



UNIVERSITÀ DEGLI STUDI DI ANCONA  
DIPARTIMENTO DI ECONOMIA

**MULTINATIONAL ENTERPRISES  
AND TECHNOLOGICAL SPILLOVERS:  
AN EVOLUTIONARY MODEL**

TOMMASO PEREZ

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**Abstract.** This paper analyses the determinants of the impact of foreign multinational enterprises on the technological development of domestic firms. It argues that the consequences of the foreign presence change according to market and technological conditions. An evolutionary model of technological competition between foreign and domestic firms is developed which is able to generate both vicious and virtuous circles of development in locations affected by foreign MNE activities. Theoretical analysis is tested against the empirical evidence for the UK economy (1983-1989).

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## 1. Introduction.\*

Economic analysis has devoted a considerable effort to analysis of the impact of international production on the competitiveness of indigenous firms. The debate has centred on the existence of technological spillovers from foreign multinational enterprises (MNEs) onto domestic firms, which may spur their pace of technological development by means of technology diffusion, imitation or increasing competition.

Although all authors seem to agree on the importance of the local activity of foreign MNE affiliates for a country's development, opinions differ widely concerning its impact. While most scholars argue for a positive effect of the presence of foreign multinationals on the technological development of domestic firms (e.g., Caves, 1974; Findlay, 1978; Blomstrom, 1989), the opinion of some (e.g., Hymer, 1970) is entirely different, stressing the relevance of the negative consequences arising from the exportation of big firms' market power to foreign countries. Others, such as Cantwell and Dunning (Dunning and Cantwell, 1986; Cantwell, 1987, 1989), believe that the sign of the impact of the foreign presence depends on a set of conditions, and that it may turn into both virtuous and vicious circles of technological development in the locations affected by foreign MNE activity.

Just as there is no agreement at the theoretical level, so there are evident contrasts in the scant empirical evidence available. Using cross-sector industry data, Caves (1974), Globerman (1979), Blomstrom (1989), Blomstrom and Wolff (1994) and Kokko (1992) find that a foreign presence helps domestic firms to achieve higher levels of productivity.<sup>1</sup> Haddad and Harrison (1993) do not detect any spillover effect in a sample of Moroccan firms. Cantwell (1989) finds that the ability of European firms to react to competition by US MNEs during the postwar period has changed according to their initial level of technological development *vis-à-vis* US competitors. Drawing on this and other evidence, Cantwell highlights three stylised cases which emerge from

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<sup>1</sup> It is worth noting that all the above studies, with the exception of that by Caves (Australia) and Globerman (Canada), examine the Mexican manufacturing industry.

extensive empirical research regarding the industrialised countries (Cantwell, 1993). First, in industries where the technological tradition of indigenous firms is well-established, domestic firms are generally able to react promptly to foreign threats, to assimilate foreign technologies and to mobilise resources to compete with foreign MNEs in their own home markets. In the centres of excellence for development of a particular technology, the process of technological competition between foreign and domestic firms may generate technological spillovers in both directions through the concentration in these locations of high-tech phases of production and/or R&D activities by foreign and domestic firms. Thus a virtuous circle of technological development may propel the indigenous industry towards new technological frontiers. Second, where technological and industrial development of indigenous firms is very weak, the activity of foreign affiliates may benefit the host country by increasing employment and, if it is the case, by stimulating the development of indigenous vertically related firms. Third, in the intermediate case, where the domestic technological tradition is moderately developed, and the prosperity of indigenous firms depends on a protected local market, the presence of foreign MNEs is likely to damage their positions heavily. Drawing on their superior technological capabilities and on the competitive advantages deriving from exploitation of an international network of production, marketing and innovation, foreign MNEs easily displace domestic firms, which *"fall further and further behind and are gradually driven out of world markets in a process of cumulative decline."*<sup>2</sup>

Despite Cantwell's analysis, existing formal models of technological spillovers from foreign MNEs generally reflect the optimistic view of MNE activity referred to above. Like the spread of a disease, the larger the foreign presence in the national industry, the more foreign technologies leak out to domestic firms (Koizumi and Kopecky, 1977; Findlay, 1978; Das, 1987; Wang, 1990). Moreover, the wider the 'distance' between backlog indigenous firms and foreign MNE affiliates, the greater the room for improving the technological capability of domestic firms by imitation of foreign

technologies (Findlay, 1978; Wang and Blomstrom, 1992).<sup>3</sup>

In what follows, I suggest that analytical models constructed to explain the interaction between foreign and indigenous firms at the technological level should be able to generate at least two different outcomes: one corresponding to a virtuous circle of technological development, and the other to a process of cumulative decline in the domestic industry. Thus, in section 2, attention is focused on a set of circumstances which may affect the impact of international production on the technological development of domestic firms. More specifically, it is argued that both technological conditions (technological disparities, ease of learning, the appropriability regime, etc.) and market conditions (the extent of foreign penetration and its rate of increase, etc.) play a crucial role. A relatively wide technological gap can be easily reduced when foreign presence is modest and slowly growing, or when industrial policies support R&D efforts by indigenous firms. Conversely, left alone to face market competition and a rapidly increasing foreign penetration, even indigenous firms characterised by a relatively narrow technological gap may be driven out of the market by foreign competitors. Drawing on this analysis, a model is developed in which different outcomes can be generated according to market and technological conditions (section 3). The empirical evidence for the UK economy during the period 1983-1989 is reported in section 4. Conclusions follow as usual.

## 2. Foreign presence, technological gap and host country's technological development: some critical issues.

Even if a large number of interrelated circumstances<sup>4</sup> are likely to play an important role in shaping the impact of international production on the technological development of indigenous firms, technological and market conditions are probably of

<sup>3</sup> Of the latter models, Wang and Blomstrom's is the richest of implications. It assumes that the majority of spillovers do not arise 'automatically' from the foreign presence, but instead result from technological competition between foreign and indigenous firms. I will return to this point throughout the text.

<sup>4</sup> For instance, Dunning (1988) argues for the existence of a set of Economic-Social and Policy conditions (the ESP paradigm) which influence the impact of international production on a country's development.

