Adverse selection, asymmetric information, and foreign investment policies

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Abstract

This paper explores the welfare consequences of foreign investment taxation in a small open economy, based on the notion that the true productivity of imported capital may be unknown to policy-makers. It is shown that while asymmetric information between capital importers and the host government precludes the use of a productivity specific policy measure, an across-the-board policy suffers from the problem of adverse selection among capital imports of differential productivities. Conditions under which a reversal of the optimal foreign investment policy in the face of asymmetric information are examined. © 1999 Elsevier Science Inc. All rights reserved.

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1. Introduction

The search for an appropriate measure regulating the inflow of foreign direct investment dates back to Kemp (1962) and MacDougall (1960). These studies attribute the optimality of a capital import tax to the monopsony power of the host country of foreign investment, as measured by the elasticity of foreign capital supply. Indeed, evidence suggesting high rates of foreign investment taxation employed in developing economies are not uncommon, despite their noted importance in cultivating the growth of emerging export sectors in these economies. Corporate taxation in developing
countries, for instance, accounted for 31.4% of total government revenue as opposed to 8.8% in developed countries. Among the east Asian newly industrialized countries, the proportion turns out to be particularly high for countries such as Indonesia (50.3%), Malaysia (25.95%), and Thailand (16.55%) (International Monetary Fund, 1993).

The coincidence of the standard policy prescription and the observed high rates of taxation in these developing countries, however, calls for a reassessment of the underlying rational behind the welfare calculus of policy makers. Indeed, up till the mid-1980s, total annual capital inflow into developing countries accounted for less than 10% of the total capital flows originating in industrial countries. These capital imports, in turn, comprise not just of direct foreign investment, but also of official transfers, as well as medium- and long-term borrowing (Parry, 1988). A natural question arises, therefore, as to the applicability of the “large” country assumption pertaining to the impact of domestic policy changes on the international rate of return of imported capital.1

The emphasis on regulating of foreign investment inflow has also been attributed to an effort on the part of developing countries to (1) channel the inflow of foreign investments and technology in sectors that have been considered to be of priority by the government, and (2) to ensure a selective inflow of foreign technology which complements local circumstances and development needs.2 In this article, we depart from the original Kemp-MacDougall framework and consider the policy choice of a developing country faced with multiple sources of foreign direct investments, each with possibly different productivities in the host country. We are particularly interested in location specific productivity differences, such as firm-specific differences in the complementarity between foreign capital and domestic resources, that cannot be readily discerned by the capital importing country. In this context, a “lemons” problem (Akerlof, 1970) in the market for capital imports arises whenever domestic governments are equipped with imperfect information about the productivity differences of individual foreign investors. A priori, there is no presumption that the optimal foreign investment tax, in the spirit Kemp and MacDougall, coincides with the one which brings about the correct mix of direct foreign investments in the presence of imperfect information.

If the true productivity of imported foreign capital is unknown to policy makers, and if the credibility of an individual firm’s claim about its true productivity cannot be perfectly verified prior to actual investment, policies directed towards altering foreign investment incentives suffer, in general, from two related problems. The first problem can be attributed to the inability on the part of policy makers to levy a productivity specific tax/subsidy on foreign investment, precisely because of the presence of asymmetric information between capital importing firms and the domestic government. A second problem arises from the possibility of adverse selection among foreign capital importers. Indeed, it will be shown that the presence of asymmetric information implies that a uniform subsidy always increases the absolute as well as the relative amount of low productivity capital imports, as competition for the use of domestic resources due to the inflow of low productivity capital “crowds out” the investment incentives offered to high productivity ones. As the article unfolds, we contrast the nature of the optimal foreign investment policies with and without asym-
metric information. It is shown that the presence of asymmetric information and the attendant adverse selection problem among high- and low-productivity firms can lead to a reversal of the optimal policy measure targeting foreign capital imports.

