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Offshoring and reshoring of manufacturing activities: a two-country evolutionary model

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Abstract

In this paper, we consider a two-country model to study the offshoring and reshoring of manufacturing activities. A multinational enterprise (MNE) can offshore its production, or part of it, in a technologically laggard country to take advantage of a lower labour-productivity remuneration and a lower minimum wage. The concentration of the manufacturing activity in a single country causes an increment of the bargaining power of workers that mirrors in a higher labour cost. These disadvantages of the agglomeration may favour an offshoring process, which, however, empirical evidence suggests to be slow. The investigation underlines that an industrial policy that aims to increase the within-country (technological) spillovers that, on their own, increase the labour productivity in the technological-leader country, is necessary to incentivize an MNE to reshore the manufacturing activity. The economic-policy implications are confined to a monopolistic configuration of the manufacturing activity and to a market that does not distinguish the geographical origin of the goods.

Keywords

evolutionary dynamics; multinational enterprises; offshoring; reshoring

JEL Classification: F23, F63, C73

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1. Introduction

Modern business practices of multinational enterprises (MNEs) aim at the mass production of standardized products obtainable at a low cost, making the most of possible economies of scale. From this point of view, production in countries very far from those in which the output is engineered and sold has also proved to be a useful business practice to reduce production costs, since transport costs have a very slight impact on the final total cost. As it is known, this process has led to the phenomenon of production offshoring, which is production delocalization in countries where typically the cost of labour (specialized and non-specialized) is lower. These countries are generally characterized by fewer infrastructures, fewer forms of labour protection and lower levels of expenditure on education. To counterbalance this effect, many countries that have seen a large part of their production offshored abroad have implemented business support policies in various forms (profit detaxation, measures to increase labour productivity, improving existing infrastructure) to try to attract again part of the production in the countries of origin, thus giving rise to a process of reshoring. In any case, the concentration of the manufacturing activity in a single country causes an increased bargaining power of workers, resulting in a higher labour cost. Thus, the process of offshoring and reshoring can lead to a wage effect of (asymmetric) dynamic changes in labour productivity, which is a typical example of an agglomeration disadvantage, as described in Maurer and Walz (2002). Some of these research questions have been studied within the modelling framework of the 'new economic geography (NEG), firstly proposed in Krugman (1991). NEG models are general equilibrium models with separate local markets and capital mobility that is driven by market demand and production factor remunerations. Notably, NEG models have been extended to a dynamic set-up by integrating factor mobility in an evolutionary system to explain their dynamic patterns – see, among others, Agliari et al. (2014), Commendatore et al. (2008, 2014). Bischi et al. (2018) and Radi et al. (2019) consider a modelling framework different from the NEG one. In particular, the latter are partial equilibrium models with a unique market for the manufactured good and factor mobility determined by the supply-side only.

In this paper, we propose a revisited version of the model in Radi et al. (2019) where we isolate the effects of (knowledge) spillovers of the technologically advanced country on the labour productivity. For this purpose, we present a formal model for describing the dynamics of offshoring and reshoring of (all or a share of) production in two countries (a technologically advanced country and a technologically laggard country) by a representative MNE. We assume that this decision is made through a comparison of advantages in terms of production costs, which are influenced by elements of the country systems (infrastructures, education programmes, wage policies, etc.).

We first address a very useful benchmark of the model, where knowledge spillovers in the technologically advanced leader are neglected. This case corresponds to a scenario in which political decisions in the technologically advanced country tend to underfinance education and research, which, in turn, reduces the potential labour productivity of the technological leader. Then we explore the possible dynamic scenarios when, on the contrary, knowledge spillovers in the technologically advanced country are present, similarly to the mechanism proposed in D'Aspremont and Jacquemin (1988) and in Bischi et al. (2003a, b). These effects are due to massive investment in education and research that are able to provide trained workers that can fully exploit their skills; this is reflected in higher labour productivity in that country. In this paper, for benchmarking purposes, we assume that in the technologically laggard country, these forms of massive education are difficult to be implemented and are not able to enhance the labour productivity in that country. In addition, we implement a mechanism that tends to introduce higher minimum wages in countries where production is more concentrated.

Our investigation underlines that an industrial policy that aims to increase the within-country (technological) spillovers that, on their own, increase the labour productivity in the technological-leader country, is necessary to incentivize an MNE to reshore the manufacturing activity. The economic-policy implications are confined to a monopolistic configuration of the manufacturing activity and to a market that does not distinguish the geographical origin of the goods.