<sup>2</sup> Cantwell (1987), p. 28.

major importance. Among the latter, the analysis in this section will focus on three main factors which may affect spillovers, namely, the initial technology gap of domestic firms, the level of foreign penetration and its rate of increase, and the implications of the existence of market selection processes driven by technological disparities.

#### Technological gap and technological spillovers.

An important point to be discussed in the search for a formal representation of the impact of foreign MNEs activity on the technological development of indigenous firms is the relationship between technological spillovers and technological disparities. Two very different perspectives exist in the literature on this matter. On the one hand, it is argued, according to the 'advantages of backwardness hypothesis', that the wider the disparities, the greater the opportunities for indigenous firms to achieve higher levels of efficiency by imitating foreign technologies (Findlay, 1978). On the other hand, it is asserted that a wide technological gap impairs indigenous firms' ability to catch up with foreign competitors (Cantwell, 1989, 1993).

Clearly, these two assumptions have very different implications. In the first case, international production would show a tendency to reduce inequalities among nations. In the other case, MNE activity would be a reinforcing factor of diverging development patterns.

Even if it might be accepted that a minimum level of technological disparities must exist in order to create room for the possibility that the leaking out of technological knowledge from MNE affiliates will benefit indigenous firms' technological capabilities,<sup>5</sup> there exist several reasons for giving priority to the other point of view. I shall deal with them briefly.

In the first place, recent empirical and theoretical literature about technological

activity and technology diffusion points out that a firm's ability both to follow and adapt to its needs technological developments by other firms and organisations - viz., the firm's *absorptive capacity* - and to pursue independent lines of technological development depends on its existing technological capability (Cohen and Levinthal, 1989; Cantwell, 1993). Thus, the hypothesis of the existence of 'advantages of backwardness' ensuring to backlog firms faster rates of productivity growth has been partly replaced by the idea that 'success breeds success', so that the most competitive firms are likely to consolidate their position cumulatively. In the case of the host country's effects of international production, this implies that the ability of indigenous firms to benefit from dissemination of foreign technology increases with their initial level of technological competence. Indigenous firms which lag far behind foreign competitors may be unable to sustain - by imitating foreign technologies or by pursuing indigenous lines of technological development - sufficient rates of productivity growth and product innovations to defend their relative competitiveness *vis-à-vis* other firms (which include foreign MNE affiliates) operating in the market.

Secondly, it is widely recognised that the existence and the amount of technological spillovers depend on a heterogeneous set of conditions, which includes the linkages that foreign MNE affiliates establish with vertically related indigenous firms and the quality of the technologies imported by foreign MNE affiliates. While linkages affect the size and the frequency of technological spillovers, and technology imports the amount of technological knowledge that may leak out from foreign MNE affiliates to indigenous firms, both factors are likely to be positively related with the level of technological development of the domestic industry. In fact, on the one hand, a low level of technological competence will render indigenous firms unable to meet the technological standards required by foreign firms and, hence, will reduce local sourcing by foreign enterprises with perverse effects both on the balance of payments and technological spillovers (Dunning, 1986). On the other hand, since technology imports are expensive (Teece, 1977), foreign firms will have no reason to import more and newer technologies from their parent companies, if competition from domestic firms does not threaten their market shares and profits. Thus, in such cases "... a large

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<sup>5</sup> However, if technological change is 'localised' (Atkinson and Stiglitz, 1969), in the sense that firms from different countries tend to follow different technological trajectories, it is argued that a sufficient condition for spillovers might be the existence of 'diversities', instead of 'disparities', in technological development between indigenous and foreign firms.

*foreign presence may coexist with a slow technology transfer and the transfer of old technologies”*<sup>6</sup> and, hence, it may result in a low amount of technology ‘available’ for imitation by indigenous firms.

The main problem arising from the above discussion is to find a way to take into account of both the positive relationship between the technological disparities and the opportunities of improving the technological level of domestic firms by the imitation of foreign technologies suggested by the ‘advantages of backwardness hypothesis’, and the negative relationship which links technological disparities with the ability of indigenous firms to appropriate technological spillovers from foreign MNE affiliates. One reasonable way to deal with this problem is to assume that spillovers increase with the technological gap up to a certain critical level of it. Beyond this point technological competence by indigenous firms will be so low that they will generally not be able to fully exploit the technological opportunities arising from foreign MNE presence. Thus, as technological disparities increase further, spillovers diminishes as well as the ability of domestic firms to catch up with foreign competitors.

Obviously, various factors determine the critical size of the gap compatible with the competitive upgrading of indigenous firms. The appropriability regime, the level of complexity of the technologies in use by foreign firms, and other technological factors influence the leaking out of technological knowledge from foreign plants. Market conditions, which includes the level of foreign penetration and its rate of increase, affect, as we shall soon discuss, a firm’s profits and, hence, resources which are available to monitor, decode and imitate foreign technologies, and/or to pursue indigenous lines of technological development. Government intervention influences spillovers by modifying competitive environment, by helping the competitive upgrading by domestic firms and/or by stimulating technology import by foreign MNE affiliates.

### **Foreign presence and technological spillovers.**

Another valuable point of discussion is the relationship between technological spillovers and the level of the foreign presence within a national industry, as well as its rate of increase. While, on the one hand, both factors may be the outcome of technological disparities between foreign and indigenous firms, so that

*“...widespread foreign investment usually indicates that the process of competitive upgrading in an economy is not entirely healthy because domestic firms in many industries lack the capabilities to defend their market position against foreign firms.”*<sup>7</sup>

On the other hand, it is also likely that the same factors will affect to some extent domestic firms’ ability to imitate foreign technologies or to exploit indigenous lines of technological development.

Wang and Blomstrom (1992) in their model hypothesise that the majority of spillovers do not arise ‘automatically’ from foreign presence. Instead, they assume that imitation of foreign technologies requires specific investment in learning activities by indigenous firms. Hence, since learning investment depends on a firm’s profits, which are negatively correlated with foreign firms’ output and technological disparities, the greater the foreign presence, the lower, *ceteris paribus*, spillovers will be. Similarly, Cantwell (1989, 1993) suggests that where the domestic technological tradition is weak the ability of foreign MNEs to capture market shares may force indigenous firms to cut back on research or to concentrate efforts on narrower fields of specialisation. Empirical evidence collected by Globerman and Meredith (1984) for Canada and by Veugelers and Vanden Houte (1990) for Belgium suggests that foreign presence reduces indigenous firms’ R&D expenditure, while Kokko (1992) does not detect any positive effect of foreign presence on the productivity level of Mexican firms in sectors characterised by a high (over 50%) foreign share and/or a wide technological gap.<sup>8</sup>

<sup>6</sup> Wang and Blomstrom (1992), p. 138.