This article is related to an enormous literature on international factor mobility among trading economies. The notion that foreign direct investment involves the transfer of not just physical capital but also that of firm/sector-specific technologies and know-how is exemplified in a number of recent articles (Batra & Ramachandran, 1980; Brecher & Findlay, 1983; Neary & Ruane, 1988), where the welfare and income distributional effects of international capital flows are examined under the assumptions of perfect capital mobility and competitive markets with constant returns. Subsequent extensions also discuss the pattern of international capital movements under various institutional settings, including the presence of increasing returns (Markusen, 1983; Panagariya, 1986), imperfectly competitive markets (Wong, 1995), and the cross-hauling of capital inputs (Jones, Neary, & Ruane, 1983; Razin & Wong, 1993). As a welfare analysis of foreign investment policies, this article introduces to this literature the notion that asymmetric information about the true productivity of imported capital may lead to a reversal of optimal policy measures facing high productivity firms, in addition to the possibility of an optimal subsidy on foreign investment in a small capital importing country. We also study the direction and the pattern of international capital flows in response to foreign investment policies and point out the possibility of adverse selection among capital importers of differing productivities as a result of the crowding-out effect which occurs in the presence of asymmetric information.

The plan of the article is as follows: in section 2 we develop the basic model and explain its operation; in section 3, the optimal foreign investment policy under perfect information is examined; in section 4 we incorporate the asymmetric information constraint and derive the optimal foreign investment policy; in section 5 we conclude.

2. The basic model

Consider a small open economy, referred to in the sequel as the home country, that consists of two competitive sectors: an exportable sector $X$ and an importable sector $M$. With no loss of generality, international prices of both the importable and the exportable commodities, through appropriate choice of units, are assumed to be unity. Production of the exportable is subject to constant returns to scale, employing domestic labor $L_x$ and a fixed endowment of land, $T$, as inputs. Let the production function of the exportable good be given by

$$X = X(L_x, T)$$

with positive and diminishing marginal product. Demand for labor in the $X$ sector $L_x = L_x(w)$ is implicitly defined by Eq. (1):

$$X(L_x, T) = w,$$  \hspace{1cm} (1)

where $w$ is the competitively determined wage rate in the home country.

The importable sector is operated by a large number ($N$) of foreign firms. Each
firm seeks to allocate a fixed amount of firm-owned capital $K$, between the home country and the rest of the world. In particular, foreign capital is combined with home country labor to produce an internationally traded commodity, $M$, via production technologies that are subject to constant returns to scale and diminishing marginal products.

Each foreign firm belongs to one of $n$ types, with a firm-type specific production function

$$
\bar{M}(K_i, L_i; \gamma_i) = M(K_i, \gamma_i L_i).
$$

To capture the differential degrees of complementarity between domestic labor and foreign capital inputs, the index $\gamma_i$, $i = 1, \ldots, n$ is taken to be a capital saving technological measure, with $\gamma_i > \gamma_j$, whenever $i > j$.

In the sequel, we consider two benchmark cases, each characterized by the degree of information asymmetry regarding the productivity parameter $\gamma_i$ between foreign firms and the government. Specifically, we compare the case of perfect information with the more realistic scenario where the firm specific productivity index $\gamma_i$ is private information to the firm, while the distribution of productivity types across the $N$ foreign firms is common knowledge. Accordingly, let $\alpha_i$ represent the density function which gives the fraction of firms endowed with productivity parameter $\gamma_i$, where $1 \geq \alpha_i \geq 0$ and $\sum_{i=1}^{n} \alpha_i = 1$.

The problem of each firm involves the allocation of capital between the rest of the world and the home economy. Let $\mu$ be the average rate of return of a unit of capital in the rest of the world and $C(K)$ be a quadratic variable setup cost of foreign investment, where $C(\cdot)$ is twice continuously differentiable, increasing and strictly convex in the amount of foreign capital invested. The maximization problem facing a typical foreign firm endowed with productivity index $\gamma_i$ can be written as

$$
\max_{K_i, L_i} M(K_i, \gamma_i L_i) - wL_i - C(K_i) + \mu(K - K_i) + s_i \mu K_i,
$$

