

# A General Equilibrium Perspective on Offshoring and Economic Growth

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## Abstract

Faced with the empirical difficulty to demonstrate direct links to growth, several attempts have recently been made to isolate alternate channels through which offshoring and foreign direct investment may promote economic growth in host countries. This paper offers a new macroeconomic perspective on this issue and highlights positive effects on human and physical capital accumulation. It first makes the point that there need not be cross-border flows of resources for globalization to benefit an economy, especially when foreign entrepreneurs can raise resources locally to meet their production needs as documented by Graham and Krugman (1991), Kindleberger (1969), and Lipsey (2003). We find that upward pressures on factor prices provide locals with the necessary incentives to accumulate the relevant factors, thus spurring economic growth in a more “natural” way than generally discussed in the literature. A dynamic general equilibrium framework in which offshoring and FDI materialize as an aggregate positive shock to the demand for intermediate goods is developed and solved analytically. In addition to fostering consumption growth while raising the capital intensity of tradeables along the transition path, these features of the global economy era are also shown to improve the net foreign asset position of the host country over the very long run.

**Keywords:** Offshoring; Endogenous Growth; Foreign Asset Position.

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# 1 Introduction

The contribution of offshoring, and more generally of foreign direct investment (FDI) to the economic growth of host countries has been a recurrent theme of the international trade literature over the recent years. Faced with the difficulty to demonstrate direct links to growth, several attempts have lately been made to isolate alternate channels through which FDI and offshoring promote economic growth in host countries.<sup>1</sup> While most of the recent attempts involve appealing empirical endeavors, this paper offers a theoretical investigation while adding to the literature on structural transformations whose main contributors include Temple and Voth (1998), Laitner (2000), Kongsamut et al. (2001), Gollin, Parente and Rogerson (2002), Ngai and Pissarides (2007), and Echevarria (2008).

Early in the 90ies the endogenous growth literature pointed to the process of technological diffusion as the main mechanism through which FDI fosters economic growth in host countries. Since then the predominant view has been that FDI contributes to the direct increase of capital formation in the recipient economy while allowing the introduction of new technologies such as new production processes and techniques, managerial skills, ideas, and new varieties of capital goods. Yet, in a recent survey of the literature Kose and al. (2003) conclude that empirical research does not find a robust significant effect of financial integration on growth, hence the renewed interest for this issue.

This paper sheds light on a demand channel whereby FDI may promote economic growth in host countries while inducing the structural transformation of (recipient) developing economies. It has now been well documented that foreign direct investment and offshoring increase the demand for intermediate goods in host countries (see, *e.g.* Markusen and Venables, 1997; Feenstra and Hanson, 1997). Based on this finding we develop a simple and tractable endogenous growth model within an dynamic general equilibrium framework in which we introduce an exogenous index to feature the magnitude of foreign direct investment flows to an economy.<sup>2</sup> By shifting the demand for intermediate goods in proportion

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<sup>1</sup>Forbes (2004) provides an overview of this emerging micro literature.

<sup>2</sup>That we consider an exogenous shock is by no means inconsistent with a general equilibrium analysis.

to incoming flows of FDI this parameter holds central stage in the model and its impact on factor prices and returns allows us to rationalize economic growth through direct factors accumulation.

Our modeling strategy is governed by the notion that there need not be cross-border flows of resources for globalization to benefit an economy, especially when foreign entrepreneurs can raise resources directly in the host country to meet their production needs. In fact, Graham and Krugman (1991), Kindleberger (1969), and Lipsey (2003) document that investors engaging in FDI often fail to bring all the capital with them, but rather tend to finance an important share of their investment in the local market.<sup>3</sup>

Our model features an economy where packaging together a continuum of non-traded and horizontally-differentiated human capital intermediate goods yields a composite human capital good, whereas packaging together a continuum of non-traded and horizontally-differentiated physical intermediate goods yields a tangible final good. The latter can either be accumulated or consumed. In this environment foreign direct investment takes the form of foreign entrepreneurs engaging in the production of final goods in the host country, whereas offshoring refers to the arrangement whereby firms carry out stages of production abroad.<sup>4</sup> An extreme case of the latter arises when, say, only administration is maintained in the source-country. A crucial feature of the model pertains to the assumption that both final goods, *i.e.* human and physical capital composite goods enter the production process of each intermediate good. Given this description and to follow the lead of Grossman and Rossi-Hansberg (2008) FDI and offshoring mainly map into an aggregate shock along the demand side of local markets for intermediate goods. The increased demand for intermediate goods is then shown to raise factor prices and returns, hence providing locals with the necessary incentives to accumulate the relevant factors. Economic growth ultimately unfolds in a more

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The issue of whether and how economic growth may feedback into FDI inflows is beyond the scope of our analysis.

<sup>3</sup>Furthermore, Prasad *and al.* (2007) show that countries with underdeveloped financial systems may not be able to use foreign capital to finance growth.

<sup>4</sup>An example of foreign firms engaging in the production of final human capital goods abroad is provided by the increasing number of western universities opening affiliates in developing countries.

“natural” way than usually discussed in the literature, and yet our demand channel clearly departs from the usual spill-over effect line of analysis which so far has found only mixed empirical support as Kose and al. (2003) pointed out.<sup>5</sup>

That intermediate goods are non-traded is a standard assumption in the literature (see, *e.g.* Grossman and Helpman, 1990; Markusen and Venables, 1999; Rodriguez-Clare, 1996). This assumption implies that foreign firms directly produce in the host country, say by building a plant instead of simply exporting. This strategy is traditionally rationalized with reference to either the OLI line of analysis - Ownership, Localization, Internalization advantage (see, Dunning, 1981), or to domestic factors such as local content requirements, opportunities to tap into local resources, access to low-cost inputs, or to bypass tariffs that protect a market from imported goods. Clearly, the notion that host countries might be protecting local markets while FDI is taking place bears no contradiction, hence our strategy to first highlight the key mechanism using a closed economy set up. An extension to the small open economy case subsequently offers the opportunity to investigate the long-run dynamics of the net asset position.

In exploring the demand channel whereby FDI and offshoring spur economic growth in host countries we elected to focus on downstream outcomes. In fact, firms’ motivations to either go offshore or engage in FDI are extensively investigated in numerous recent contributions to the literature (see, *e.g.* Grossman and Rossi-Hansberg, 2008; Nocke and Yeaple, 2008; Almazan *et al.*, 2007; Antras, Garicano and Rossi-Hansberg, 2006; Grossman and Helpman, 2005). In clear, investigating the micro-economic channels through which FDI raises the demand for intermediate inputs is beyond the scope of this paper.

With regard to human capital, offshoring and FDI are often cited in explaining the raising wage premium for skilled workers in developing countries (see, *e.g.* Feenstra and Hanson,

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<sup>5</sup>That FDI may be accompanied with capital inflows has no incidence on the conclusions one can derive from an inter-temporal framework like ours. In fact, this may initially depress the return to physical capital while raising the return to human capital. However, as human capital accumulation takes place, the marginal product of physical capital would increase, and thus would trigger the same mechanism as the one highlighted in this paper.

1997). However, on the one hand skilled labor wage captures the return to human capital investments (incentive for accumulation), and on the other hand, through trainers' wages it also determines the cost of skills acquisition (a constraint to human capital accumulation). Therefore, the notion that offshoring and FDI encourage skilled labor supply in the host country is all but trivial. Clearly, one might witness a growing wage premium for skilled workers without any further accumulation, with the result that there is no real benefit for the host country over the long run.

Likewise, capital inflows might be feared to lower the return to capital in host countries, and thus prevents any local accumulation. Yet, using data from 19 emerging economies, Kumar (2007) documents that FDI actually crowds in domestic investment and delivers a positive impact on savings, a puzzling finding we are able to rationalize in this paper. In the current framework incoming resources raise the demand for complementary factors, and this in turn raises the demand for capital needed to produce those very same factors. As we find that the return to capital is higher in the general equilibrium of the economy, this suggests that overall the demand for extra capital offsets the initial injection, and thus spurs local savings and investment.