<sup>7</sup> Porter (1990), p.671.

<sup>8</sup> It should be noted, as Kokko does, that the latter results may be due to a possible selection bias

Combining these pieces of evidence and analytical reflections with the discussion of the preceding section, it follows that the reaction of indigenous firms is likely to be jointly determined by market and technological conditions. More specifically, it is argued that the critical level of technological disparities, beyond which indigenous firms' absorptive capacity declines, does not depend on technological factors alone, but also on other circumstances affecting indigenous firms' R&D efforts and profitability. In industries where a relatively wide technological gap is associated with a relatively low and slowly growing foreign share, indigenous firms may be able to catch up gradually. Conversely, where technological disparities are relatively modest but indigenous firms have to cope with a foreign presence which is 'too high' or which grows 'too fast', the same firms may be unable to compete with foreign rivals and may enter into a process of cumulative decline.

#### Indigenous firms' productivity growth and market selectiveness.

In the preceding discussion, it has been pointed out that both technological and market conditions contribute to determine the impact of foreign direct investment over the technological development and the market performance of domestic firms. What is missing is an explicit analysis of the process explaining the interaction between these two sets of conditions.

In what follows, I suggest that market selection processes driven by technological disparities may constitute the interface by which technological and market conditions interact with each other. A tight selective environment will imply a strong relationship between a firm's competitiveness and its level of profits. Hence, market selectiveness will ensure the survival of only few firms very homogenous in terms of technological competence. *Vice versa*, a loose selective environment will permit even to firms which lag far behind the technological frontier, to earn sufficient profits to finance the

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in the grouping of industry. In fact, by splitting the sample of industries according to the level of the technological gap at a certain point of time, we can automatically place in the group of sectors characterised by a high technology gap those industries where the current level of the gap is the result of a lack of technological spillovers.

investment required in order not to fall further behind competitors (Teece, Pisano and Shuen, 1990; Cantwell, 1993).

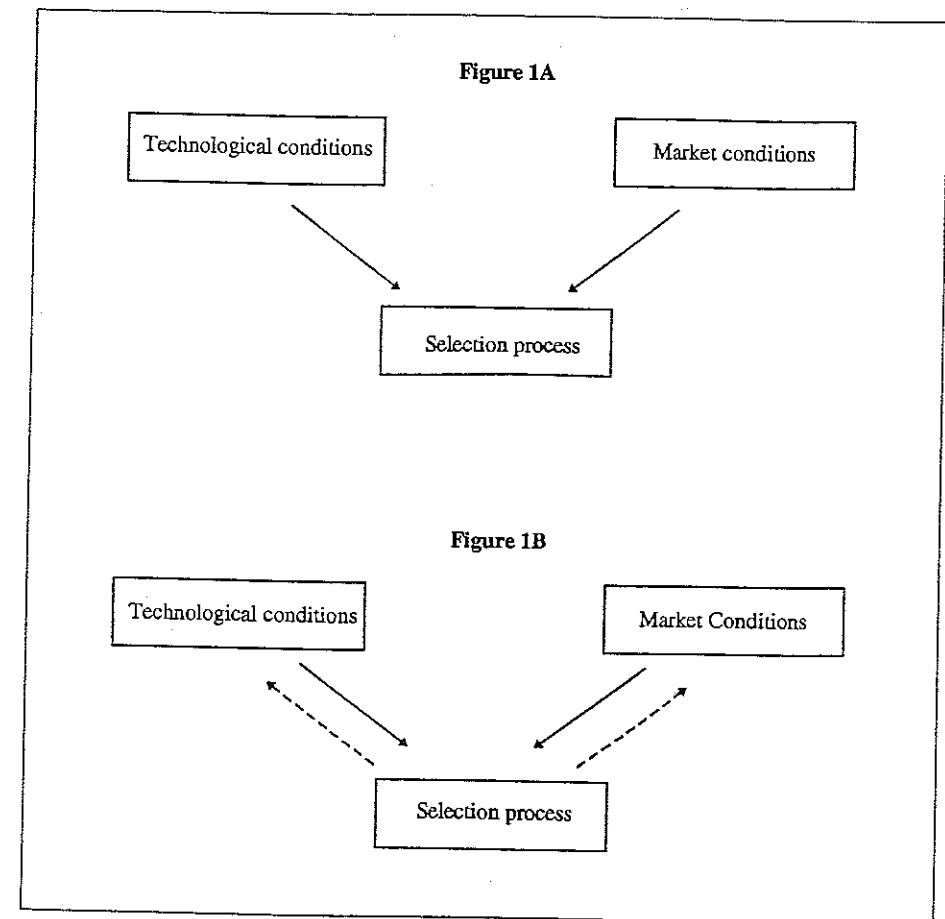


Fig. 1. The interaction between technological and market conditions: a simplified schema.

As it is represented in figure 1A, technological and market conditions constitute the inputs of the selective process by determining a firm's relative competitiveness (which depends on each firm's market share and absolute competitiveness, as it will be more formally set out in the following section) and its absorptive capacity. The selection mechanism processes this information and sets the resultant change in a firm's market

share and its actual level of profits. Consequently (figure 1B), the output of the selective process influences the technological and market conditions of the subsequent period by determining resources available for learning investment, new machinery and capital equipment, each firm's market share, and, hence, a firm's productivity growth and relative competitiveness.

Clearly additional circumstances might alter or reinforce the causation mechanism at work by affecting one or more elements of this stylised representation. For instance, the growth of demand associated with new foreign direct investment (FDI) and average productivity growth might partly offset the tightness of the selective environment. Government intervention by financing R&D expenditure, favouring technological co-operation between foreign and indigenous firms and/or regulating FDI flows can alter the competitive game and the spread of the leaking out of technological knowledge from foreign plants.