This paper is organized as follows. Section 2 presents the formal model of offshoring and reshoring of production in a two-country system. In Section 3 the model and its dynamic properties are analysed assuming that knowledge spillovers in the technologically advanced country are not present. Then in Section 4 we explore the possible dynamic scenarios in the complete model, which is when knowledge spillovers are introduced. Section 5 concludes. All the technical details are relegated in the Appendix.

2. Model

Let us assume that a representative firm, a multinational enterprise (MNE), of a given industrial sector can decide whether to produce in the country it belongs to (Country 1) or to produce in Country 2, which is characterized by lower labour costs, a lower level of union protection and a lower level of education of workers. In particular, Country 1 is considered the technological-leader country, while Country 2 is the technological-laggard country. As an intermediate choice, the company can also relocate only a fraction of its production to Country 2. For the sake of simplicity and without loss of generality, let us normalize to one the total production of the representative firm. Then, in the following, we will denote by $x \in [0,1]$ the fraction of total production that is produced in Country 1. Anyway, the good produced in the two countries must maintain a certain level of quality and can be considered identical from the point of view of the final consumer, who is therefore interested in the manufacturer's brand and not in the place where the good was produced.

The total industry production is then sold in a common market at fixed price P. For the sake of simplicity, we assume total production is constant over time and it is thus normalized to one. Moreover, we assume a constant remuneration for each unit of labour productivity, which in country i is equal to α_i.

Summing up, for each unit of production, the profit generated depends on the level of production in either country, so that it can be formalized as a function of the share $x \in [0,1]$ of the output of the MNE that is produced in Country 1. In detail, the profit for a unit of production in Country 1 and in Country 2, given the choice of producing the share $x \in [0,1]$ of total production in Country 1, are given, respectively, by:

$$\pi_1(x) \ = P - C_1(x) = P - \alpha_1 - \frac{c_1 + \varphi_1 x}{1 + \beta_1 x}$$

$$\pi_2(x) \ = P - C_2(x) = P - \alpha_2 - [c_2 + \varphi_2(1 - x)]$$

The (real) cost of production in the two countries is given by the nominal wage for a unit of production divided by the productivity of labour. Therefore, the cost of production of a single unit of output depends on the coefficient of labour productivity remuneration, that is α_i for country i, and the minimum wage adjusted (divided) by the labour productivity. Notice that the minimum wage is given by a fixed component c_i plus the level of production in country i multiplied by φ_i. This later parameter measures the bargaining power remuneration, which is proportional to the concentration of production in the country. Moreover, the labour productivity in Country 2 (the technological-laggard country) is normalized to one, while in Country 1 (the technological-leader country) it depends on the so-called 'within-country' spillovers, see, for example, Marshall (1982) and Alcácer et al. (2013, 2015), and it is measured by the non-negative parameter β_1. The within-country (knowledge) spillover is an example of an agglomeration driver that explains an increase in labour productivity in the region in which the economic activity concentrates; that is a sort of efficiency generated by the effects of learning by doing.

The parameter space is defined by several constraints. First of all, we expect that labour productivity remuneration is higher in the technological-leader country. Therefore, we impose $\alpha_1 > \alpha_2$. Second of all, we expect that the minimum wage is higher in the technological leader country. Therefore, we assume $c_1 > c_2$.

Defined the profit function in the two countries, we model the dynamic choice of the representative firm. For this purpose, we employ a useful dynamic representation for selecting location strategies such that more production is localized in the country where such choice is currently more profitable. Discrete time is assumed as location decisions are typically incompatible with instantaneous choices. In the following, we will denote by x_t the share of production in Country 1 at time *t*. The specific dynamic equation we employ is borrowed from evolutionary game theory and is often referred to as *exponential replicator* dynamics, firstly introduced in Cabrales and Sobel (1992); see also Hofbauer and Sigmund (2003). Thus, the map assumes the following form

$$x_{t+1} = f(x_t) = \frac{x_t}{x_t + (1 - x_t) e^{\theta\left(\pi_2(x_t) - \pi_1(x_t)\right)}} \qquad (1)$$

which in explicit form becomes

$$x_{t+1} = \frac{x_t}{x_t + (1 - x_t) e^{\theta\left(\alpha_1 - \alpha_2 - c_2 + \frac{c_1 + x_t \phi_1}{1 + x_t \beta_1} - (1 - x_t)\phi_2\right)}}$$

where $\boldsymbol{\theta} \geq \mathbf{0}$ is a speed of adjustment (also known as the *intensity of choice*), which measures how reactive the MNE is in implementing offshoring/reshoring strategies suggested by signals of incremental profits.