The mechanism highlighted in this paper also allows us to connect different pieces of some recent empirical evidence showing that (1) developing countries' share of foreign direct investments inflows has significantly increased over time; (2) their exports are increasingly becoming skill and capital-intensive; and (3) these countries' contribution to FDI outflows has recently been on the rise.<sup>6</sup>

Our theory of trade-induced structural transformation for (at least) emerging countries stipulates that once foreign entrepreneurs engage into production activities in an economy and incidentally induce locals to accumulate human and physical capital as shown in this paper, the new configuration of the economy alters the factor content of the host country's commodities and exports, a dynamics that eventually overturns the host country's patterns

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<sup>6</sup>See, UNCTAD - United Nations Conference on Trade and Development (2007), *World Investment Report*, p. 3; UNCTAD (2006), *World Investment Report*, p 108, and UNCTAD (2004), *Development and Globalization: Facts and Figures*, p. 93.

of trade. Thus, an initially skill and capital-scarce economy can end up exporting skill and capital intensive goods while improving its current account position. Our results lay support to both the desirability and the sustainability of a development strategy that rests on attracting foreign entrepreneurship and investment in the light of the global economy era. As we also find that welfare improves faster after an initial drop in consumption, our analysis bears significant implications for today's developing countries.

In particular, that developing countries would export skill and capital intensive goods contrasts significantly with the standard Heckscher-Ohlin prediction of international trade patterns. This mainstream theory predicts that the comparative advantage of labor-intensive developing countries should lie in primary goods and unskilled-labor rather than skill and technology-intensive activities. We rationalize the intuition that the unprecedented inflows of foreign direct investment, which some developing countries have witnessed over the recent decades, may have triggered their structural transformation through direct human and physical capital accumulation. This analysis sets the connection with the literature on structural transformations (see, *e.g.* Laitner, 2000; Gollin, Parente, Rogerson, 2002), and the potential role of human capital (see, *e.g.* Temple and Voth, 1998). In particular, our analysis contrasts well with the sectoral approach of this strand of the literature as contributed by Kongsamut et al. (2001), Echevarria (2008), Ngai and Pissarides (2007).

Exogenously-driven growth differentials in total factor productivity across sectors underlie the mechanism of structural transformation in Ngai and Pissarides (2007). Likewise, Echevarria (2008) emphasizes sectoral TFP differentials along with non-homothetic preferences to explain the shift away in trade specialization from primary toward manufactured goods. While both papers offer compelling growth and structural change theories, they overlook the undeniable role of cross-border arbitrages in production, a typical feature of the global economy era. Yet, the notion that offshoring and inward FDI have played a central role in some recent economic development experiences is hardly disputable. This paper shuts down sectoral TFP growth differentials and emphasizes trade-induced factors accumulation as a driving force for structural transformation.

The production side of our model economy consists of two stages. Each stage involves two kinds of goods, *i.e.* human capital goods on the one hand and tangible goods on the other hand. Imperfectly competitive firms *à la* Dixit-Stiglitz (1977) produce differentiated human capital and physical intermediate goods using both the human capital composite good and the tangible final good. Composite goods in turn are produced by packaging either human or physical intermediate goods together. Perfect competition prevails in the final good sectors and technology is of the CES form. Each intermediate good is produced using a standard Cobb Douglas technology.<sup>7</sup> It is also assumed that the human capital composite and all intermediate goods are non-tradeable whereas the tangible final good (our numeraire) is tradeable.<sup>8</sup> In addition, the former can only be accumulated, whereas the latter is either consumed or accumulated.

The consumption side of the economy consists of a large number of homogenous households, each endowed with homothetic preferences defined over the tangible final good only. To follow the lead of Echevarria (2008), the representative consumer owns the factors of production and decides their distribution between alternative uses.

Summarizing our findings, under mild conditions:

(1) foreign direct investment and offshoring raise the price of, and even more so, the return to both human and physical capital;

(2) the same features accelerate direct human and physical capital accumulation, and as such, foster economic growth;

(3) foreign direct investment and offshoring also raise the (physical) capital intensity of tradeables, and,

(4) while being initially welfare-reducing, they spur consumption growth thereafter;

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<sup>7</sup>In the appendix section we show that the results remain even if one considers differing production functions for human capital and tangible goods.

<sup>8</sup>One can still use this framework to investigate the effects of vertical integration of production across countries. Clearly, if foreign firms can enter the sector of intermediate goods, say with affiliates producing for their parent enterprises abroad, our results would still hold. This is because both final goods are required to produce each of the intermediate goods. The input-output structure of our model clearly sets backward and forward linkages which in turn ensure a great deal of generality to the results.

(5) the net foreign asset position of the host country improves in the steady-state of the economy.

The remainder of this paper is structured as follows. Section 2 presents the benchmark model in closed economy. Section 3 solves for the model's solution. Section 4 extends the benchmark model to the small open economy case and section 5 contains concluding remarks.

## 2 A benchmark model economy

The model is a direct extension of Lucas (1988) and Benassy (2003), which we have adapted for the purpose of our study. We assume an environment in which economic activities extend over an infinite number of periods  $t = 0, 1, \dots$ . Foreign entrepreneurs may carry out production in the final good sectors and as such, boost the demand for intermediate goods. This effect of foreign direct investment and offshoring has now been extensively documented in the literature. Thus our goal is to investigate the implications for factors accumulation, the growth rate of the economy and welfare.

### 2.1 The final goods sector

The tangible final good,  $Y_t$ , is produced by perfectly competitive firms according to a CES technology. The production of this good consists of packaging together tangible intermediate goods, hence:

$$Y_t = \left( \int_0^1 Y_{jt}^\theta dj \right)^{1/\theta}, \quad 0 < \theta < 1, \quad (1)$$

where  $Y_t$  denotes total output,  $Y_{jt}$  the quantity used of the tangible intermediate good  $j$ , and  $\theta$  a positive parameter which captures the degree of substitutability between the different intermediate goods and as such, the market power of the corresponding suppliers, with  $j \in [0, 1]$ . Our normalization of the measure of intermediate inputs to equal one follows a standard practice in the literature (see, *e.g.* Grossman and Rossi-Hansberg, 2008).

Since the tangible final good is either consumed or accumulated as next period stock of physical capital, the following identity holds :

$$Y_t = C_t + I_t, \quad (2)$$

where  $C_t$  is aggregate consumption and  $I_t$  total (physical) capital investment.

Next, since  $Y_t$  is our numeraire, letting  $P_{jt}$  denote the relative price of intermediate good  $j$  profit maximization yields the following demand schedule for type- $j$  tangible intermediate good:

$$Y_{jt} = (P_{jt})^{-1/(1-\theta)} Y_t. \quad (3)$$

Likewise, human capital composite,  $X_t$ , derives from a CES aggregation over human capital intermediate goods:

$$X_t = \left( \int_0^1 X_{it}^\theta di \right)^{1/\theta}, \quad 0 < \theta < 1, \quad (4)$$

where  $X_{it}$  denotes type- $i$  human capital “good” with  $i \in [0, 1]$ . Letting  $\rho_{it}$  denote its relative price, profit maximization in this sector yields the following demand schedule:

$$X_{it} = \left( \frac{\rho_{it}}{\rho_t} \right)^{-1/(1-\theta)} X_t, \quad (5)$$

where  $\rho_t$  is the price index associated to (4). Both (3) and (5) give the standard downward sloping demand curves facing the monopolists.