where $w$ is the competitive wage rate, and $s_i$ denotes an ad valorem capital import subsidy. The strict convexity of $C(\cdot)$ together with the assumption imposed on the production relation in the $M$ sector guarantees that Eq. (2) is a standard concave problem with a unique set of solution $(K_i, L_i)$ for every $w$, $\gamma_i$, $s_i$, and $\mu$. We assume, in addition, that there is no lag between the time of subsidy payments and the investment of foreign capital so that the question of reform credibility on the part of the government (Froot, 1988; Rodrik, 1989, 1991; Srivastava, 1994) or time inconsistency of subsidy payment do not arise (Calvo, 1987; Engel & Kletzer, 1991; Staiger & Tabellini, 1989). The first order conditions associated with the above maximization problem are:

$$
M_{K_i} - \mu = C_i' - \mu s_i,
$$

$$
\gamma_i M_{L_i} = w
$$

where $M_{\bar{j}} = M_j(K_i, \gamma_i L_i); j = K, L$ is the marginal product of input $j$ in an $i$-type firm.
Note that at constant rates of subsidy \((s_i = s_j)\), the marginal benefit of investment in the home country \((M_{K_i} + \mu s_i - \mu - C'(K))\) is increasing in \(\gamma_i\) for any given amount of capital import \(K\). In addition, it can be readily shown that the capital saving nature of the parameter \(\gamma_i\) guarantees that labor intensity \((L_i/K_i = \ell_i)\) increases with \(\gamma_i\). In other words, high productivity firms also employ relatively more home country labor per unit foreign capital, for every \(w\)\(^\dagger\). Let \(L_i = L_i(w, s_i), K_i = K_i(w, s_i), i = 1, \ldots, n\), denote the labor demand functions and the foreign capital supply functions of firm type \(i\), as determined by the system of Eq. (3) and (4).

To complete the formalization of our model, consider the labor market equilibrium in the home country:

\[
\sum_{i=1}^{n} \alpha_i L_i(w, s_i) + L_s(w) = \mathscr{L}
\]

(5)

where \(\sum_{i=1}^{n} \alpha_i L_i(w, s_i)\) denotes the aggregate demand of labor in the importable sector. With Eq. (5), the competitive wage \(w\) in the home country can be had. Accordingly, the equilibrium supply of capital from a typical \(i\)-type firm can also be obtained using Eq. (3) and (4), for every given capital subsidy vector \(\{s_i\}_{i=1}^{n}\).

Before proceeding further, a number of additional comments are in order.

**Proposition 1:**

1. \(w\) is strictly increasing in \(s_i\).
2. \(K_i(K_j, j \neq i)\) is increasing (strictly decreasing) in \(s_i\).
3. For every \(i > j\), \(\partial w/\partial s_i > \partial w/\partial s_j\) if and only if \(\alpha_i \ell_i > \alpha_j \ell_j\).

Proposition 1 summarizes the general equilibrium outcomes of a capital import subsidy on the competitive wage rate as well as the resulting change in the amount of foreign capital supply. In particular, from part 1 of the proposition, an increase in \(s_i\), by raising the incentives of type \(i\) firm to invest in the home country, has the effect of bidding up the home country competitive wage. It follows that the effects of an increase in \(s_i\) on the aggregate supply of foreign capital depends on the interaction of two effects: While an increase in \(s_i\) always increases the import of foreign capital by \(i\)-type firms, competition for home country laborers raises the competitive wage facing firms of all productivity types and, hence, an increase in \(s_i\) also entails an indirect effect, through the reduction in the amount of capital import foreign firms of productivity type \(j \neq i\). (The proof of proposition 1 appears in Appendix B.)

In addition, if the proportions of types \(i\) and \(j\) firms are similar \((\alpha_i = \alpha_j)\), an increase in capital import subsidy to the relatively high productivity firms always gives rise to a larger increase in the home country competitive wage rate. This result follows directly from our observation following Eqs. (3) and (4), high productivity firms tends to be more labor intensive \((\ell_i > \ell_j\) whenever \(i > j\).