For the sake of notational simplicity and without loss of generality, we define $\gamma = \alpha_1 - \alpha_2 - c_2$. Then, according to the conditions specified above, we have the following restrictions:

Assumption 1: The parameter space is given by

$\Phi = \{(\gamma, c_1, \varphi_1, \varphi_2, \beta_1) | c_1, \beta, \varphi_1, \varphi_2 > 0; \gamma > -c_1, \beta_1 \geq 0\}$

Then, the general properties of the map $\boldsymbol{f}$, see Equation (1), which defines the offshoring and reshoring dynamics, are defined in the following Lemma.

Lemma 1 (baseline properties): Let us define $\Delta(x) = \pi_2(x) - \pi_1(x)$

Then, the following properties hold:

1. The interval $[0,1]$ is an invariant set, that is if $x_t \in [0,1]$, then $x_{t+n} \in [0,1]$ for all $n \in \mathbb{N}$.
2. An increase in offshoring will take place in the next period when $\Delta(x_t) > 0$ and $x_t \in (0,1)$;
3. An increase in reshoring will take place in the next period when $\Delta(x_t) < 0$ and $x_t \in (0,1)$;
4. Offshoring all the production, that is $x^0 = 0$, is an equilibrium of the model;
5. Reshoring all the production, that is $x^1 = 1$, is an equilibrium of the model;
6. An $x^* \in (0,1)$ is an (inner) equilibrium of the model if and only if $\Delta(x^*) = 0$.

Lemma 1 specifies that the model always admits border equilibria $x^0 = 0$ and $x^1 = 1$, which exist independently on the configuration of the parameter values. Moreover, it specifies that an inner equilibrium of the system is characterized by an iso-profit condition $\pi_2(x) = \pi_1(x)$, or equivalently $\Delta(x) = 0$. In the following, we investigate the local and global dynamics of the model and we study the effect of possible industrial policy interventions and labour policy interventions on the offshoring and reshoring process. The investigation is conducted in two steps. In the next section we investigate the effects of some possible labour policy interventions by setting to zero the within-country spillovers. In Section 4, instead, we study the combined effect of industrial policy interventions and labour policy interventions.

3. Benchmark case: Labour policy interventions and no within-country spillovers

In this section, we analyse the structural properties of the dynamic model (1) when within-country (knowledge) spillovers are neglected, that is when $\beta_1 = 0$.

In this case, the iso-profit condition $\pi_1(x) = \pi_2(x)$ that characterizes the inner equilibrium, see Lemma 1, is linear in x so that, at most, a unique inner equilibrium exists, which is given by

$$x^* = \frac{\phi_2 - c_1 - \gamma}{\phi_1 + \phi_2} \tag{2}$$

The existence conditions for this inner equilibrium, as well as the global dynamics of the model, are summarized in the following proposition.

Proposition 1: Let us define the value $\gamma^{TB0} = \varphi_2 - c_1$. Then, under Assumption 1 with $\beta_1 = 0$, we have that:

- For $\gamma > \gamma^{TB0}$, the *total offshoring* equilibrium x^0 and the *total reshoring* equilibrium x^1 are the only two equilibria of the model and x^0 is the only stable equilibrium of the model, with basin of attraction given by $\mathcal{B}(x^0) = [0,1)$.
- At $\gamma = \gamma^{TB0}$, a transcritical bifurcation occurs through which x^* merges with x^0, therefore it enters the invariant set $[0,1]$.
- For $\gamma^{TB0} > \gamma > -c_1$, x^0 (total offshoring), x^1 (total reshoring) and x^* are the only three equilibria of the model and either x^* is the only stable equilibrium of the model, with basin of attraction given by $\mathcal{B}(x^*) = (0,1)$, or no stable equilibria exist.

These results about the global dynamics of the model under all the possible different labour-policy configurations indicate that total reshoring needs to be sustained by industrial policy interventions, otherwise it will never be a stable equilibrium. In fact, according to Assumption 1, labour may be more expensive in Country 1, with respect to Country 2, because of a higher labour productivity remuneration and a higher minimum wage. Then, Country 1 needs to be the technological-leader country. In other words, $\beta_1 > 0$ is a necessary condition to have that reshoring (all the production located in Country 1) is a stable equilibrium. Since the value of the parameter β_1 is determined by measures of industrial policies adopted in Country 1, we can say that a technological leader needs to combine in a suitable way labour policies and industrial policies to be an attracting manufacturing location.