## 2.2 Introducing offshoring and FDI

In taking advantage of the extensive evidence that foreign direct investment and offshoring raise the demand for intermediate goods in host countries, we first define a generic index  $\varepsilon \in [0, 1]$  to proxy the magnitude of FDI incoming flows to an economy. The larger the flows, the higher the corresponding index. However, while FDI flows may vary across sectors and over time, we assume away any time-varying or sector-specific dynamics. In that we follow the lead of Grossman and Rossi-Hansberg (2008) by modeling FDI as an aggregate permanent shock hitting all sectors across the economy alike. While firm or sector-specific

shocks may be intellectually more appealing, they tend to blur the analysis without adding much to the paper's main mechanism. Therefore, it is assumed that on average foreign direct investment and offshoring raise the demand for intermediate goods by a factor of  $\delta \equiv (1 - \varepsilon)^{-1}$ . The altered demand schedules are given below:

$$\tilde{Y}_{jt} \equiv (1 - \varepsilon)^{-1} Y_{jt} = (1 - \varepsilon)^{-1} (P_{jt})^{-1/(1-\theta)} Y_t, \quad (6)$$

$$\tilde{X}_{it} \equiv (1 - \varepsilon)^{-1} X_{it} = (1 - \varepsilon)^{-1} \left( \frac{\rho_{it}}{\rho_t} \right)^{-1/(1-\theta)} X_t. \quad (7)$$

Equations (6) and (7) embody the notion that given the respective initial aggregate demands for each of the final goods,  $Y_t$  and  $X_t$ , the larger the inflows of FDI (*i.e.* bigger  $\varepsilon$ ), the larger the demand for type  $-h$  intermediate good,  $h = i, j$ .

The next section describes the production environment for intermediate goods.

### 2.3 The intermediate-goods sector

Differentiated intermediate goods are produced by monopolistic competitive firms indexed by  $j$  (for tangible goods) and  $i$  (for "human capital goods"), with  $i, j \in [0, 1]$ . Firms combine physical and human capital composites according to the following Cobb Douglas production function:

$$Y_{jt} = AK_{jt}^\gamma H_{jt}^{1-\gamma}, \quad 0 < \gamma < 1, \quad (8)$$

$$X_{it} = ZK_{it}^\gamma H_{it}^{1-\gamma}, \quad (9)$$

where  $K_{ht}$  ( $H_{ht}$ ) is physical (respectively, human) capital rented out by firm  $h = i, j$ ,  $A$  and  $Z$  are positive technological parameters which we assume time-invariant.

Next, human and physical capital composites can each be accumulated for next period. However, they also fully depreciate after usage, hence the following laws of motion:

$$K_{t+1} = I_t, \quad (10)$$

$$H_{t+1} = X_t. \quad (11)$$

On the other hand, market clearing conditions are given by the following equations:

$$K_t = K_{xt} + K_{yt}, \quad H_t = H_{xt} + H_{yt}, \quad (12)$$

with

$$K_{xt} = \int_0^1 K_{it} di, \quad K_{yt} = \int_0^1 K_{jt} dj, \quad H_{xt} = \int_0^1 H_{it} di, \quad H_{yt} = \int_0^1 H_{jt} dj. \quad (13)$$

In the appendix section we show that the first order conditions of the maximization problems can be rewritten as follows:

$$(1 - \varepsilon)^{-1} \gamma \theta P_{jt} Y_{jt} = R_{jt} K_{jt}, \quad (14)$$

$$(1 - \varepsilon)^{-1} (1 - \gamma) \theta P_{jt} Y_{jt} = W_{jt} H_{jt}, \quad (15)$$

$$(1 - \varepsilon)^{-1} \gamma \theta \rho_{it} X_{it} = R_{it} K_{it}, \quad (16)$$

$$(1 - \varepsilon)^{-1} (1 - \gamma) \theta \rho_{it} X_{it} = W_{it} H_{it}. \quad (17)$$

hence the result:

**Lemma 1** *(Part one) All else equal, imperfect competition (i.e. low  $\theta$ ) lowers the return to human and physical capital.*

*(Part two) All else equal, foreign direct investment and offshoring raise the return to human and physical capital.*

**Proof.** In the appendix section we show that

$$R_t = \frac{\gamma \theta}{(1 - \varepsilon)} \frac{(Y_t + \rho_t X_t)}{K_t}, \quad (18)$$

$$W_t = \frac{(1 - \gamma) \theta}{(1 - \varepsilon)} \frac{(Y_t + \rho_t X_t)}{H_t}. \quad (19)$$

■

We consider the consumption side of the economy next.

## 2.4 Preferences

A large number of homogenous households have preferences defined over expected streams of consumption,  $C_t$ . The representative household ranks alternative streams of consumption using the following expected utility function:

$$E_t \sum_{t=0}^{\infty} \beta^t \ln C_t, \quad (20)$$

where  $0 < \beta < 1$  denotes the usual rate of time discounting and the operator  $E_t$  the mathematical expectation conditional on period  $t$  information.

The representative household seeks to maximize (20) subject to the sequence of its periodic budget constraints. Time  $t$  budget constraint is as follows:

$$C_t + K_{t+1} + \rho_t H_{t+1} = R_t K_t + W_t H_t + \Pi_t, \quad (21)$$

where  $K_{t+1}$  denotes investment,  $K_t$  and  $H_t$  stand for the accumulated stocks of physical and human capital respectively,  $\rho_t$  is the relative price of human capital,  $R_t$  is the monetary return on physical capital,  $W_t$  is the nominal wage rate, and  $\Pi_t$ , the nominal profits accruing to the household. Equation (21) illustrates the fact that (i) the tangible final good is the numeraire, and (ii) capital fully depreciates after usage. Thus, resource constraint is given by:

$$\psi_t \equiv Y_t + \rho_t X_t = C_t + K_{t+1} + \rho_t H_{t+1}. \quad (22)$$

On the other hand, equations (1), (4), (8) and (9) imply that

$$\psi_t = BK_t^\gamma H_t^{1-\gamma}, \quad (23)$$

where aggregate total factor productivity,  $B$ , is some combination of sectoral TFP,  $A$  and  $Z$ .

Solving for the optimal values of  $C_t$ ,  $H_{t+1}$  and  $K_{t+1}$ , it can be shown that

$$\frac{\rho_t}{C_t} = \beta E_t \left( \frac{W_{t+1}}{C_{t+1}} \right), \quad (24)$$

and

$$\frac{1}{C_t} = \beta E_t \left( \frac{R_{t+1}}{C_{t+1}} \right). \quad (25)$$

Combining equations (24) and (25) unveils a one-to-one relationship between the current relative price of the final human capital good and its expected relative return:

$$\rho_t = E_t (W_{t+1}/R_{t+1}), \quad (26)$$

hence the result:

**Lemma 2** *The higher the expected stock or supply of physical capital relative to human capital, the higher the current relative price of human capital.*

**Proof.** The proof proceeds by substituting equations (18) and (19) into equation (26):

$$\rho_t = (1 - \gamma) \gamma^{-1} E_t \left( \frac{K_{t+1}}{H_{t+1}} \right). \quad (27)$$

This ends the proof. ■

Lemma 2 illustrates the important point that anticipations of human capital shortage relative to physical capital cause upward pressures on the current price of human capital goods. This is because forward-looking agents would typically react to such prospects by raising their demand for skill-enhancing programs in the current period.

The next section solves for the general equilibrium of the economy.

### 3 Equilibrium analysis

The following definition provides an equilibrium concept to underlie our study:

**Definition 1 (Equilibrium)** *An inter-temporal general equilibrium for this economy is a sequence of prices,  $\{\rho_t, \rho_{it}, P_{jt}, R_{it}, R_{jt}, R_{xt}, R_{yt}, R_t, W_{it}, W_{jt}, W_{xt}, W_{yt}, W_t\}_{t=0}^{\infty}$ , a sequence of consumption  $\{C_t\}_{t=0}^{\infty}$  and investment levels  $\{I_t, X_t\}_{t=0}^{\infty}$ , a sequence of resource allocations across firms,  $\{K_{ht}, K_{ht}, H_{ht}, H_{ht}\}_{t=0}^{\infty}$ ,  $h = i, j$ , and sectors  $\{K_{xt}, K_{yt}, H_{xt}, H_{yt}\}_{t=0}^{\infty}$ , such that, for all  $t$ :*

- (i)  $W_{jt} = W_{it} = W_{xt} = W_{yt} = W_t^*$  and  $R_{jt} = R_{it} = R_{xt} = R_{yt} = R_t^*$ ;
- (ii) given prices  $(\rho_t, \rho_{it}, P_{jt}, R_t, W_t)$ ,  $C_t$ ,  $H_{t+1}$  and  $K_{t+1}$  solve (20) - (25),  $I_t = K_{t+1}$ , and  $X_t = H_{t+1}$ ;
- (iii) given total output for the tangible final good  $(Y_t)$ ,  $K_{xt}, K_{yt}, H_{xt}, H_{yt}, W_t$  and  $R_t$ , solve (6) - (17);
- (iv) all markets clear.