Consider now a uniform subsidy on firms of both productivity types such that \(s_i = s\) for all \(i\), we have the following analogue of proposition 1:

**Proposition 2:**

1. \(w\) is strictly increasing in \(s\).
2. $K_1$ is strictly increasing in $s$.
3. $K_j$ is strictly decreasing in $s$, for every $j > 1$, if and only if $(w/K_j)/(wL_j) < e_w$, where $e_w > 0$ denotes the elasticity of the competitive wage, $w$, with respect to the uniform subsidy $(aw/\delta w)/w$.
4. The proportion of low productivity capital imports, $\sum_{i=0}^j \alpha_i K_i / \sum_{i=0}^n \alpha_i K_i$, is strictly increasing in $s$, if, for every $k < j < h < n$, $\ell_k / \ell_h > K_k / K_h$.

Contrary to the case of an increase in $s$, which has the effect of unambiguously increasing the absolute as well as the relative level of capital imports from high and low productivity firms, a uniform subsidy, on the other hand, can in fact perform qualitatively the same role as a subsidy to low productivity firms, by increasing the absolute and relative levels of capital imports from low productivity foreign firms and reducing the supply of capital from their high productivity counterparts. To see the intuition behind this result, Eq (3) and (4) can be manipulated to obtain, for every $i > j$,

$$\frac{\partial K_i / \partial w}{\partial K_i / \partial s} = \ell_i; \quad \frac{\partial K_j / \partial w}{\partial K_j / \partial s} = \ell_j < \ell_i$$

$\partial K_i / \partial s > 0$ represents the direct effect of an increase in $s$ on the amount of foreign capital imports by type $i$ firms. $\partial K_j / \partial w$, on the other hand, represents the negative indirect effect of a uniform subsidy as a result of the attendant increase in the competitive wage rate. The relative magnitude of these two effects thus depends only on the labor intensity of the typical $i$-type firm. In particular, since $\ell_i > \ell_j$, whenever $\gamma_i > \gamma_j$, the negative indirect effect always takes a relatively larger toll on high productivity firms. It follows, therefore, that $K_i$ increases in both absolute and relative terms in response to a uniform subsidy. Meanwhile, whether $K_i$ rises or falls depends on the magnitude of the wage increase triggered by the implementation of a uniform capital import subsidy in addition to the labor intensity of high productivity firms. In particular, the larger is $\gamma_i$ (and hence $\ell_i$), relative to $\gamma_j$ ($\ell_j$), the more likely it is that the absolute amount of high productivity capital declines upon an increase in $s$. The same intuition applies to part 4 of the propositions. The proportion of low productivity capital import of type $k < j$ rises with $s$ whenever $\ell_k$ is sufficiently larger than $\ell_h$ for every $h > j$.

The use of a uniform subsidy to encourage foreign capital inflow, therefore, suffers from adverse selection among foreign firms with differing productivities. In particular, an increase in $s$ serves to increase the absolute as well as the proportion of low productivity capital imports. Competition for home country labor between high and low productivity firms, in turn, guarantees that as long as the condition stated in part 3 of proposition 2 is satisfied the absolute amount of high productivity capital imports is reduced in response to a uniform subsidy.

3. Optimal policy under perfect information

The analysis section 2 demonstrates the equilibrium allocation of capital between the home country and the rest of the world. To evaluate the national welfare conse-
sequences of capital import subsidies and to demonstrate the possibility that asymmetric information may indeed lead to a reversal of the optimal policy measures targeting high productivity firms, we shall proceed in two stages. Consider first the case where the government has perfect information about firm types. Accordingly, let the $n$-tuple, $\{s_i^*\}_{i=1}^n$, denote the productivity specific subsidies for each firm type $i$, which maximize national income, $G^p$, in the absence of asymmetric information:

$$G^p = N \sum_{i=1}^n [\alpha_i (wL_i - \mu s_i K_i)] + X(T, L_i)$$

$$= N \sum_{i=1}^n [\alpha_i (M(K_i, \gamma L_i) - (\mu + C'_i)K_i)] + X(T, L_i).$$

(6)