Before discussing the combined effect of industrial and labour policies, let us focus on the labour policy interventions when $\beta_1 = 0$. In particular, we can underline that Assumption 1 implies $\gamma + c_1 > 0$, which is the condition that ensures that Country 1 has both a higher labour productivity remuneration and a higher minimum wage. Of course, it may be possible to implement policies to reduce the bargaining power of workers in Country 1, i.e. to reduce the value of parameter φ_1 in the model, but Proposition 1 indicates that this labour policy intervention does not prevent production offshoring. In conclusion, the message that Proposition 1 conveys is the fact that a higher labour remuneration, independently of how it is implemented – i.e. either through a minimum wage salary or through a higher labour productivity remuneration – will increase the offshoring process if it is not sustained by an industrial policy intervention. This is evident in the bifurcation diagram of Figure 1, where for each value of γ in the range [-1,1] we observe the equilibria of the model as well as their basins of attraction and at $\gamma = \gamma^{TB0} = 0$, with $\gamma^{TB0} = \varphi_2 - c_1$, we observe the transcritical bifurcation at which the inner equilibrium (in red) merges with the offshoring equilibrium x^0 (in grey). For $\gamma > \gamma^{TB0} = 0$, the inner equilibrium exits the invariant region [0,1], which is the state space of the map, and the offshoring equilibrium becomes the only stable equilibrium of the map. The bifurcation diagram in Figure 1 indicates that when the extra labour productivity remuneration in Country 1 plus the extra minimum wage in Country 1 overcome the bargaining power remuneration in Country 2, then the chances to have some manufacturing activity located in Country 1 vanish. It is worth noting that the transcritical bifurcation condition, at which all the manufacturing activity is allocated in Country 2, corresponds to the condition at which for whatever level of offshoring, the production in Country 2 is cheaper than the production in Country 1.

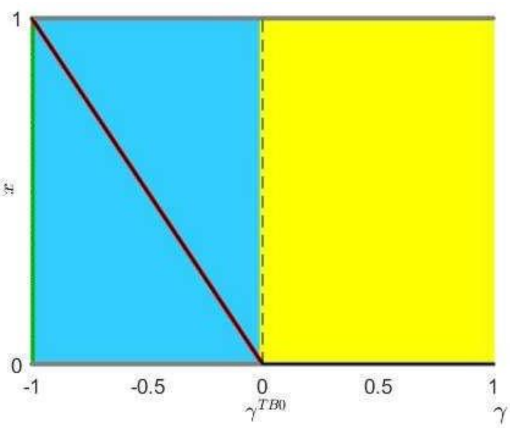

Figure 1 Bifurcation diagram showing the equilibria and their basins of attraction for each value of the bifurcation parameter γ in the range [-1,1]. In particular, the inner equilibrium x^* is indicated in red, the border equilibria (total offshoring and reshoring) are in grey, the asymptotic trajectory of the model is in black, the basin of attraction of the inner equilibrium is the blue region, and the basin of *attraction of the offshoring* equilibrium is the yellow region. Values of the parameters: $c_1 = 1, \quad \varphi_1 = 0, \quad \varphi_2 = 1, \quad \theta = 1$

The dynamic configuration depicted in Figure 1 may not be the only one. In fact, for $-c_1 < \gamma < \varphi_2 - c_1$, Proposition 1 indicates that the inner equilibrium may be unstable. To study the possible dynamics of the model in this region of the parameter space, we investigate the local stability of the inner equilibrium x^* in (2), which can be ascertained by linearizing map (1) around the fixed point itself, calculating

$$f'(x^*) = 1 - \frac{((\theta(c_1+\gamma+\varphi_1)(-c_1-\gamma+\varphi_2))}{\varphi_1+\varphi_2} = 1 - x^*\theta(c_1+\gamma+\varphi_1)$$

By the previous discussion, if the inner equilibrium x^* is feasible (i.e. $x^* \in (0,1)$) then $c_1 + \gamma + \varphi_1 > 0$. Thus, $f'(x^*) < 1$ always holds and by standard results about bifurcation theory, we have that the inner equilibrium x^* can lose stability only through a flip bifurcation occurring at $f'(x^*) = -1$. More precisely, equilibrium x^* is stable provided that $\theta < \hat{\theta}$ and loses stability through a flip bifurcation at $= \hat{\theta}$, where

$$\hat{\theta} = \frac{2(\varphi_1 + \varphi_2)}{\alpha(c_1 + \gamma + \varphi_1)(-c_1 - \gamma + \varphi_2)}$$

The period-doubling (or flip) bifurcation can also be defined with respect to the parameter γ as follows:

$$\gamma_{1,2}^{FP} = \frac{(2c_1 - \varphi_1 - \varphi_2) \pm \sqrt{(2c_1 - \varphi_1 - \varphi_2)^2 - \frac{8}{\theta}(\varphi_1 + \varphi_2)}}{-2}$$

The condition for the flip bifurcation indicates that for a low evolutionary frenzy in chasing the manufacturing location that offers the lower cost of productions (low θ), the unique and inner stable equilibrium is stable, otherwise a stable period orbit or a chaotic attractor exists. An example of these dynamics is depicted in Figure 2. Here, the intensity of choice parameter θ is set ten times higher than in Figure 1. The effect of a higher intensity of choice is the presence of two period-doubling (or flip) bifurcations that leads to a stable 2-period cycle for $\gamma \in [\gamma_1^{FP}, \gamma_2^{FP}]$.