The next definition provides the conceptual framework of our study.

**Definition 2 (Balanced growth path)** *Along a balanced growth path the ratio of (physical) capital to aggregate output is constant.*

This definition underlies our only theorem. Let:

$$(1 - \varepsilon)^{-1} \theta \beta < 1, \quad (28)$$

where  $\varepsilon \in (0, 1)$ ,  $\theta \in (0, 1)$  and  $\beta \in (0, 1)$ , then:

**Theorem** *There exists a balanced growth path for this economy.*<sup>9</sup>

**Proof.** Using equation (23) it can be shown that  $K_t/\psi_t = B^{-1}(K_t/H_t)^{1-\gamma}$ . In the appendix section we also show that  $K_t/H_t = (1 - \gamma)(1 - \varepsilon)^{-1} \theta \beta$ . Thus,

$$\frac{K_t}{\psi_t} = \frac{1}{B} [(1 - \gamma)(1 - \varepsilon)^{-1} \theta \beta]^{1-\gamma}. \quad (29)$$

This ends the proof. ■

Equation (29) also carries the important implication that the larger foreign direct investment and offshoring inflows to an economy, the higher the ratio of physical capital to total output. At first glance this finding may seem trivial especially as FDI generally involves some cross-border transfers of resources. The actual underlying mechanism is investigated in more detail below and the results unveil a more complex dynamics.

On our way to featuring the dynamics of this economy, we first highlight some important results pertaining to factor prices and returns.

**Proposition 1** *Let condition (28) hold. Then :*(1) *The larger foreign direct investment and offshoring inflows, the higher the return to physical capital.*

(2) *The larger foreign direct investment and offshoring inflows, the bigger the return to human capital and the higher the relative price of “human capital goods.”*

**Proof.** Provided in the appendix section. ■

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<sup>9</sup>Unbalanced growth may arise in the event of sector-specific shocks.

The results above still pose a challenge in that inward waves of foreign direct investment raise both the cost of, and the return to human capital accumulation. Hence it is not clear whether a rational individual would opt for accumulation in such situation. The next proposition clears out this issue.

**Proposition 2** *Let condition (28) hold. Then, in the long run foreign direct investment and offshoring foster both human and physical capital accumulation in host countries.*

**Proof.** Provided in the appendix section. ■

Proposition 2 is important because it suggests that foreign direct investment and offshoring may foster economic growth through its fundamentals, *i.e.* through factors accumulation. The result in Proposition 2 aligns with Kumar's (2007) finding based on data from 19 emerging economies and pointing to the fact that FDI actually crowds in domestic investment and delivers a positive impact on savings in host countries. Kumar finds that one percentage point rise in the ratio of FDI to GDP leads to an increase of a half percentage point in domestic investment and three-fourths percentage point in domestic savings.

Proposition 2 arises as the net benefit of accumulation - which we define in natural logarithmic terms as the difference between, say, the return to human capital accumulation,  $W_t$ , and its cost,  $\rho_t$  - increases with the size of FDI and offshoring inflows. In fact, it can be shown that

$$\frac{W_t}{\rho_t} = (1 - \varepsilon)^{-\gamma} (1 - \gamma)^{-(1-\gamma)} \beta^{-(1-\gamma)} \gamma \theta^\gamma A.$$

Similarly, since the tangible final good is our numeraire, that the net return to physical capital is higher follows directly from Part 1 in Proposition 1 (FDI raises the direct return to physical capital).

With the above results in hand, a natural extension is to formally rationalize the impact of foreign direct investment and offshoring on the economic growth of host countries. We take that step next in the following corollary to Proposition 2:

**Proposition 2 - Corollary:** *Let condition (28) hold. Then, foreign direct investment and offshoring foster economic growth in the host country. The larger the flows, the higher the growth rate of the economy.*

**Proof.** The result follows from (23) and proposition 2, which together imply that  $g_\psi = g_k = g_h$ .

This ends the proof. ■

Proposition 2 and its corollary were derived under the simplifying assumption that production functions are identical for both human capital and tangible intermediate goods. As a robustness check we relax that assumption below. This exercise provides more insight into the growth process of this economy. The next proposition highlights the dynamics of factor contents in the light of the available evidence that developing countries' exports are increasingly becoming capital intensive.

**Proposition 3** *Let condition (28) hold. If in addition output is relatively more sensitive to capital in the  $y$ -industry compared to the  $x$ -industry, then in the long run foreign direct investment raises the capital intensity of tangible goods.*

**Proof.** To prove the result, we consider the following production functions:

$$\begin{aligned} Y_{jt} &= AK_{jt}^\gamma H_{jt}^{1-\gamma}, \quad 0 < \gamma < 1; \\ X_{it} &= ZK_{it}^\alpha H_{it}^{1-\alpha}, \quad 0 < \alpha < 1. \end{aligned}$$

In the appendix section, while generalizing Proposition 2 we also show that

$$\kappa_y = \frac{(1 - \varepsilon) \gamma}{\gamma(1 - \varepsilon) - (\gamma - \alpha) \theta \beta},$$

where

$$\kappa_y \equiv \frac{K_{yt}/K_t}{H_{yt}/H_t} \equiv \frac{K_{yt}/H_{yt}}{K_t/H_t}.$$

Differentiating  $\kappa_y$  with respect to  $\varepsilon$  then yields the result:

$$\frac{d\kappa_y}{d\varepsilon} = \frac{(\gamma - \alpha) \gamma \theta \beta}{[\gamma(1 - \varepsilon) - (\gamma - \alpha) \theta \beta]^2}.$$

This ends the proof. ■

The intuition for this result is as follows. Assume physical capital is more productive if used to produce tangible goods instead of human capital ones, *i.e.* it impacts output more in

the former sector. Then, in order to boost output when experiencing a demand shock the  $y$ -industry emphasizes physical capital relatively more than the  $x$ -industry. Capital goods will then become more capital intensive over time even after controlling for the capital intensity of the whole economy.

At this point our results suggest a potential dilemma for an economy that undergoes such transformations. At issue is the challenge to fulfil the rising capital intensity of the  $y$ -industry while meeting consumption needs. The issue arises as investment and consumption are competing claims on the  $y$ -industry's output. In discussing the welfare implications of the model we proceed under the maintained and simplifying assumption that  $\gamma = \alpha$ . The next proposition summarizes our findings:

**Proposition 4** *Let condition (28) hold. Then foreign direct investment is initially welfare-reducing but fosters consumption growth thereafter.*

**Proof.** As shown in the appendix section, the ratio of total consumption to aggregate output is constant and given by the following equation:

$$\frac{C_t}{\psi_t} = 1 - \frac{\theta\beta}{1 - \varepsilon}. \quad (30)$$

The first claim then follows by way of differentiation with respect to  $\varepsilon$ .

The second claim stems from the fact that  $C_t/\psi_t$  is constant. This implies that consumption growth keeps pace with economic growth.

This ends the proof. ■

Intuitively, as FDI leads the typical household to accumulate more of both human and physical capital in the host country, proposition 4 points to an initial crowding-out effect on consumption. However, as shown in Proposition 1 foreign direct investment and offshoring also raise the return to both types of investment, hence allowing the typical household to afford more consumption later on.

The next section investigates the dynamics of the net asset position in the light of our findings in closed economy.

## 4 The small-open economy case

This section allows for international trade in final tangible goods and specializes the analysis to a small-open economy with unlimited access to world markets. The typical household still ranks alternative streams of consumption according to the utility function given in (20). Letting domestic and foreign final composite goods be perfect substitutes and endowing consumers with identical preferences internationally, the small open economy assumption implies that export and import prices are determined in world markets. Total expenditures on the final physical good can be expressed as follows:

$$Y_t = C_t + I_t + NX_t, \quad (31)$$

where  $NX_t$  denotes net exports.