### 3. The model.

The preceding section of this paper has been dedicated to discuss the principal factor affecting the interrelationship between FDI and the technological development of indigenous firms. Accordingly, the following pages will be devoted to develop a model which embodies the following properties:

- (i) technological spillovers depend on the absorptive capacity of indigenous firms;
- (ii) the technology imports by foreign firms are inversely related to the existing technological gap;
- (iii) a firm's market share dynamic depends on its technological level relative to the other firms which operate in the market;
- (iv) the dimension of the market grows with the national income according to a Keynesian-type demand formation mechanism.

In formulation of the model, I have drawn extensively on the work by Dosi and Freeman (1992)<sup>9</sup> aimed at explaining the process of forging ahead and falling behind

<sup>9</sup> See also Dosi and Fabiani (1994).

among countries according to an evolutionary perspective. However, substantial changes have been made with respect to the original formulation. Firstly, given the scope of this paper, equations describing the interaction between foreign MNEs and indigenous firms at the technological level have been incorporated into the model. This has been done to take account of some of the more interesting lines of development in the recent literature concerning technological spillovers from foreign MNEs. As in the Wang and Blomstrom's (1992) model, the decision to import new technology by foreign firms depends on the existing technological gap between foreign and indigenous firms, while the imitation of foreign technology requires specific investment. Secondly, for the sake of simplicity, the number of parameters has been reduced by eliminating stochastic processes and foreign trade. Thirdly, the model will refer to a single-sector economy.

Although comprising these substantial modifications with respect to Dosi and Freeman's work, the model illustrated below still belongs to the methodological perspective of evolutionary economics. In fact, it displays two of the main characteristics of that methodological tradition.<sup>10</sup> The first is the existence of a strong path-dependency. The absorptive capacity of indigenous firms depends on their past process of technological accumulation. Hence, the latter is the major cause of virtuous or vicious circles of technological development. Secondly, heterogeneity among individuals (e.g., between foreign and domestic enterprises or within each group of firms) is explicitly recognised as a cause of evolutionary paths, driven by market selectiveness.<sup>11</sup>

### Market selection process.

Following Dosi, Silverberg and Orsenigo (1988), it is assumed that the evolution of the market share of indigenous firms in terms of total output ( $f$ ) depends on their

<sup>10</sup> For a wider discussion of these issues see, for instance, Hall (1994).

<sup>11</sup> Conversely, a third characteristic of the evolutionary approach, namely its probabilistic nature, is not present in my model. This in order not to complicate my formulation and numeric simulations with elements which do not significantly affect the issues analysed. However, probabilistic processes may be easily re-introduced without changing the main framework of the model.

relative competitiveness ( $RC$ ) vis-à-vis the other firms operating in the market (the symbol  $\dot{f}_i(t-1, t)$  stands for the change occurred in the value of  $f$  between  $t-1$  and  $t$ ):

$$\dot{f}_i(t-1, t) = \alpha [RC_i(t-1) - 1] f_i(t-1)$$

Taking into account that  $f_i(t) = \frac{Q_i(t)}{Q(t)}$ , where  $Q_i$  and  $Q$  are a firm's and total output, and assuming, for the sake of simplicity, the existence of only one domestic firm, firm 1, and one foreign firm, firm 2, the previous equation has been reformulated as regards the domestic firm into:

$$\dot{Q}_1(t-1, t) = \alpha [RC_1(t-1) - 1] Q_1(t-1) + Q_1(t-1) \frac{\dot{Q}(t-1, t)}{Q(t-1)} \quad (1)$$

with

$$RC_i(t) = \frac{E_i(t)}{\bar{E}(t)} \quad (2)$$

$$E_i(t) = \frac{1}{P_i(t)} \quad (3)$$

$$\bar{E}(t) = \sum_i f_i(t) E_i(t) \quad (4)$$

where  $P_i$  is the price charged by the  $i$ -th firm and  $E_i$  its absolute competitiveness.

Similarly, the output dynamic of the foreign firm depends on its relative competitiveness and on the flows of new foreign direct investment (FDI), which is measured in terms of the additional investment available to employ new workers ( $N^{FDI}$ ):

$$\dot{Q}_2(t-1, t) = \alpha [RC_2(t-1) - 1] Q_2(t-1) + Q_2(t-1) \frac{\dot{Q}(t-1, t)}{Q(t)} + N^{FDI}(t) \pi_2(t) \quad (5)$$

with

$$N^{FDI}(t) = \frac{FDI(t)}{w_2(t)} \quad (6)$$

$$FDI(t) = \tau Y(t-1) \quad (7)$$

where  $\pi$  is labour productivity and  $Y$  the real national product,

$$Y(t) = \sum_i \frac{Q_i(t)}{P_i(t)} \quad (8)$$

Each firm fixes prices according to a simple mark-up rule over labour costs:

$$P_i(t) = (1 + \rho) \frac{w_i(t)}{\pi_i(t)} \quad (9)$$

where  $w$  is the nominal wage and  $\rho$  the mark-up.

Workers use all the wages received at time  $t-1$  to buy goods in the following period. Thus, total demand, which is equal to total output, as we shall see later, is equal to:

$$Q(t) = \sum_i w_i(t-1) N_i^P(t-1) + w_2 N^{FDI}(t-1) + w_1 N^{IM}(t-1) \quad (10)$$

where  $N^P$  and  $N^{IM}$  are the number of workers engaged in, respectively, productive and imitating activities.

### Technology import and imitation.

As has been discussed above, it is assumed that a firm's capacity to absorb foreign technologies depends:

- (a) on its existing level of technological competence; and
- (b) on its learning efforts.