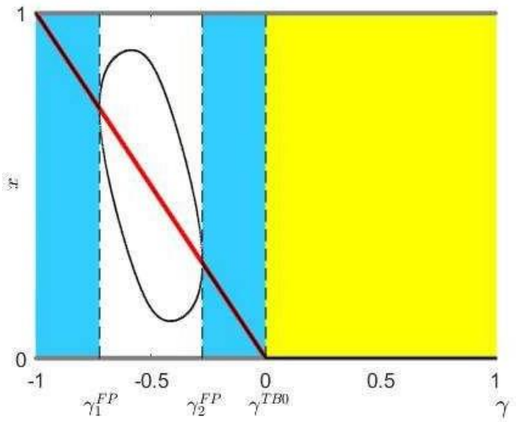

Figure 2 Bifurcation diagram showing the equilibria and their basins of attraction for each value of the bifurcation parameter γ in the range [-1,1]. In particular, the inner equilibrium x^* is indicated in red, the border equilibria (total offshoring and reshoring) are in grey, the asymptotic trajectory of the model is in black, the basin of attraction of the inner equilibrium is the blue region, the basin of attraction of a 2-period cycle is the white region and the basin of attraction of the offshoring equilibrium is the yellow region. Values of the parameters: $c_1 = 1, \ \ \varphi_1 = 0, \ \ \varphi_2 = 1, \ \ \theta = 10$.

Increasing further the value of the intensity of choice, we can first observe a cascade of period-doubling bifurcations and then a sequence of period-halving bifurcations for $\gamma \in [\gamma_1^{FP}, \gamma_2^{FP}]$. These sequences of bifurcations lead to detecting cycles of any possible period and chaotic attractors as well, as clearly observable in Figure 3, where the values of the parameters are as in Figure 2 but the intensity of choice parameter is one and a half times larger.

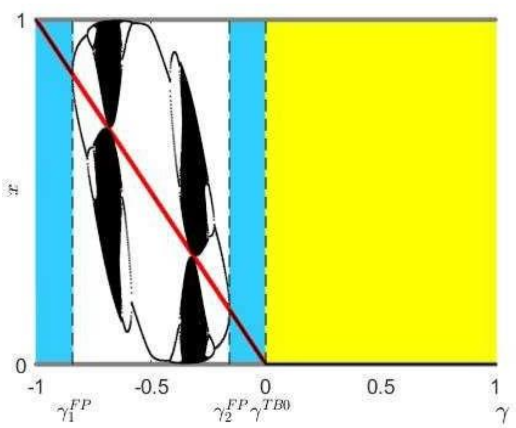

Figure 3 Bifurcation diagram showing the equilibria and their basins of attraction for each value of the bifurcation parameter γ in the range [-1,1]. In particular, the inner equilibrium x^* is indicated in red, the border equilibria (total offshoring and reshoring) are in grey, the asymptotic trajectory of the model is in black, the basin of attraction of the inner equilibrium is the blue region, the basin of attraction of the periodic/chaotic attractor is the white region and the basin of attraction of the offshoring equilibrium is the yellow region. Values of the parameters: $c_1 = 1, \ \ \varphi_1 = 0, \ \ \varphi_2 = 1, \ \ \theta = 15$.

In the next section, we explore the impact of knowledge spillovers in the most technologically advanced country (Country 1).

4. The effects of knowledge spillovers

By neglecting the within-country spillovers in the technologically advanced country, up to now we have disregarded any possible form of intervention in the industrial policies of Country 1. The within-country spillovers refer to an increase in the labour productivity due to higher levels of workers' education and to some forms of learning by doing that allow the development of new technologies of production or more efficient skills among workers. Therefore, within-country spillovers reflect in lower production costs. The possibility to develop within-country spillovers requires at the same time manufacturing activity concentrated in a single country and industrial policies aimed at sustaining it. In particular, the possibility to develop within-country spillovers requires the formation of the workforce through massive investment in education for schools and universities, research laboratories and the realizations of platforms or projects that favour the spin-offs between industry and universities/research centres. Therefore, particularly relevant in this direction is the possibility of having physical and technological infrastructures to favour technological, cultural and organizational development. The investments to obtain such results are referred to as 'industrial policy interventions'. They require a huge amount of financial resources that we assume only Country 1 (the technological-leader country) can afford. Therefore, we assume an enhancing of labour productivity due to within-country spillovers only in Country 1. In Country 2, spillovers are assumed to be negligible. Moreover, we neglect the effects of spillovers between countries (the so-called 'nearby-country' spillovers).