The first line of Eq. (6) expresses national income as the sum total of the income of all domestic factor inputs. The second line of Eq. (6) follows from the linear homogeneity of the production function, $M$, and the profit maximization condition of foreign firms, as stated in Eq. (3). Hence, $G^p$ is simply the value of total output, evaluated at international prices, net of repatriated foreign capital earnings and subsidy payments. In particular, $\mu + C'_i(K_i)$, should be interpreted as the supply price of $K_i$ units of foreign capital from a typical $i$-type firm. Therefore,

$$\frac{dG^p}{ds_i} = N \alpha_i (M_{K_i} - \mu - C'_i - C''_i K_i) \frac{\partial K_i}{\partial s_i} + N \sum_{j \neq i} \alpha_j (M_{K_i} - \mu - C'_j - C''_j K_j) \frac{\partial K_j}{\partial s_i}$$

$$= -N \alpha_i (\mu s_i + C''_i K_i) \frac{\partial K_i}{\partial s_i} - N \sum_{j \neq i} \alpha_j (\mu s_j + C''_j K_j) \frac{\partial K_j}{\partial s_i}.$$

(7)

From Eq. (7), whether national welfare improves in response to a subsidy to type 1 firms depends once again on a direct and an indirect effect. The term $M_{K_i}$ denotes the marginal contribution of foreign capital, while $\mu + C'_i + C''_i K_i$ represents the corresponding change in the amount of repatriated foreign capital earnings. From Eq. (3), foreign firms set $M_{K_i} - \mu - C'_i + \mu s_i$ to zero in their profit maximization calculus. It follows, therefore, that beginning with $s_i = 0$ the first term in of Eq. (7), indicating the direct effect on an increase in $s_i$, on national welfare is always negative. The indirect effect, which arises as a result of the reduction in capital imports from firm type $j \neq i$ (proposition 1) constitutes the possibility of a welfare improvement as a result of an increase in $s_i$ beginning with $s_j = 0$. To see this, note that $-(\mu s_j + C''_i K_j)(\partial K_j/\partial s_j) = -C''_i K_j (\partial K_j/\partial s_j) > 0$.

Making use of Eq. (8), an obvious candidate for the $n$-tuple, $\{s_i^*\}_{i=1}^n$, which equates the $n$ first order condition to zero is that:

$$s_i^* = - \frac{C''_i K_i}{\mu} = \frac{M_{K_i}}{\mu} \eta_i,$$

for every $i$, where $\eta_i$ denotes the elasticity of the supply price foreign capital with respect to $K_i$, $d\log (\mu(1 - s) + C'_i)/d \log K_i$.

It is perhaps of interest to note that Eq. (8) implies that the Kemp-MacDougall
solution to the foreign investment problem carries over to the case with multiple sources of capital inflow. In particular, with perfect information, each \( i \)-type firm can be subject to a productivity specific tax, which is proportional to the elasticity of its capital supply schedule.\(^7\)

**Proposition 3:**

\[
s_i^* = - \frac{M_{K_i}}{\mu} \eta_b < 0 \text{ for all } i.
\]

### 4. Optimal Policy under imperfect information

We now turn to the case where the government cannot perfectly decipher the true quality of foreign firms. Denote \( G_I \) as the expectation of national welfare under imperfect information,\(^8\)

\[
G_I = \sum_{i=1}^{n} \left[ \alpha_i (wL_i - \mu_s K_i) \right] + X(T, L,)
\]

\[
= \sum_{i=1}^{n} \alpha_i [M(K_i, \gamma_i L_i) - (\mu + C_i)K_i] + X(T, L,).
\]

Therefore [Eq. (10)],

\[
\frac{dG_I}{ds} = \sum_{i=1}^{n} \alpha_i (M_{K_i} - \mu - C_i' - C_i'' K_i) \frac{dK_i}{ds}
\]

\[
= - \sum_{i=1}^{n} \alpha_i (\mu_s + C_i K_i) \frac{dK_i}{ds}.
\]