Thus, the indigenous firm's labour productivity growth is related to the technological gap vis-à-vis the foreign MNE (proxy for domestic firm's level of technological competence), which is defined as the ratio between labour productivity in foreign and domestic plants (i.e.,  $GAP(t) = \pi_2(t)/\pi_1(t)$ ), and to the number of workers engaged in the learning activity. Furthermore, technological spillovers are greater, the wider the gap up to a certain critical level. Thereafter absorptive capacity declines:

$$\frac{\pi_1(t-1, t)}{\pi_1(t-1)} = \mu_1 + \lambda_0 [1 - \exp \{-\eta N^{IM}(t-1)\}] \frac{GAP(t-1) - 1}{\exp \{\lambda_1 GAP(t-1)\}} \quad (11)$$

As regards the foreign firm, it is simply assumed that its technology imports are inversely proportional to the existing technological gap:

$$\frac{\pi_2(t-1, t)}{\pi_2(t-1)} = \mu_2 + \delta \exp \{-GAP(t-1)\} \quad (12)$$

### Labour market dynamic.

The last part of the model describes labour market dynamics.

All profits are reinvested by domestic firms in the imitating activity. Thus, we have:

$$\dot{N}^{IM}(t) = \frac{RD(t)}{w_1(t)} \quad (13)$$

with

$$RD(t) = P_1(t) Q_1(t) - w_1(t) N_1^P(t) \quad (14)$$

As regards workers employed in the productive activity, firms instantaneously adjust employment to the level of demand:

$$N_1^P(t) = \frac{Q_1(t)}{P_1(t)\pi_1(t)} \quad (15)$$

Nominal wages changes with inflation, average productivity growth and total employment dynamics:

$$\frac{\dot{w}_1(t-1,t)}{w_1(t)} = \vartheta_1 \frac{\dot{\pi}(t-1,t)}{\pi(t-1)} + \vartheta_2 \frac{\dot{P}(t-1,t)}{P(t-1)} + \vartheta_3 \frac{\dot{N}(t-1,t)}{N(t-1)} \quad (16)$$

with

$$\bar{\pi} = \sum_i f_i \pi_i \quad (17)$$

$$\bar{P} = \sum_i f_i P_i \quad (18)$$

$$N = N_1^P + N_2^P + N_1^{IM} \quad (19)$$

In the numerical simulations set out below, it is hypothesised that the wage dynamic is the same for both firms, but that wages paid by foreign firms are equal to  $w_2(t) = (1 + \varepsilon)w_1(t)$  with  $\varepsilon > 0$ , in order to take into account the additional costs that foreign firms have to sustain to penetrate the host country's market.

### Comments.

Before discussing simulation results, a few comments on the working of the model are in order.

Firstly, the expansion of foreign MNE's output produces two opposite effects. Increasing the income produced and distributed tends to expand domestic firms' profits and, hence, their R&D efforts. However, the increasing foreign share reduces

the relative competitiveness of indigenous firms and raises wages, eroding their profits. The algebraic sum of these two effects is the principal engine driving the dynamics of the model.

Secondly, the major deficiencies of the model are the closed-economy assumption and the exogeneity of FDI flows. The incorporation of foreign trade dynamics will probably reinforce the causation mechanisms at work. Endogenising FDI would be an important extension of my analysis.

Thirdly, only two firms, one domestic and one foreign, are assumed to exist in my model. This is a severe limitation of the analysis as regards the representation of the market selection processes whereby, as discussed in section 2, even in the absence of spillovers, foreign presence may lead to a faster rate of productivity growth by indigenous firms. This assumption has been made in order to simplify the numerical simulations (otherwise, I would have made further hypotheses about the distribution of productivity differences among the average values) and to focus the analysis on the main issue of this paper, namely the technological performance of domestic firms in changing technological (the gap) and market (the foreign share and its pace of increase) conditions.

### Simulation results.

A large number of different parametrisations were performed which showed the model's robustness to variations in the parameters. In the numerical simulations reported, parameters were set up as follows:  $\alpha=0.1$  (relatively weak market selection process),  $\lambda_0=1$ ,  $\lambda_1=1$ ,  $\mu_1=0$ ,  $\mu_2=0.01$ ,  $\delta=0.04$ ,  $\vartheta_1=1$ ,  $\vartheta_2=1$  (wages adjust completely to productivity and price growth),  $\vartheta_3=0$  (labour supply elasticity at a given wage rate equal to infinity),  $\eta=0.1$ ,  $\varepsilon=0.2$  (foreign firms face labour costs 20% higher than domestic firms),  $\rho=0.1$  (mark up is 10% over production costs). The results reported refer to 20 iterations given the initial conditions  $f_1=0.99$  and  $f_2=0.01$ .

In a first group of simulations, it has been set  $\tau=0$  (no new FDI after time  $t=0$ ). The results obtained highlight the influence of the initial technological gap on the 'success'

or the 'failure' of domestic firms faced by foreign competition. Three different types of reaction emerge.

When the initial technological gap is wide, domestic firms do not have the necessary absorptive capacity successfully to imitate foreign technology (figure 2). The market selection process drives indigenous competitors out of the market, eroding domestic firms' profitability and, hence, their investment in learning. Foreign firms permeate throughout the economy. Moreover, since indigenous firms exert a very moderate competitive pressure over foreign firms, technology import is modest and the location concerned becomes the basis for low value-added activities by foreign MNEs.

Conversely, when the initial technological competence of domestic firms is high, they are able to reduce the original gap (figure 3). Initially, foreign penetration increases slowly. Later, domestic firms re-conquer market shares, while the location attracts high-tech foreign MNE productive activities. Technological competition and spillovers interact with each other in a virtuous circle of technological development.

Of particular interest is an intermediate case characterised by an initial apparent process of catching up by domestic firms, which subsequently changes into a rapid process of falling behind (figure 4). In this case, the initial conditions in terms of technological gap and foreign penetration ensure sufficient profits for domestic firms to finance R&D activities for the successful imitation of foreign technologies. However, as foreign presence increases, market conditions erode the domestic firms' profitability, causing the cumulative decline of the national industry.

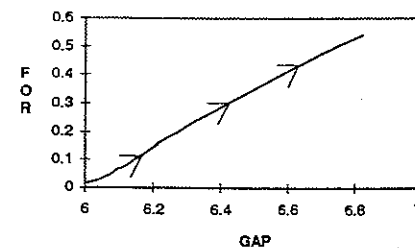


Fig. 2. The vertical axis measures foreign penetration (FOR) terms of total output, the horizontal axis the productivity gap (GAP).