### 4.1 The current account's dynamics

In a model like ours general equilibrium effects can be quite blurry when analyzing an open economy. To clarify these effects we restrict our attention to long-run effects by emphasizing the current account's behavior in the steady state of the economy.

**Definition 3 (Steady state equilibrium)** *A steady state equilibrium is a general equilibrium which in addition satisfies  $K_t^* = K_{t-1}^* = K^*$ , and  $H_t^* = H_{t-1}^* = H^*$  for all  $t$ , where  $K^*$  and  $H^*$  denote the steady-state values of physical and human capital respectively.*

Following the lead of Obstfeld and Rogoff (1995), and Sheffring and Woo (1990), the inter-temporal model of the current account can be expressed in real terms as:

$$CA_t = \Delta F_{t+1} = NX_t + r_t F_t, \quad (32)$$

where  $r_t$  is the real interest rate, and  $F_t$  the net asset position. For a small open economy as the one we are investigating the real interest rate is also exogenously determined, hence  $r_t = \bar{r}$ .

Combining (31) and (32) yields the following expression for the current account:

$$CA_t = \Delta F_{t+1} = Y_t - C_t - I_t + \bar{r}F_t.$$

Thus, in real terms net foreign asset holdings in the steady state of the economy can be expressed as follows:

$$F^* = \frac{-1}{\bar{r}} (Y^* - C^* - I^*), \quad (33)$$

hence the result:

**Proposition 5** *Let condition (28) hold. If in addition  $B < (1 - \gamma)A$ , then in the very long run (steady state), foreign direct investment and offshoring improve the host country's net asset position.*

**Proof.** While proving Proposition 1 we showed (in the appendix section) that  $Y_t = [1 - (1 - \gamma)(1 - \varepsilon)^{-1}\theta\beta] AK_t^\gamma H_t^{1-\gamma}$ . On the other hand, combining equations (23) and (27) using the result that  $K_t/H_t = (1 - \gamma)(1 - \varepsilon)^{-1}\theta\beta$  yields  $H_t/\psi_t = (1 - \varepsilon)^\gamma [(1 - \gamma)\theta\beta]^{-\gamma} B^{-1}$ . Thus, using equations (30), (29) along with the steady state feature that  $K_t^* = K_{t+1}^* = I^* = K^*$ , equation (33) can be re-written as follows:

$$\frac{F^*}{\psi^*} = \frac{\theta\beta}{(1 - \varepsilon)\bar{r}B} \left[ (1 - \gamma)A - B + \left( \frac{1 - \varepsilon}{\theta\beta} \right)^\gamma (1 - \gamma)^{1-\gamma} \right] - \frac{A - B}{\bar{r}B}.$$

Next, totally differentiating the above with respect to  $\varepsilon$  yields:

$$\frac{d(F^*/\psi^*)}{d\varepsilon} = \frac{\theta\beta}{(1 - \varepsilon)^2 \bar{r}B} \left[ (1 - \gamma)A - B + (1 - \gamma)^{2-\gamma} \left( \frac{1 - \varepsilon}{\theta\beta} \right)^\gamma \right].$$

Therefore, it suffices that  $B < (1 - \gamma)A$  for  $(d(F^*/\psi^*)/d\varepsilon) > 0$

This ends the proof. ■

Since aggregate TFP,  $B$ , is a weighted-average of sectoral TFPs,  $A$  and  $Z$ , Proposition 5 states that FDI and offshoring benefit the host country's asset position in the very long run provided tradeable goods account for less than  $1 - \gamma$  of total output. As both sectors expand under the influence of FDI and offshoring, the result above suggests that adverse effects may be avoided if the sector of tradeable goods does not overwhelmingly dominates

the other sector. A plausible rationale for this is that increased net exports do not backfire through exchange rate appreciation, hence allowing a long lasting favorable position. In fact, Bosworth and Collins (1999), and Kumar (2007) document a positive effect of FDI on the host country's current account.

Furthermore, given our inter-temporal approach to the current account, Proposition 5 also rationalizes recent findings that developing countries' contribution to FDI outflows has recently been on the rise while these countries used to host economies. In fact, as the current account improves, a host country for FDI and offshoring gradually accumulates foreign assets, a situation that preceded the initial waves of foreign direct investment in more developed economies. Our results align well with some recent development experiences, especially those of emerging countries including India, Brazil, South Korea, etc.

## 5 Concluding remarks

This paper develops an inter temporal general equilibrium framework to highlight the effects of foreign direct investment and offshoring on the accumulation of production factor, and as such, on economic growth. Provided foreign entrepreneurs can engage in production activities in an economy, positive shocks to the demand for intermediate goods cause both prices and (even more so) returns on factor inputs to rise. This in turn provides individuals with the necessary incentives for accumulation, thus fostering economic growth in more natural way that usually discussed in the literature. We find that while trade-induced growth through FDI and offshoring may initially be detrimental to welfare, such strategy spurs consumption growth thereafter. Also of interest is our result that in the steady state of the economy, foreign direct investment and offshoring improve a host country's net asset position, hence placing such economy in ideal conditions to become a source for FDI as well. Overall our findings faithfully replicate the recent development experience of most emerging countries.

## Appendix: Proof of lemmas and propositions.

### Deriving the decision rule of monopolist firms in the intermediate sector.

When confronted with incoming waves of offshoring and FDI, firm  $j$  in the intermediate good sector picks  $P_{jt}$  and  $\tilde{Y}_{jt}$  to

$$\max \Pi_j \equiv P_{jt} \left( \tilde{Y}_{jt} \right) \tilde{Y}_{jt} - R_t K_{jt} - W_t H_{jt},$$

subject to

$$\begin{cases} H_{jt} = A^{-1/(1-\gamma)} K_{jt}^{-\gamma/(1-\gamma)} \left( \tilde{Y}_{jt} \right)^{1/(1-\gamma)}, \\ K_{jt} = A^{-1/\gamma} H_{jt}^{-(1-\gamma)/\gamma} \left( \tilde{Y}_{jt} \right)^{1/\gamma}. \end{cases} \quad (34)$$

where  $\tilde{Y}_{jt}$  is the modified demand for type- $j$  physical intermediate. Substituting (34) back into the objective function and taking the derivative with respect to  $\tilde{Y}_{jt}$  yield:

$$\left[ 1 + \frac{1}{\frac{P_{jt} d\tilde{Y}_{jt}}{\tilde{Y}_{jt} dP_{jt}(\tilde{Y}_{jt})}} \right] P_{jt} = \frac{1}{\gamma} A^{-1/\gamma} H_{jt}^{-(1-\gamma)/\gamma} \left( \tilde{Y}_{jt} \right)^{1/\gamma} \left( \tilde{Y}_{jt} \right)^{-1} R_{jt},$$

That is, using  $(P_{jt} dY_{jt}/Y_{jt} dP_{jt}) = -1/(1-\theta)$  and arranging terms,

$$\gamma \theta P_{jt} \tilde{Y}_{jt} = R_{jt} K_{jt}.$$

or, equivalently

$$(1-\varepsilon)^{-1} \theta \gamma P_{jt} Y_{jt} = R_{jt} K_{jt},$$

since

$$\tilde{Y}_{jt} \equiv (1-\varepsilon)^{-1} Y_{jt} = (1-\varepsilon)^{-1} (P_{jt})^{-1/(1-\theta)} Y. \quad (35)$$

Similarly it can be shown that

$$(1-\varepsilon)^{-1} (1-\gamma) \theta P_{jt} Y_{jt} = W_{jt} H_{jt}.$$

Following the same steps as above for firm  $i$  thus yields:

$$\begin{aligned} (1-\varepsilon)^{-1} \theta \gamma \rho_{it} X_{it} &= R_{it} K_{it}, \\ (1-\varepsilon)^{-1} (1-\gamma) \theta \rho_{it} X_{it} &= W_{it} H_{it}. \end{aligned}$$