From proposition 2, both the absolute and the relative levels of \( K_i \) rise upon an increase in the uniform subsidy, \( s \). \( K_i \), on the other hand, may fall as a result of an increase in \( s \), as long as \( j > 1 \) and if the labor intensity of firm type \( j \) is sufficiently large, which, in turn, once again gives rise to the possibility of a welfare improvement upon an increase in the uniform subsidy. We have the following result,

**Proposition 4:** The optimal foreign investment policy under asymmetric information is a uniform subsidy on the import of foreign capital if and only if

\[
\frac{\mu \sum_{i=1}^{n} \alpha_i K_i}{w \sum_{i=1}^{n} \alpha_i L_i} = \frac{\mu kM}{wLM} < e_u.
\]

Hence, in the presence of imperfect information and the adverse selection problem discussed above, the normative ordering of the optimal foreign investment policy can be reversed, with a strictly positive foreign investment subsidy, as long as the labor income response to the subsidy, as measured by elasticity \( e_u \), is no less than the increase in subsidy expenditure. Note, in particular, the same condition which guarantees an optimal foreign investment subsidy coincides with that which governs the extent of adverse selection as stated in proposition 2, 3.
To see this, note that if \((\mu K_M)/(L_M) < e_w\), then, while \(K_1\) is strictly increasing in \(s\), there must be some foreign capital type \(j\) such that for \(i \geq j\), \(\mu k_i/w < e_w\). Thus, \(K_i\) is strictly decreasing in \(s\) due to adverse selection and relatively high quality capital inflow decreases upon an increase in the uniform subsidy. In addition, making use of Eq. (14) in Appendix B, it can be readily verified that \(\partial K_M/\partial s < 0\) if and only if \((\mu K_M)/(wL_M) < e_w\). In other words, the domestic wage increase impact of the uniform subsidy is large enough to force a sufficiently large amount of high quality foreign capital out of the home country, so that the aggregate supply of foreign capital bears an inverse relationship with \(s\).

As such, adverse selection reverses the slope of the aggregate foreign capital supply curve with respect to the uniform subsidy \(s\), and drives a (positive) wedge between the average and marginal cost of subsidizing foreign capital inflows. It follows, therefore, that the appropriate policy response in the face of an undersupply of foreign capital when \(s = 0\), is to impose a capital import subsidy.

5. Conclusion

We have shown in this article how asymmetric information regarding the true productivity of capital imports, and the attendant adverse selection problem can lead to a reversal of trade reform. It bears emphasizing that the above analysis refers to the problem of a policy maker faced with newly entering foreign firms with unknown productivities. What seems to be particularly interesting in this context is the possibility of learning by host country governments in the face of strategic investment decisions that foreign firms may undertake over time, precisely to masquerade their true productivity type.

Appendix A

Totally differentiating Eq. (3) and (4), we have

\[
\begin{bmatrix}
M_{K_i} - C_i'' & \gamma_i M_{K_{Li}} \\
\gamma_i M_{L_{Ki}} & \gamma_i^2 M_{L_{Li}}
\end{bmatrix}
\begin{bmatrix}
dK_i \\
dL_i
\end{bmatrix}
= 
\begin{bmatrix}
-M_{KL_i}d\gamma_i - \mu ds_i \\
-(M_{Li} + \gamma_i L_i M_{Li})d\gamma_i + dw
\end{bmatrix}
\]

where the determinant of the above matrix \(D\) is given by,

\[-C_i'' M_{Li} > 0.\]

Routine manipulation yields:

\[
dK_i = \frac{1}{C_i} \mu ds_i - \frac{\ell_i}{C_i} dw + \frac{\ell_i M_{Li}}{C_i} d\gamma_i;
\]

\[
dL_i = \frac{\ell_i}{C_i} \mu ds_i - \left(\frac{\ell_i^2}{C_i''} - \frac{1}{M_{Li}}\right) dw + \left(\ell_i \frac{\partial K_i}{\partial \gamma_i} - \frac{M_{Li}}{\gamma_i M_{Li}} - \frac{L_i}{\gamma_i}\right) d\gamma_i.
\]
Making use of these results, it can be readily confirmed that the labor intensity \( \ell_i \) is strictly increasing in \( \gamma_i \) since,

\[
\frac{\partial \ell_i}{\partial \gamma_i} = \frac{L_i}{\gamma_i} (\frac{M_{L_i}}{\gamma_i M_{LL_i}} - 1) > 0.
\]

The term in brackets is strictly positive whenever the production function is strictly concave in \( \gamma_i L_i \) and that \( M(K,0) = 0 \).