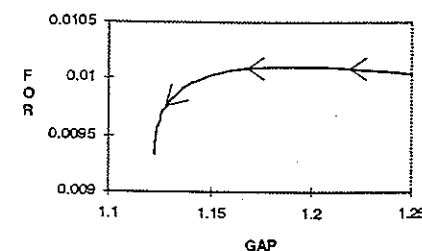


Fig. 3. Axes as in figure 2.

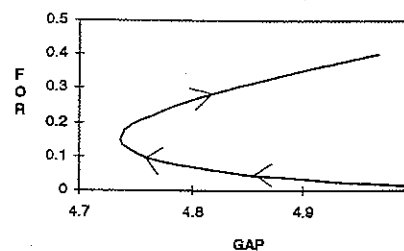


Fig. 4. Axes as in figure 2.

A second set of simulations was performed in order to detect the influence of FDI flows on the technological development of indigenous firms. Figures 5 to 7 report the effects of a change in the parameter  $\tau$  from 0 to 0.1 on the technological gap, domestic firms' productivity and real wages. The results obtained seem consistent with Cantwell's analysis. Locations characterised by a high level of technological development benefit from an increase in the FDI flows. The technological gap diminishes, while productivity and real wages increase. A completely different dynamic prevails in production sites characterised by a mid/low level of technological development. Here, rapidly increasing foreign penetration erodes domestic firms' profits and, hence, investment in learning. The gap increases, productivity and real wages decrease. Finally, locations characterised by a very low level of technological development are not harmed by an increase in FDI flows. Here, the lack of any technological and productive capability by indigenous firms entails that the market expansion effects of FDI outweigh the crowding out effects on domestic firms. Technological gap, domestic firms' productivity and real wages are almost unchanged.

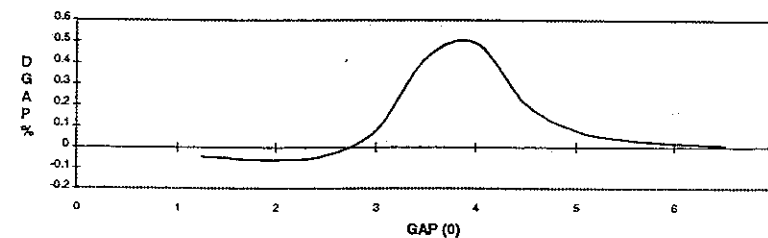


Fig. 5. The vertical axis measures the percentage change in the productivity gap (DGAP%) which occurs when  $\tau$  increases from 0 to 0.1, the horizontal axis the initial productivity gap (GAP 0).

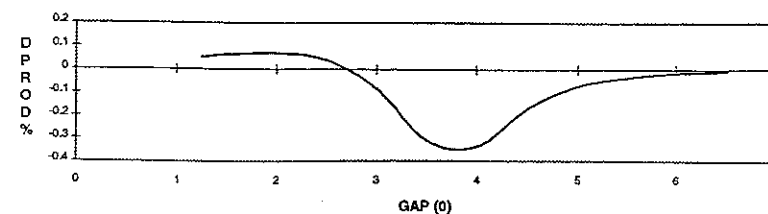


Fig.6. The vertical axis measures the percentage change in the domestic firm's productivity (DPROD%) which occurs when  $\tau$  increases from 0 to 0.1, the horizontal axis the initial productivity gap (GAP 0).

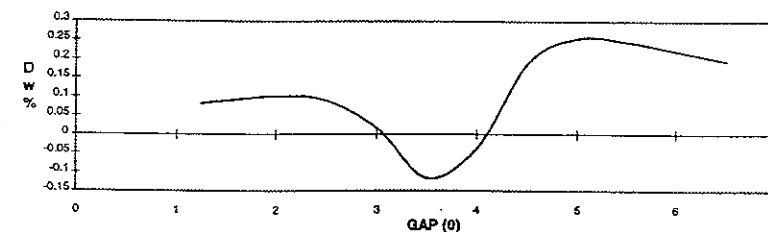


Fig. 7. The vertical axis measures the percentage change in the real wage rate (DW%) calculated according to the formula  $(\sum w_i / \sum p_i)$  which occurs when  $\tau$  increases from 0 to 0.1, the horizontal axis the initial productivity gap (GAP0).

#### 4. Empirical evidence.

The scarcity of available data on international production does not permit in-depth assessment of the goodness of fit of my theoretical analysis to empirical evidence. However, some indications can be drawn from the data available on foreign MNE operations for some countries. Hereafter, I shall refer to the experience of the UK economy during the 1980s. This case is of particular relevance to my analysis given the particular strategy pursued by UK governments over the period under investigation. In fact, industrial policies were characterised by measures designed to attract a larger share of FDI and by close reliance on market forces to generate industrial development.

For empirical purposes, use have been made of data drawn from the UK Census of Production which refers to 18 two-digit manufacturing sectors at two points of time, 1983 and 1989. The data set, which is described in further detail in the appendix, allows the figures for domestic and foreign enterprises to be separated.

##### Test 1. Technological competence and productivity growth.

A main point of theoretical analysis has been the dependence of indigenous firms' ability to catch up with foreign competitors on their initial level of technological competence. Given the lack of data on the technological development of indigenous and foreign firms with the same classification as my industry-level data, I have used the initial technological gap as a proxy for this variable. The latter is defined as the ratio between average productivity in foreign firms and average productivity in domestic firms (respectively, GAPVAE when referring to value-added per employee and GAPNOE when using net output per employee).

A first attempt to regress domestic firms' productivity growth between 1983 and 1989 (DLVAED and DLNOED) on the initial technological gap (GAPVAE83 and GAPNOE83) for the whole sample of 18 industries yielded very unsatisfactory results (results not reported). This finding is not surprising, bearing the analysis of previous sections in mind. On the one hand, industries at a very low level of development may have benefited from in-coming FDI because the expansive effects of the presence of

foreign firms may have outweighed the crowding out effects on domestic firms. The setting up of new plants by foreign firms may have enhanced, in this kind of sector, the development of vertically related indigenous firms, and this phenomenon may have offset the negative effects produced on indigenous firms in direct competition with foreign MNE plants.<sup>12</sup> On the other hand, differences in the conditions possibly affecting technological spillovers (such as technological complexity, the appropriability regime, etc.) may result in non-linear relationships between initial technological gap and productivity growth when referring to cross-sector data. Both points of view seem to find some empirical support, as we shall see.