**Proof of lemma 1:**

Using (14) and (16), it follows that:

$$\begin{aligned} R_{jt} &= \frac{\gamma\theta}{(1-\varepsilon)} \frac{P_{jt}Y_{jt}}{K_{jt}} = R_{yt} = \frac{\gamma\theta}{(1-\varepsilon)} \frac{Y_t}{K_{yt}} \\ R_{it} &= \frac{\gamma\theta}{(1-\varepsilon)} \frac{\rho_{it}X_{it}}{K_{it}} = R_{xt} = \frac{\gamma\theta}{(1-\varepsilon)} \frac{\rho_t X_t}{K_{xt}} \end{aligned}$$

In equilibrium,  $R_{yt} = R_{xt} = R_t$ . Thus

$$R_t = \frac{\gamma\theta}{(1-\varepsilon)} \frac{Y_t}{K_{yt}} = \frac{\gamma\theta}{(1-\varepsilon)} \frac{\rho_t X_t}{K_{xt}} = \frac{\gamma\theta}{(1-\varepsilon)} \frac{(Y_t + \rho_t X_t)}{K_t}. \quad (36)$$

Likewise, using (15) and (17) we have

$$W_t = \frac{(1-\gamma)\theta}{(1-\varepsilon)} \frac{Y_t}{H_{yt}} = \frac{(1-\gamma)\theta}{(1-\varepsilon)} \frac{\rho_t X_t}{H_{xt}} = \frac{(1-\gamma)\theta}{(1-\varepsilon)} \frac{(Y_t + \rho_t X_t)}{H_t}. \quad (37)$$

The result then follows by way of differentiation with respect to  $\theta$  and  $\varepsilon$ .

This ends the proof.

**Proving the theorem:**

Combining (25) with (18) using  $K_{t+1} = I_t$  yields

$$\frac{I_t}{C_t} = (1-\varepsilon)^{-1} \gamma\theta\beta E_t \left[ \frac{Y_{t+1} + \rho_{t+1}X_{t+1}}{C_{t+1}} \right]. \quad (38)$$

Similarly, combining (24) with (19) using  $H_{t+1} = X_t$  also yields

$$\frac{\rho_t X_t}{C_t} = (1-\varepsilon)^{-1} (1-\gamma)\theta\beta E_t \left[ \frac{Y_{t+1} + \rho_{t+1}X_{t+1}}{C_{t+1}} \right].$$

Summing the two equations above yields

$$\frac{I_t + \rho_t X_t}{C_t} = (1-\varepsilon)^{-1} \theta\beta E_t \left[ \frac{Y_{t+1} + \rho_{t+1}X_{t+1}}{C_{t+1}} \right].$$

Using  $Y_t = C_t + I_t$ , this amounts to

$$\begin{aligned} \frac{I_t + \rho_t X_t}{C_t} &= (1-\varepsilon)^{-1} \theta\beta E_t \left[ 1 + \frac{I_{t+1}}{C_{t+1}} + \frac{\rho_{t+1}X_{t+1}}{C_{t+1}} \right] \\ &= (1-\varepsilon)^{-1} \theta\beta + (1-\varepsilon)^{-2} \theta^2 \beta^2 E_t \left[ 1 + \frac{I_{t+2}}{C_{t+2}} + \frac{\rho_{t+2}X_{t+2}}{C_{t+2}} \right] \end{aligned}$$

Thus, applying the law of iterated expectations while letting  $\theta\beta < (1 - \varepsilon)$  gives

$$\frac{I_t + \rho_t X_t}{C_t} = \frac{\theta\beta}{1 - \varepsilon - \theta\beta}, \quad (39)$$

which upon combination with (38) and  $Y_{t+1} = C_{t+1} + I_{t+1}$  yields

$$\frac{I_t}{C_t} = \frac{\gamma\theta\beta}{1 - \varepsilon - \theta\beta}. \quad (40)$$

Thus, from  $Y_t = C_t + I_t$ , it follows that

$$C_t = \frac{(1 - \varepsilon - \theta\beta)}{1 - \varepsilon - (1 - \gamma)\theta\beta} Y_t, \quad (41)$$

$$I_t \equiv K_{t+1} = \frac{\gamma\theta\beta}{1 - \varepsilon - (1 - \gamma)\theta\beta} Y_t. \quad (42)$$

Next, combining (39), (40) and (41) gives

$$\frac{\rho_t X_t}{Y_t} = \frac{(1 - \gamma)\theta\beta}{1 - \varepsilon - (1 - \gamma)\theta\beta}. \quad (43)$$

Thus, from (36) it follows that

$$\frac{K_{xt}}{K_t} = \frac{\rho_t X_t}{(Y_t + \rho_t X_t)} = (1 - \gamma)(1 - \varepsilon)^{-1} \theta\beta.$$

Similarly, (37) implies that

$$\frac{H_{xt}}{H_t} = \frac{\rho_t X_t}{(Y_t + \rho_t X_t)}.$$

Therefore,

$$\frac{K_{xt}}{K_t} = \frac{H_{xt}}{H_t} = (1 - \gamma)(1 - \varepsilon)^{-1} \theta\beta,$$

or, equivalently,

$$\frac{K_{xt}}{H_{xt}} = \frac{K_t}{H_t} = (1 - \gamma)(1 - \varepsilon)^{-1} \theta\beta. \quad (44)$$

This ends the proof.

**Proof of proposition 1: The proof proceeds in two steps.**

Since  $R_t = \gamma\theta(1 - \varepsilon)^{-1}(Y_t + \rho_t X_t)/K_t$  - see equation (18) - using (43) and arranging terms yield

$$R_t = \gamma\theta(1 - \varepsilon)^{-1} \frac{(1 + \rho_t X_t/Y_t)}{K_t/Y_t} = \frac{\gamma\theta}{1 - \varepsilon - (1 - \gamma)\theta\beta} \frac{Y_t}{K_t}. \quad (45)$$

Similarly, as  $W_t = (1 - \gamma)(1 - \varepsilon)^{-1} \theta (Y_t + \rho_t X_t) / H_t$  - see equation (19) - using (43) and arranging terms yield

$$W_t = \frac{(1 - \gamma) \theta}{1 - \varepsilon - (1 - \gamma) \theta \beta} \frac{Y_t}{H_t}. \quad (46)$$

**Step one: Computing  $Y_t/K_t$  and  $Y_t/H_t$ .**

Market clearing for factor inputs imposes that

$$\frac{K_{yt}}{K_t} = \frac{H_{yt}}{H_t} = 1 - (1 - \gamma)(1 - \varepsilon)^{-1} \theta \beta, \quad (47)$$

which states that the  $y$ -industry uses a fraction  $1 - (1 - \gamma)(1 - \varepsilon)^{-1} \theta \beta$  of resources available economy-wide. Therefore the total supply of the  $y$ -good can be derived from:

$$Y_t = [1 - (1 - \gamma)(1 - \varepsilon)^{-1} \theta \beta] A K_t^\gamma H_t^{1-\gamma}, \quad (48)$$

or, equivalently,

$$\frac{Y_t}{K_t} = [1 - (1 - \gamma)(1 - \varepsilon)^{-1} \theta \beta] \left( \frac{H_t}{K_t} \right)^{1-\gamma} A.$$

The above equation can be rewritten using (44) as follows

$$\frac{Y_t}{K_t} = [1 - (1 - \gamma)(1 - \varepsilon)^{-1} \theta \beta] \left[ \frac{(1 - \varepsilon)}{(1 - \gamma) \theta \beta} \right]^{1-\gamma} A. \quad (49)$$

(Note that under (28)  $(1 - \gamma)(1 - \varepsilon)^{-1} \theta \beta < 1$ ).

Likewise (48) carries the implication that

$$\frac{Y_t}{H_t} = [1 - (1 - \gamma)(1 - \varepsilon)^{-1} \theta \beta] \left( \frac{K_t}{H_t} \right)^\gamma A.$$

Once again, using (44) yields

$$\frac{Y_t}{H_t} = [1 - (1 - \gamma)(1 - \varepsilon)^{-1} \theta \beta] [(1 - \gamma)(1 - \varepsilon)^{-1} \theta \beta]^\gamma A \quad (50)$$

**Step two:** We now turn to proving our claims.

**Claim 1:** FDI raises the return to physical capital in the host country.

We prove this by combining (45) and (49).

$$R_t = (1 - \varepsilon)^{-\gamma} [(1 - \gamma) \beta]^{-(1-\gamma)} \gamma \theta^\gamma A.$$

Differentiating the above with respect to  $\varepsilon$  yields the result.