In the modelling se-tup proposed, the extra labour productivity coming from within-country spillover is measured by the parameter β_1. Thus, this parameter is controlled through industrial policy interventions, an increase of which mirrors in a higher value of that parameter.

The first relevant aspect to investigate is the level of the within-country spillovers required to have that total reshoring is a stable equilibrium. The following proposition underlines this point.

Proposition 2 Consider the restrictions in Assumption 1 and $\beta_1 > 0$. Then,

- For $\beta_1 < \beta_1^{NC} = \varphi_1 / c_1$, the equilibrium of total reshoring x^1 is always unstable.

- For $\beta_1 > \beta_1^{NC}$, the equilibrium of total reshoring x^1 is stable when $\gamma \in (-c_1, -(c_1 + \varphi_1)/(1 + \beta_1))$, it undergoes a transcritical bifurcation at
$$\gamma = \gamma^{TB1} = -\frac{c_1 + \varphi_1}{1 + \beta_1} < 0$$
and it is unstable otherwise.

Proposition 2 states that a minimum level, that is β_1^{NC} (given by the ratio between bargaining-power remuneration and minimum wage), of the within-country spillovers parameter, is required to have that total reshoring is a stable equilibrium. However, this condition is not enough, as the extra labour productivity remuneration in Country 1 minus the minimum wage in Country 2, that is γ, must be negative, specifically lower than γ^{TB1}. This indicates that the labour productivity remuneration in Country 1 must be smaller than the labour productivity remuneration in Country 2 plus the minimum wage in Country 2. Therefore, an industrial policy intervention aimed at increasing the within-country spillovers cannot offset any form of labour policy and favours reshoring. At the opposite, total reshoring can be achieved by combining in a suitable way labour policy interventions and industrial policy interventions.

The bifurcation diagram in Figure 4 is obtained by using the same constellation of the values of the parameters as in Figure 1, but with $\beta_1 = 1$. There, we can observe that for $\gamma < \gamma^{TB1}$ the equilibrium x^1 (total reshoring) is a (almost) globally stable equilibrium since its basin of attraction (dark-green region) is given by $\mathcal{B}(x^1) = (0,1]$.

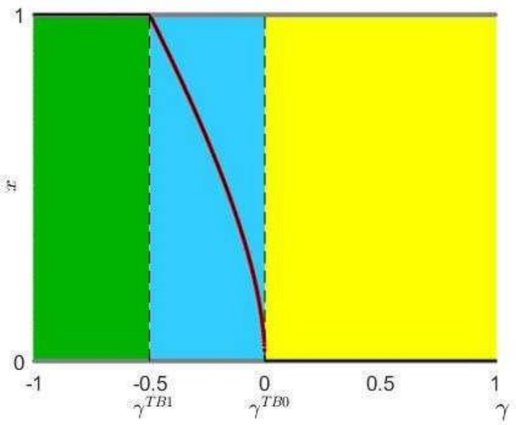

Figure 4 Bifurcation diagram showing the equilibria and their basins of attraction for each value of the bifurcation parameter γ in the range [-1,1]. In particular, the inner equilibrium x^* is indicated in red, the border equilibria (total offshoring and reshoring) are in grey, the asymptotic trajectory of the model is in black, the basin of attraction of the reshoring equilibrium is the dark-green region, the basin of attraction of the inner equilibrium is the blue region, and the basin of attraction of the offshoring equilibrium is the yellow region. Values of the parameters: $c_1 = 1, \quad \varphi_1 = 0, \quad \varphi_2 = 1, \quad \beta = 1$.

In the interplay between industrial policy interventions and labour policy interventions, it could be that the equilibrium of total reshoring is stable and coexists with the stable equilibrium of total offshoring. It occurs for $\gamma \in (\gamma^{TB0}, \gamma^{TB1})$, when $\beta_1 > \beta_1^{NC}$ and $\gamma^{TB1} > \gamma^{TB0}$. This dynamic configuration can be observed in the bifurcation diagram in Figure 5, where the same constellation of the values of the parameters as in Figure 4 is used, but with $\phi_2 = 0.45$.