Table 1. *Domestic firms' productivity growth and technological gap, OLS regressions, 18 UK manufacturing industries, 1983-1989.*

|     |        |   |           |   |                |   |                             |                    |        |
|-----|--------|---|-----------|---|----------------|---|-----------------------------|--------------------|--------|
| (a) | DLVAED | = | 2.609     | - | 3.730 GAPVAE83 | + | 1.439 GAPVAE83 <sup>2</sup> | $\bar{R}^2 = 0.56$ | n = 18 |
|     |        |   | (4.028)** |   | (4.138)**      |   | (4.917)**                   |                    |        |
| (b) | DLNOED | = | 4.511     | - | 6.620 GAPNOE83 | + | 2.538 GAPNOE83 <sup>2</sup> | $\bar{R}^2 = 0.29$ | n = 18 |
|     |        |   | (3.199)** |   | (3.002)**      |   | (2.989)**                   |                    |        |
| (c) | DLVAED | = | 0.562     | - | 0.285 GAPVAE83 |   |                             | $\bar{R}^2 = 0.15$ | n = 15 |
|     |        |   | (2.526)*  |   | (-1.550)       |   |                             |                    |        |
| (d) | DLNOED | = | 0.689     | - | 0.363 GAPNOE83 |   |                             | $\bar{R}^2 = 0.30$ | n = 15 |
|     |        |   | (3.773)** |   | (2.471)*       |   |                             |                    |        |

Notes: absolute values of the t- statistics in brackets. \*, \*\* and denote respectively significance at the 5 and 1 per cent level of confidence (two-tailed test). Standards errors have been corrected for heteroschedasticity. n is the number of observations.

To investigate the first issue, a non-linear OLS regression was performed on the same variables employed in the preceding estimations. Indigenous firms' productivity growth was regressed against a quadratic function of the initial technological gap, with

<sup>12</sup> Note that given the high level of aggregation of the data it is likely that in many cases vertically related firms belong to the same industrial sector.

very good results obtained in terms of fit, especially when value-added per employee was employed as performance indicator (eqs. a and b in table 1). In both cases, as expected, an upward oriented parabola was obtained: productivity growth is higher when indigenous firms are characterised by high or very low levels of initial technological gap.

Even if apparently very satisfactory, the estimates reported above may be heavily affected, given the small number of observations, by the existence of few outliers. Inspection of the plot of the data suggests the existence of only 3 industries in which an above-average initial productivity gap is associated with a catching up process by domestic firms, while for the remaining industries there seemingly prevail a linear relationship between the initial productivity gap and its rate of increase. These three industries are: Manufacturing of metal goods, Man made fibres and Other manufacturing industries. Metal manufacturing is a sector which probably uses relatively simple technologies, which can easily be imitated even by firms lagging far behind foreign MNEs. Man made fibres is a very small sector compared with the other industries at a 2-digit level.<sup>13</sup> Thus, the close-down of a few domestic enterprises or their acquisition by foreign MNEs may have heavily affected the performance of the two groups of firms. As regards the sector Other manufacturing industries, the heterogeneity of the firms belonging to it may by itself be a cause of abnormal behaviour. It is accordingly argued that the non-linear relationship between domestic firms' productivity growth and initial technological gap depends on the specific characteristics of a few sectors.

To test this hypothesis, a linear OLS was re-run after the data referring to these three sectors were excluded (eqs. c and d). The explanatory power of the estimated regressions is significantly reduced when we use value-added per employee as performance indicator. Conversely, using net output per employee the goodness of fit of our estimation is almost unchanged.

<sup>13</sup> In 1983, it accounted for roughly 0.2% of total manufacturing employment and net output. In the same year, there were only 4 foreign enterprises operating in the sector.

## Test 2. Technological competence and catching up processes.

More than domestic firms' productivity growth *tout court*, it may be relevant to analyse their performance relative to foreign competitors. To this end, I now turn to changes occurring in the technological gap over the period concerned (DLGAPVAE and DLGAPNOE) and to their relationships with the initial technological disparities.

Table 2 (eqs. e and f) sets out results for the non-linear specification of the model after excluding observations for the Manufacturing of metal goods sector (the full-sample gives a poor fit). Both equations give satisfactory results in terms of R-squared. All coefficients are statistically different from zero and show the expected signs. In fact, the downward oriented parabolas obtained from the OLS regressions suggest that the gap has decreased (or increased less) in sectors characterised by a low initial productivity gap or a very high one.

Table 2. *Catching up by domestic firms and technological gap, OLS regressions, 18 UK manufacturing industries, 1983-1989.*

|     |                                                                   |                    |        |
|-----|-------------------------------------------------------------------|--------------------|--------|
| (e) | DLGAPVAE = - 2.011 + 3.090 GAPVAE83 - 1.125 GAPVAE83 <sup>2</sup> | $\bar{R}^2 = 0.20$ | n = 17 |
|     | (2.488)* (2.754)** (3.158)**                                      |                    |        |
| (f) | DLGAPNOE = - 3.457 + 5.305 GAPNOE83 - 1.963 GAPNOE83 <sup>2</sup> | $\bar{R}^2 = 0.15$ | n = 17 |
|     | (2.542)* (2.609)** (2.634)**                                      |                    |        |
| (g) | DLGAPVAE = - 0.553 + 0.517 GAPVAE83                               | $\bar{R}^2 = 0.36$ | n = 15 |
|     | (3.100)** (3.381)**                                               |                    |        |
| (h) | DLGAPNOE = - 0.616 + 0.562 GAPNOE83                               | $\bar{R}^2 = 0.51$ | n = 15 |
|     | (4.001)** (4.535)**                                               |                    |        |

Notes: as table 1.

After excluding the three sectors identified above, the OLS linear regressions were re-run (eqs. g and h). Using changes in the technological GAP as the dependent variable, linear regressions fit much better than non-linear ones. Again, industries characterised by a high initial technological gap seemed to be falling further behind

foreign MNEs. Conversely, where the technological gap was modest, indigenous firms seem to have been able to catch up with foreign firms.