**Claim two:** FDI raises the relative price of human capital goods and the wage rate.

Since the relative price of human capital goods is given by  $\rho_t = (1 - \gamma) \gamma^{-1} E_t (K_{t+1}/H_{t+1})$  - see (27) - we use (44) to get

$$\rho_t = (1 - \varepsilon)^{-1} (1 - \gamma)^2 \gamma^{-1} \theta \beta.$$

On the other hand, combining (46) and (50) yields

$$W_t = (1 - \varepsilon)^{-(1+\gamma)} (1 - \gamma)^{1+\gamma} \theta^{1+\gamma} \beta^\gamma A.$$

The result follows by differentiating the two equations above with respect to  $\varepsilon$ .

This ends the proof.

**Proof of proposition 2:**

Using logs we first rewrite (48) as follows

$$y_t = a + \gamma k_t + (1 - \gamma) h_t + \log [1 - (1 - \gamma) (1 - \varepsilon)^{-1} \theta \beta]. \quad (51)$$

Similarly, (44) implies that the total supply for the  $x$ -good can be derived from:

$$X_t = (1 - \gamma) (1 - \varepsilon)^{-1} \theta \beta Z K_t^\gamma H_t^{1-\gamma}, \quad (52)$$

*i.e.*, in logs terms

$$x_t = z + \gamma k_t + (1 - \gamma) h_t + \log [(1 - \gamma) (1 - \varepsilon)^{-1} \theta \beta]. \quad (53)$$

Next, combining (42) and (48) gives the level of accumulated physical capital in the next period (in log terms) as:

$$k_{t+1} = a + \log (\gamma \theta \beta) - \log (1 - \varepsilon) + \gamma k_t + (1 - \gamma) h_t, \quad (54)$$

or, equivalently,

$$k_{t+1} - k_t = a + \log \left( \frac{\gamma \theta \beta}{1 - \varepsilon} \right) - (1 - \gamma) (k_t - h_t). \quad (55)$$

Similarly, using (52) and  $H_{t+1} = X_t$  we find the level of accumulated human capital in the next period (in log terms) as:

$$h_{t+1} = z + \gamma k_t + (1 - \gamma) h_t + \log [(1 - \gamma) (1 - \varepsilon)^{-1} \theta \beta], \quad (56)$$

that is

$$h_{t+1} - h_t = z + \gamma (k_t - h_t) + \log \left[ \frac{(1 - \gamma) \theta \beta}{(1 - \varepsilon)} \right]. \quad (57)$$

On the other hand, (54) and (56) can be combined to get

$$\begin{aligned} \gamma k_{t+1} + (1 - \gamma) h_{t+1} &= \gamma \log (\gamma \theta \beta) - \gamma \log (1 - \varepsilon) + \gamma k_t + \gamma a + (1 - \gamma) z \\ &\quad + (1 - \gamma) h_t + (1 - \gamma) \log [(1 - \gamma) (1 - \varepsilon)^{-1} \theta \beta]. \end{aligned} \quad (58)$$

In clear, using (56),

$$k_{t+1} - h_{t+1} = a - z + \log (\gamma \theta \beta) - \log [(1 - \gamma) \theta \beta]. \quad (59)$$

Substituting (59) back into (55) and (57) yields

$$g_k = g_h = \gamma a + (1 - \gamma) z + \log [(1 - \varepsilon)^{-1} \theta \beta] + \gamma \log \gamma + (1 - \gamma) \log (1 - \gamma).$$

where  $g_h$  and  $g_k$  stand for the growth rate of human and physical capital. The result then follows by way of differentiation with respect to  $\varepsilon$ .

This ends the proof.

**Proof of proposition 3:** In generalizing proposition 2 we consider the following production functions:

$$Y_{jt} = AK_{jt}^\gamma H_{jt}^{1-\gamma}, \quad 0 < \gamma < 1, \quad (60)$$

$$X_{it} = ZK_{it}^\alpha H_{it}^{1-\alpha}, \quad 0 < \alpha < 1. \quad (61)$$

We first prove the claim that FDI and offshoring raise the capital intensity of tangible goods in the host country.

From the first order conditions for capital, it can be shown that

$$\begin{aligned} R_{jt} &= \frac{\theta}{(1-\varepsilon)} \frac{\gamma P_{jt} Y_{jt}}{K_{jt}} = R_{yt} = \frac{\theta}{(1-\varepsilon)} \frac{\gamma Y_t}{K_{yt}}, \\ R_{it} &= \frac{\theta}{(1-\varepsilon)} \frac{\alpha \rho_{it} X_{it}}{K_{it}} = R_{xt} = \frac{\theta}{(1-\varepsilon)} \frac{\alpha \rho_t X_t}{K_{xt}}. \end{aligned}$$

In equilibrium,  $R_{yt} = R_{xt} = R_t$ . Thus

$$R_t = \frac{\theta}{(1-\varepsilon)} \frac{\gamma Y_t}{K_{yt}} = \frac{\theta}{(1-\varepsilon)} \frac{\alpha \rho_t X_t}{K_{xt}} = \frac{\theta}{(1-\varepsilon)} \frac{(\gamma Y_t + \alpha \rho_t X_t)}{K_t}. \quad (62)$$

Similarly, from the first order conditions for human capital, it can be shown that

$$\begin{aligned} W_t &= \frac{\theta}{(1-\varepsilon)} \frac{(1-\gamma) Y_t}{H_{yt}} = \frac{\theta}{(1-\varepsilon)} \frac{(1-\alpha) \rho_t X_t}{H_{xt}}, \\ &= \frac{\theta}{(1-\varepsilon)} \frac{[(1-\gamma) Y_t + (1-\alpha) \rho_t X_t]}{H_t}. \end{aligned} \quad (63)$$

Combining (62) and (25) using  $K_{t+1} = I_t$  yields:

$$\frac{I_t}{C_t} = \frac{\theta}{(1-\varepsilon)} \beta E_t \left[ \frac{\gamma Y_{t+1} + \alpha \rho_{t+1} X_{t+1}}{C_{t+1}} \right]. \quad (64)$$

Likewise, combining (63) and (24) using  $H_{t+1} = X_t$  yields

$$\frac{\rho_t X_t}{C_t} = \frac{\theta}{(1-\varepsilon)} \beta E_t \left[ \frac{(1-\gamma) Y_{t+1} + (1-\alpha) \rho_{t+1} X_{t+1}}{C_{t+1}} \right]. \quad (65)$$

Following the same steps as before yields

$$\frac{I_t + \rho_t X_t}{C_t} = \frac{\theta \beta}{1 - \varepsilon - \theta \beta},$$

that is,

$$\frac{\rho_t X_t}{C_t} = \frac{\theta \beta}{1 - \varepsilon - \theta \beta} - \frac{I_t}{C_t}. \quad (66)$$

Substituting (66) back into (64),

$$\begin{aligned} \frac{I_t}{C_t} &= \frac{\theta \beta}{(1-\varepsilon)} \left( \gamma + \frac{\alpha \theta \beta}{1 - \varepsilon - \theta \beta} \right) + \frac{(\gamma - \alpha) \theta \beta}{(1-\varepsilon)} E_t \left[ \left( \frac{I_{t+1}}{C_{t+1}} \right) \right] \\ &= \frac{\theta \beta}{(1-\varepsilon)} \left( \gamma + \frac{\alpha \theta \beta}{1 - \varepsilon - \theta \beta} \right) + \frac{(\gamma - \alpha) \theta \beta}{(1-\varepsilon)} \frac{\theta \beta}{(1-\varepsilon)} \left( \gamma + \frac{\alpha \theta \beta}{1 - \varepsilon - \theta \beta} \right) \\ &\quad + \left[ \frac{(\gamma - \alpha) \theta \beta}{(1-\varepsilon)} \right]^2 E_t \left( \frac{I_{t+2}}{C_{t+2}} \right). \end{aligned}$$