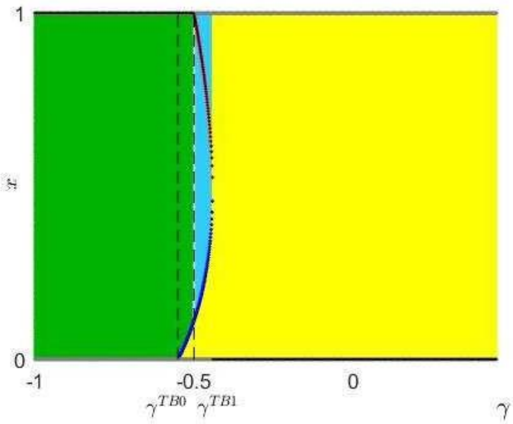

Figure 5 Bifurcation diagram showing the equilibria and their basins of attraction for each value of the bifurcation parameter γ in the range [-1,1]. In particular, the inner equilibrium x_1^* is indicated in red, the inner equilibrium x_2^* is indicated in blue, the border equilibria (total offshoring and reshoring) are in grey, the asymptotic trajectory of the model is in black, the basin of attraction of the reshoring equilibrium is the dark-green region, the basin of attraction of the inner equilibrium is the blue region, and the basin of attraction of the offshoring equilibrium is the yellow region. Values of the parameters: $c_1 = 1, \quad \varphi_1 = 0, \quad \varphi_2 = 0.45, \quad \beta = 1$.

The bifurcation diagram of Figure 5 also underlines that two inner equilibria can coexist and they appear/disappear by decreasing/increasing γ through a saddle-node bifurcation. To detect the analytical values of these two equilibria, we have to solve the iso-profit condition $\pi_1(x) = \pi_2(x)$, from which up to two inner equilibria can be obtained, which are given by

$$x_{1,2}^* = \frac{-\beta\gamma - \phi_1 - \phi_2 + \beta\phi_2 \pm \sqrt{\Delta}}{4\beta\phi}$$

where

$$\Delta = 4\beta\phi_2(\phi_2 - c_1 - \gamma) + (\phi_1 + \phi_2 - \beta(\gamma + \phi_2))^2$$

and $x_1^* \leq x_2^*$. The next Proposition characterizes the stability and the basins of attraction of the model in (1) when multiple inner equilibria exist.

Proposition 3: When two inner equilibria $0 < x_1^* < x_2^* < 1$ exist, then:

- x_1^* is an unstable equilibrium;
- x_2^* may be a locally asymptotically stable equilibrium;

- the generic trajectory starting at $\bar{x} \in (x_1^*, 1)$ may converge to x_2^*;
- the generic trajectory starting at $\bar{x} \in (0, x_1^*)$ converges to $x^0 = 0$;

To summarize, from the point of view of the dynamics, within-country spillovers introduce the possibility of different long-run scenarios (coexisting attractors) and the possibility to have a stable equilibrium of total reshoring. The investigation underlines that within-country spillovers, which imply industrial policy interventions, may ensure reshoring only under specific configurations of the labour policies.

5. Conclusions

The globalized economy characterized by the free movement of goods and people has helped to intensify competition between nations to attract multinational enterprises. The model considered in this work analyses this phenomenon by considering a multinational enterprise that produces a single commodity that is sold in a global market that does not discriminate against the geographic origin of the manufactured goods. On the other hand, the multinational enterprise moves its manufacturing production from a technological-leader country to a technological-laggard country (offshoring) or vice versa (reshoring), looking for extra profits due to lower labour costs. The investigation reveals that the possibility to produce in a technological-laggard country that offers a lower labour cost sparks an offshoring process. This process can be curbed by developing a flexible remuneration scheme of workers. However, industrial policies that aim to favour within-country (technological) spillovers that increase the labour productivity in the technological-leader country are essential to foster a reshoring process and to prevent offshoring. To summarize, the investigation reveals that a policymaker of a technological-leader country should combine labour and industrial policies in a suitable way to prevent offshoring.

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Appendix

The proofs of the Lemmas and Propositions are listed below:

Proof of Lemma 1. Concerning the first property, it is a consequence of the fact that $f([0,1]) = [0,1]$. Concerning the second property, by definition of the map $f(x)$, we have $x < f(x)$ when $x+(1-x)e^{\theta\Delta(x)} < 1$ and $x \in [0,1]$, therefore when $\Delta(x) < 0$. Since $x_t < f(x_t)$ implies offshoring, i.e. $x_{t+1} < x_t$, we have proved the second property. Concerning the third property, it can be proved in an analogous way. Concerning the fourth and the fifth property, they are a consequence of the fact that $f(0) = 0$ and $f(1) = 1$, respectively. Concerning the sixth property, it is a consequence of the fact that solving $f(x) = x$ in $[0,1]$ is equivalent to solve $\Delta(x) = 0$.