### Test 3. Market selection and foreign presence.

The last issue investigated here is the relationship between initial technological gap and output growth by domestic firms. In previous sections it was supposed that a high technological gap is reflected in a relatively slow-growing market share by domestic firms because of the existence of market selection mechanisms driven by technological disparities.

If technological capabilities are not a major factor affecting a firm's competitiveness, we should find no statistically significant relationship between the technological gap and output growth by domestic firms. *Vice versa*, when technological factors are important, a negative relationship between the two variables should be registered.

The results reported in table 3 seem to confirm the latter hypothesis. Using the gap in terms of either value-added or output per employee, indigenous firms' output growth (DLNOD) seems to have been negatively affected by the initial technological disparities. The larger the technological gap between domestic and foreign firms, the smaller the output growth by domestic firms.

Table 3. Domestic firms' output growth and technological gap, OLS regressions, 18 UK manufacturing industries, 1983-1989.

|                                                           |                         |
|-----------------------------------------------------------|-------------------------|
| (i) DLNOD = 0.655 - 0.349 GAPVAE83<br>(4.152)** (2.850)** | $\bar{R}^2 = 0.22$ n=15 |
| (j) DLNOD = 0.750 - 0.417 GAPNOE83<br>(5.087)** (3.711)** | $\bar{R}^2 = 0.34$ n=15 |

Notes: as table 1.

### 5. Concluding remarks and policy implications.

This paper suggests that the effect of foreign MNE presence on the technological development of indigenous firms is likely to vary according to a number of circumstances. In particular, I have focused attention on two factors which affect the sign of the impact of in-flowing FDI on domestic firms' competitiveness, namely, the original technological gap between foreign and domestic firms and the pace of FDI flows. In this respect, a large technological gap may impair the capacity of domestic firms to absorb foreign technology, while a foreign presence in rapid expansion might dramatically reduce their profitability and hence their investment in R&D activity, new machinery and capital equipment.

On the basis of a theoretical model which adopts an evolutionary perspective, I have argued that when domestic firms excel in the development of a particular technology they benefit from in-coming FDI. In this case, technological competition between foreign and domestic firms creates room for a large amount of technological spillovers. By the rapid absorption of foreign technologies, indigenous firms reduce the original gap and spur foreign MNEs to import more advanced technology. Conversely, indigenous firms lagging far behind foreign competitors are penalised by in-flowing FDI. The greater competitive pressure generated by the foreign presence erodes their profits and hence reduces their investment in learning activities, new machinery and capital equipment. This gives rise to a cumulative process of technological decline in the locations concerned, which eventually leads to a large presence of foreign firms specialised in low-tech productions.

Similarly, I have suggested that an increase in the pace of FDI inflows produces different effects according to the level of technological development of indigenous industries. Highly technologically developed indigenous competitors may easily offset the negative influences of greater competitive pressure by exploiting the expansive effects associated with FDI. Backward domestic firms are instead likely to be almost completely crowded out by a rapidly growing foreign presence.

The empirical evidence for the UK seems to confirm these predictions. In all regressions, indigenous firms' productivity growth and catching up *vis-à-vis* foreign

MNEs are inversely correlated to the initial productivity gap. Similarly, output growth by domestic firms is negatively affected by technological disparities.

Both the theoretical and the empirical analyses of the preceding pages challenge the *laissez faire* view about in-flowing FDI as optimal policy prescription. Instead, it is suggested that the positive (or negative) effects of the foreign MNE entry might be enhanced (offset) by regulating FDI flows and by taking actions to speed up the dissemination of foreign technologies among domestic firms either by encouraging technological co-operation between foreign and indigenous enterprises or by financing R&D efforts by indigenous firms.

The scant empirical evidence available does not allow to measure costs and benefits of available policy instruments, and to assess the best combination of them. However, it is able to show that international production is not a processes which unambiguously leads to the competitive upgrading of the indigenous industry. Instead, it entails losers and winners which may correspond, alternatively, with foreign or indigenous firms, or with a group of enterprises independently from their nationality. Governments may use their power to change significantly the result of the game in order to maximise economic and social gains and to minimise loses.

This does not imply that they should try to stop the increasing movements towards internationalisation of productive activities (which will probably be impossible). Instead, as Dunning said, governments should *"...be aware both of the role MNEs may play in restructuring their economies, and of their own responsibilities in ensuring that MNEs, in achieving their corporate objectives, do not drive out indigenous firms (suppliers as well as he competitors) ..."*<sup>14</sup>. To this end, I believe, particular attention should be given to measures able to restrain competitive pressure by regulating FDI flows for the time necessary for the competitive upgrading of the domestic industry, while governments do their best for rapidly improving the technological competence of the indigenous firms.

<sup>14</sup> Dunning (1985), p.429.

#### Appendix. Data sources and description of variables.

All the data are from UK Census of Production PA1002. Data for domestic-owned firms have been obtained by subtracting the figures for majority-owned foreign enterprises (table 19) from the corresponding figures for all UK enterprises (table 13). Percentage changes have been obtained by log differentiating the original variables after dividing them for the producer price index (source OECD).

The 18 two-digit sectors used in the empirical analysis are:

Table A.1.

| SIC (REV.2) | Sector                                                        |
|-------------|---------------------------------------------------------------|
| 22          | Metal manufacturing                                           |
| 24          | Manufacturing of non metallic mineral products                |
| 25          | Chemical industry                                             |
| 26          | Production of man made fibres                                 |
| 31          | Manufacture of metal goods not elsewhere specified            |
| 32          | Mechanical engineering                                        |
| 33          | Manufacture of office machinery and data processing equipment |
| 34          | Electrical and electronic engineering                         |
| 35          | Manufacture of motor vehicles and other parts thereof         |
| 36          | Manufacture of other transport equipment                      |
| 37          | Instrument engineering                                        |
| 41/42       | Food, drink and tobacco                                       |
| 43          | Textiles                                                      |
| 45          | Footwear and clothing                                         |
| 46          | Timber and wooden furniture                                   |
| 47          | Paper and paper products; printing and publishing             |
| 48          | Processing of rubber and plastic                              |
| 49          | Other manufacturing industries                                |



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