The inequality \( \ell_i/\ell_j > K_i/K_j \) is satisfied, for \( i > j \), if and only if \( \ell_i/K_i \) is strictly increasing in \( \gamma_i \). We have, making use of the above results once again, and denote \( \theta L_i (\theta_k) \) as the share of labor (capital) in firms of productivity type \( i, wL_i/M (M_K K_i/M) \). \( \partial (\ell_i/K_i)/\partial \gamma_i > 0 \) if and only if \([\text{Eq. (11)}]\),

\[
\frac{M_{L_i} \gamma_i}{\gamma_i^2 L_i M_{LL_i}} = \frac{\theta_k \eta_i + \theta_{L_i}}{\theta_k \eta_i} = \frac{-w \frac{\partial L_i}{\partial \gamma_i} - \frac{\theta_k \eta_i + \theta_{L_i}}{\theta_k \eta_i}}{\frac{\partial \gamma_i}{\partial \gamma_i}} = \epsilon_{\omega_i} > 0,
\]

if the elasticity of the supply price of type \( i \) capital imports, \( \eta_i \), and the elasticity of labor demand, \( \epsilon_{\omega_i} \), are sufficiently large.

**Appendix B**

**Proof of Proposition 1**

Making use of Eq. (5) and the comparative statics results above, we obtain,

\[
\frac{d \epsilon_i}{ds_i} = \frac{\alpha_i N \partial L_i/\partial s_i}{N \sum_{i=1}^n \alpha_i dL_i/dw + dL_x/dw} = \frac{\alpha_i N \ell_i}{C_i \Delta} > 0,
\]

where

\[
\Delta = -N \sum_{i=1}^n \frac{\alpha_i}{\gamma_i L_i M_{LL_i}} - \frac{1}{X_{LL}} + N \sum_{i=1}^n \frac{\alpha_i \ell_i^2}{C_i} = \Omega + N \sum_{i=1}^n \frac{\alpha_i \ell_i^2}{C_i} > 0,
\]

where \( w \Omega/L > 0 \) is the elasticity of aggregate demand for labor \([\sum \alpha_i L_i(w, s_i) + L_i(w)]\) with respect to \( w \), holding \( K_i \) constant.

Using part 1 of the proposition, we have,
From the proof of part 1 of proposition 1, we have,
\[
\frac{dw}{ds_i} = \frac{N\mu}{\Delta C'} \left[ \alpha_i \ell_i - \alpha_i \ell_j \right] > (\equiv) 0,
\]
if and only if \( \alpha_i \ell_i > (\equiv) \alpha_i \ell_j \).

**Proof of Proposition 2**

Making use of Eq. (5) and the comparative statics results in the proof of proposition 1, we obtain
\[
\frac{dw}{ds} = \frac{N\sum_{i=1}^{n} \alpha_i dL_i}{\Delta}.
\]
\[
= \frac{N\mu}{\Delta} \sum_{i=1}^{n} \frac{\alpha_i \ell_i}{C_i'} > 0.
\]

From part 1 of the proposition, we have Eqs (14) and (15):
\[
\frac{dK_i}{ds} = \frac{\mu}{C_i'} - \frac{\ell_i}{C_i'} \frac{\partial w}{\partial s_i}
\]
\[
= \frac{\mu}{C_i'} \left( \Omega + N\sum_{j=1}^{n} \alpha_j \ell_j \right) / C_i''.
\]

If \( i = 1, \ell_i \ll \ell_j \) for every \( j > 1 \) and hence, \( \partial K_i/\partial s > 0 \). Otherwise \( \partial K_i/\partial s \) is no longer unambiguously positive since \( \ell_j < \ell_i \) whenever \( j < i \). From Eq. (12), therefore, a necessary and sufficient condition for \( K \) to be strictly decreasing in \( s \) is that \( \mu - \ell_i (\partial w/\partial s) = \ell / \mu K_i < 0 \).