Proof of Proposition 1. Since the iso-profit condition $\Delta(x) = \pi_2(x) - \pi_1(x) = 0$ has a unique solution, by Lemma 1 we have that at most a unique equilibrium exists in $[0,1]$. Therefore, $\Delta(x)$ can change sign at most once in the interval $[0,1]$. Moreover, since for $\beta_1 = 0$ we have $\Delta(1) = \gamma + c_1 + \varphi_1 > 0$, see Assumption 1, by Lemma 1 (second and third properties) and continuity of the map $f(x)$, we have that the reshoring equilibrium x^1 cannot be an asymptotically stable fixed point of the model. Then, by continuity of $\Delta(x)$ we can conclude that the equilibrium of offshoring x^0 is either stable or unstable. Since $\Delta(0) = \gamma + c_1 - \varphi_2$, we have $\Delta(0) > 0$ if and only if $\gamma > \varphi_2 - c_1$. Then, the first point of the Proposition follows by Lemma 1. The second point of the proposition follows from the fact that for $\gamma + c_1 = \varphi_2$ we have $\Delta(0) = 0$, which indicates that the first derivative of the map in x^0 is equal to 1, i.e. x^0 is a non-hyperbolic fixed point, and from standard results on bifurcation theory, we know that the first derivative of the map in x^0 is equal to one is a necessary condition for either a transcritical bifurcation or a saddle-node bifurcation. Since the equilibrium x^0 exists after and before the bifurcation, we can conclude that it undergoes a transcritical bifurcation (the sufficient condition for the existence of this bifurcation follows from the third point of this Proposition, which is proved in the following). The third point of the proposition follows by the fact that for $0 < \gamma + c^1 < \varphi^2$ we have $\Delta(0) < 0$, therefore the offshoring equilibrium x^0 is unstable by Lemma 1. In addition, we have already discussed that $\Delta(1) > 0$ always holds. Thus, by continuity and linearity of $\Delta(x)$ there exists a unique x^* such that $\Delta(x^*) = 0$, which is therefore the unique inner equilibrium of the model and being an equilibrium is either stable or unstable.

Proof of Proposition 2. Considering $\beta_1 > 0$, we have that $\Delta(1) = \gamma + \frac{c_1+\varphi_1}{1+\beta_1}$. By Lemma 1, the reshoring equilibrium x^1 is stable when $\gamma + \frac{c_1+\varphi_1}{1+\beta_1} < 0$. Since by Assumption 1 $\gamma > -c_1$ and all the parameters of the model, excluding γ, are positive, $\frac{c_1+\varphi_1}{1+\beta_1} < c_1$ is a necessary condition to have $\Delta(1) < 0$. The sufficient condition is $\Delta(1) < 0$, i.e. $\gamma < \gamma^{TB1}$. Moreover, for $\gamma = \gamma^{TB1}$ we have $\Delta(1) = 0$, which indicates that the first derivative of the map in x^1 is equal to 1, i.e. x^1 is a non-hyperbolic fixed point and, by standard results on bifurcation theory we know that this is a necessary condition for either a transcritical bifurcation or a saddle-node bifurcation. Since the equilibrium x^1 exists after and before the bifurcation, we can conclude that it undergoes a transcritical bifurcation (the sufficient condition for the existence of this bifurcation follows from numerical evidences). This proves the Proposition.

Proof of Proposition 3. Consider $\Delta(x) = \pi_2(x) - \pi_1(x)$. The models in (1) has two internal fixed points, if the equation $\Delta(x) = 0$ has two solutions in $(0,1)$. Since $\Delta(x)$ is a differentiable function in $(0,1)$, having two solutions of the equation $\Delta(x) = 0$ in $(0,1)$ impies that the first derivative of the function $\Delta(x)$ changes sign once in $\Delta(x)$. Since

$$\Delta'(x) = \frac{\phi_1 - \beta_1 c_1}{(1 + x\beta_1)^2} + \phi_2$$

can change sign in $(0,1)$ only if $\phi_1 - \beta_1 c_1 < 0$, and this condition implies that $\Delta(x)$ is a convex function, we have that two inner equilibria can exist only when $\Delta(1), \Delta(0) < 0$. By Lemma 1, this implies that the equilibrium of offshoring is asymptotically stable, while the equilibrium of reshoring is unstable. Moreover, by continuity of the function $\Delta(x)$, two inner equilibria, that is x_1^* and x_2^* with $0 < x_1^* < x_2^* < 1$, imply that $\Delta(x) < 0$ for $x \in (x_1^*, x_2^*)$ and a non-negative value of this function otherwise. Then, by Lemma 1, we have that $\mathcal{B}(x^0) \subseteq (0, x_1^*)$. This proves the first and the fourth points of the proposition. To prove the second and the third point of the proposition, note that x^1 cannot be a stable equilibrium when two inner equilibria exist because they imply $\Delta(x^1) > 0$. This completes the proof of the proposition.