	0.0189*
	(2.88)
constant	-0.8101
	(-5.72)
Wald chi2(5)	160.92
Prob > chi2	0.0000

Figures in the parenthesis are t-statistic. *significant at 1 percent level. ** significant at 5 percent level

As can be seen from this table the lagged value of the TFP has positive and strongly significant effect while the other variables maintained their signs and significance except for the share of agriculture.

In general, the econometric results obtained from both the static panel model and the dynamic panel model conform to the theoretical model constructed in this

[6] Note that this model is estimated for the whole variables in the earlier model but total debt to export ratio, debt service to export ratio and openness turned out to be statistically insignificant thought they maintained their signs and hence the model is re estimated after dropping these variables

paper and that of Liu (2008) though the later deals with panel of firms in the Chinese economy. The essence is that FDI has technological spillover that increases the TFP of the host economy.

6. Concluding Remarks

There is enormous evidence on the effect of FDI on the performance of the host economy in general and growth of the economy in particular. Most of this literature (both theoretical and empirical) is concentrated on the investigation of the link between FDI and growth of GDP. In this paper, following a suggestion by (Borensztein, et.al., 1998) we tried to look into alternative way of identifying the link between FDI and growth. The basic argument in this paper is that if FDI has positive spillover effect to the domestic producers of the host economy, it must be captured by its positive effect on the productivity of the economy. Hence, we tried to construct an alternative analytical model, within the externalities type endogenous growth theory, in which technological spillovers from FDI generates long run growth of the host economy, through its positive effect on its TFP and tested the model using panel data from 22 Sub-Saharan African countries.

The empirical results obtained from both static and dynamic panel models conform to the theoretical model in that FDI has positive effect on TFP in the long-run and negative effect in the short run.

Though this result is by no means conclusive of the research in this area which has been characterized by mixed results and hence inconclusiveness on the link between FDI and growth, it is our firm belief that it can serve as a shift in the way we might look into this research issue.

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