It follows, therefore, that the fraction of low productivity capital increases upon an increase in the uniform subsidy if and only if
\[
\sum_{i=1}^{n} \alpha_i \frac{\partial K_i}{\partial s} > 0.
\]

Making use of Eq. (13) and upon rearranging terms, we have Eq. (16):
\[
\sum_{i=1}^{n} \alpha_i \frac{\partial K_i}{\partial s} = \sum_{i=1}^{n} \alpha_i \frac{\partial K_i}{\partial s} \sum_{j=1}^{n} \alpha_j K_j.
\]

\[
= \sum_{k=j+1}^{n} \alpha_k \frac{\partial K_i}{\partial s} \sum_{k=j+1}^{n} \alpha_j K_j.
\]

\[
= \sum_{k=j+1}^{n} \frac{\alpha_k}{C_k'' K_k} \left[ K_k - \frac{1}{C_k''} \right]
\]
The term \( \frac{1}{C_i''} (1/C_k'' K_i) \) is strictly positive since, from Appendix A, \( K_i < K_k \) whenever \( i < k \) and \( C_i'' = C_k'' \) because \( C(K) \) is quadratic. Hence, if the condition \( (\ell_k/\ell_h) = (K_k/K_h) > 0 \) for every \( k > h \) is satisfied, the proportion of low productivity capital imports is always increasing in \( s \).

**Proof of Proposition 4**

Making use of the proof of proposition 1 above, and upon rearranging terms, \( s^* \) can be written as

\[
\begin{align*}
\frac{\partial w}{\partial s} & \sum_{i=1}^{n} \left[ \alpha_i \sum_{k=i+1}^{n} \left( \alpha_k \mu K_i K_k \left( \frac{\ell_i}{C_i'' K_i} - \frac{\ell_k}{C_k'' K_k} \right) \right) \right] > 0. \\
\end{align*}
\]

(16)

Notes

1. It may also be argued that in the presence of various other forms of domestic distortions, a tax on capital inflow may still be a welfare improving policy. The key distinction is of course, the second best nature of such taxation in mitigating market distortions arising in distortion sources other than, or, in addition to the international capital market (Bhagwati, 1971; Bhagwati & Tironi, 1980; Brecher & Diaz-Alejandro, 1977).

2. Examples of these restrictions on foreign capital and technology inflow are not uncommon. See, for instance, Martin (1986), which traces out the various regulatory policies adopted in developing countries such as Brazil, India, Korea, and Mexico.

3. In an earlier version of this paper, we allowed the production relation \( \bar{M}(K_i, L; \gamma) \) to take on a more general form where with \( \bar{M}_\gamma > 0; \bar{M}_{K_i} \geq 0 \) and \( \bar{M}_{L_i} > 0 \). It is shown that all of the results below remain robust.

4. With the foreign rate of returns, \( \mu \), as well as the effective input of capital both independent of firm types, the home country government is accordingly unable to infer the true productivity of capital imports by observing productivity signals abroad.
5. The proof of these results are relegated to Appendix A.
6. See Appendix A for the conditions under which the inequality displayed in proposition 2.4 is satisfied.
7. Proposition 3 can be viewed as another instance of the envelope theorem at work. In other words, a small change in $s_i$ effects national welfare only through its direct effect on the volume of capital inflow from foreign firms with productivity index $y_i$ (the first term of Eq. (8)). The possibility of a welfare improvement, through the indirect effect of an increase in $s_i$ on the $K_j$, is eliminated once $s_j$'s are set so that $s_j^* = -M_K \eta_i / \mu$, for every $j \neq i$.
8. Note that since the random variable $\theta$ is independent and identically distributed over all foreign firms, by the law of large numbers, there is no aggregate uncertainty and hence, Eq. (9) is identical to Eq. (6).

References