Under condition 1  $(\gamma - \alpha) \theta \beta < (1 - \varepsilon)$  and it can be shown that

$$\frac{I_t}{C_t} = \frac{[(1 - \varepsilon) \gamma - (\gamma - \alpha) \theta \beta] \theta \beta}{(1 - \varepsilon - \theta \beta) [(1 - \varepsilon) - (\gamma - \alpha) \theta \beta]}. \quad (67)$$

Thus, using  $Y_t = C_t + I_t$ , minor algebraic manipulations yield

$$\frac{\rho_t X_t}{Y_t} = \frac{\theta \beta (1 - \gamma)}{(1 - \varepsilon - \theta \beta + \alpha \theta \beta)}.$$

Equation (62) and market clearing for physical capital then imply that

$$\frac{K_{yt}}{K_t} = \frac{\gamma (1 - \varepsilon - \theta \beta + \alpha \theta \beta)}{\gamma (1 - \varepsilon) - (\gamma - \alpha) \theta \beta}, \quad (68)$$

so that

$$\frac{K_{xt}}{K_t} = \frac{(1 - \gamma) \alpha \theta \beta}{\gamma (1 - \varepsilon) - (\gamma - \alpha) \theta \beta}. \quad (69)$$

Similarly, it can be shown that

$$\frac{H_{yt}}{H_t} = 1 - (1 - \alpha) (1 - \varepsilon)^{-1} \theta \beta, \quad (70)$$

and

$$\frac{H_{xt}}{H_t} = (1 - \alpha) (1 - \varepsilon)^{-1} \theta \beta. \quad (71)$$

Thus, the capital intensity in the sector of physical goods relative to that of the economy is given by:

$$\frac{K_{yt}/K_t}{H_{yt}/H_t} \equiv \frac{K_{yt}/H_{yt}}{K_t/H_t} \equiv \kappa_y = \frac{(1 - \varepsilon) \gamma}{\gamma (1 - \varepsilon) - (\gamma - \alpha) \theta \beta}.$$

Differentiating the above with respect to  $\varepsilon$  then yields

$$\frac{d\kappa_y}{d\varepsilon} = \frac{(\gamma - \alpha) \gamma \theta \beta}{[\gamma (1 - \varepsilon) - (\gamma - \alpha) \theta \beta]^2}.$$

**We now turn to showing that  $g_k = g_h$ .**

Given (69), (68), (70) and (71) we now have

$$\begin{aligned} Y_t &= A \left[ \frac{\gamma (1 - \varepsilon - \theta \beta + \alpha \theta \beta)}{\gamma (1 - \varepsilon) - (\gamma - \alpha) \theta \beta} K_t \right]^\gamma \left[ 1 - (1 - \alpha) (1 - \varepsilon)^{-1} \theta \beta H_t \right]^{1-\gamma}, \\ X_t &= Z \left[ \frac{(1 - \gamma) \alpha \theta \beta}{\gamma (1 - \varepsilon) - (\gamma - \alpha) \theta \beta} K_t \right]^\alpha \left[ (1 - \alpha) (1 - \varepsilon)^{-1} \theta \beta H_t \right]^{1-\alpha}. \end{aligned}$$

Likewise, combining (67) and  $Y_t = C_t + I_t$  now yields

$$\begin{aligned} C_t &= \frac{(1 - \varepsilon - \theta\beta) [(1 - \varepsilon) - (\gamma - \alpha) \theta\beta]}{(1 - \varepsilon) [1 - (1 - \alpha) \theta\beta]} Y_t, \\ I_t &\equiv K_{t+1} = \frac{[(1 - \varepsilon) \gamma - (\gamma - \alpha) \theta\beta] \theta\beta}{(1 - \varepsilon) [1 - (1 - \alpha) \theta\beta]} Y_t. \end{aligned}$$

Following the same steps as before, the counterparts to (55), (57) and (58) are respectively:

$$\begin{aligned} k_{t+1} - k_t &= a - (1 - \gamma)(k_t - h_t) + \log \theta\beta - \log(1 - \varepsilon) + \gamma \log \gamma \\ &\quad - \log [1 - (1 - \alpha) \theta\beta] - (1 - \gamma) \log(1 - \varepsilon) \\ &\quad + (1 - \gamma) \log [(1 - \varepsilon) \gamma - (\gamma - \alpha) \theta\beta] + \log [1 - \varepsilon - (1 - \alpha) \theta\beta], \end{aligned} \quad (72)$$

$$\begin{aligned} h_{t+1} - h_t &= z + \alpha(k_t - h_t) - (1 - \alpha) \log(1 - \varepsilon) \\ &\quad + \alpha \log(1 - \gamma) \alpha \theta\beta \\ &\quad - \alpha \log [(1 - \varepsilon) \gamma - (\gamma - \alpha) \theta\beta] + (1 - \alpha) \log [(1 - \alpha) \theta\beta], \end{aligned} \quad (73)$$

and

$$\begin{aligned} \alpha k_{t+1} + (1 - \gamma) h_{t+1} &= a\alpha + (1 - \gamma)z + \alpha k_t + (1 - \gamma)h_t + \alpha \log \theta\beta \\ &\quad + \alpha \gamma \log \gamma - \alpha \log [1 - (1 - \alpha) \theta\beta] + (1 - \gamma) \alpha \log(1 - \gamma) \alpha \theta\beta \\ &\quad + \alpha \log [1 - \varepsilon - (1 - \alpha) \theta\beta] - \alpha \log(1 - \varepsilon) - \alpha(1 - \gamma) \log(1 - \varepsilon) \\ &\quad + (1 - \gamma)(1 - \alpha) \log [(1 - \alpha) \theta\beta] - (1 - \gamma)(1 - \alpha) \log(1 - \varepsilon). \end{aligned} \quad (74)$$

We note that (74) shows that  $\alpha(k_{t+1} - k_t) + (1 - \gamma)(h_{t+1} - h_t)$  is constant, so that  $g_k = g_h$ . This in turn implies that the right-hand sides in (72) and (73) are equal and that

$$\begin{aligned} (1 + \alpha - \gamma)(k_t - h_t) &= a - z + \gamma \log \gamma - (1 - \alpha) \log(1 - \alpha) \\ &\quad - \log [1 - (1 - \alpha) \theta\beta] - (1 + \alpha - \gamma) \log(1 - \varepsilon) \\ &\quad + \log [1 - \varepsilon - (1 - \alpha) \theta\beta] - \alpha \log(1 - \gamma) \alpha \\ &\quad + (1 + \alpha - \gamma) \log [(1 - \varepsilon) \gamma - (\gamma - \alpha) \theta\beta]. \end{aligned}$$

Substituting the above back into (72) for  $(k_t - h_t)$  and arranging terms finally yields:

$$g_k \equiv k_{t+1} - k_t = \log(1 - \varepsilon)^{-1} \theta \beta + \frac{\alpha}{1 + \alpha - \gamma} \log \left[ \frac{1 - \varepsilon - (1 - \alpha) \theta \beta}{1 - (1 - \alpha) \theta \beta} \right] + \frac{\alpha a + (1 - \gamma) z}{1 + \alpha - \gamma} \\ + \frac{(1 - \gamma)(1 - \alpha)}{1 + \alpha - \gamma} \log(1 - \alpha) + \frac{(1 - \gamma)}{1 + \alpha - \gamma} \log(1 - \gamma) \alpha + \frac{\alpha \gamma}{1 + \alpha - \gamma} \log \gamma.$$

This ends the proof.

**Proof of proposition 4:**

**Claim 1:** FDI is initially welfare-reducing.

To prove this, we combine (22) with (39) using  $K_{t+1} = I_t$  and then arranging terms:

$$\frac{C_t}{\psi_t} = 1 - \frac{\theta \beta}{1 - \varepsilon},$$

Upon differentiation with respect to  $\varepsilon$  this yields

$$\frac{d(C_t/\psi_t)}{d\varepsilon} = \frac{-\theta \beta}{(1 - \varepsilon)^2} < 0.$$

This ends the proof.

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