Location decisions and Minimum Wages

Isabelle Méjean* Lise Patureau‡

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Abstract

The paper contributes to the living debate on the controversial effects of minimum wage policy on economic performances, focusing on its impact on firms' location choice. The question is investigated through a theoretical model, that incorporates features from the new trade literature (Krugman (1991)) and the labor-market literature. In a two-country framework, we model endogenous entry of firms under wage rigidity. In this setting, the impact of an unilateral increase in the home country's minimum wage is analyzed.

The policy shock is shown to have a twofold influence on the relative attractiveness of the home country, simultaneously affecting its relative cost competitiveness and the aggregate demand addressed to firms. Both effects do not necessarily go in the same direction, hence the final effect on firms' location decisions is ambiguous. We show that it notably depends on the adjustments that occur on the skilled and unskilled labor markets. Our overall results suggest that the design of labor-market policies should take into account their impact on firms' location decisions, if willing to evaluate their whole consequences in the national economy.

Keywords: Minimum wage, Home Market Effect, Firms location decisions

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*CEPII, 9 rue G. Pitard, 75015 Paris, France, Email: isabelle.mejean@cepii.fr

†THEMA, University of Cergy-Pontoise, 33 Bd du Port, 95011 Cergy-Pontoise, France, Email: patureau@eco.u-cergy.fr

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1 Introduction

The impact of labor-market institutions on macroeconomic performances lies at the heart of current debates among both economic and political circles. Debates are particularly vivid in Europe, where countries have implemented various labor-market policies over the last decades to cope with high levels of unemployment. In particular, as underlined by Dolado, Felgueroso & Jimeno (2000) and Dickens, Machin & Manning (1999), there has been a considerable resurgence of interest regarding minimum wages, which are an important feature of a large number of OECD labor markets.[1]

When asking for the impact of minimum wage policies, two broad and opposite arguments emerge. On the one hand, high minimum wages prevent flexibility on the labor market, and by raising marginal costs, lead to adverse effects on labor demand and employment level, as shown theoretically in the standard neoclassical framework (the "price competitiveness effect" hereafter). On the other hand, one major argument for minimum wage policy is tied to its role on aggregate demand. Minimum wages help maintaining the purchasing power of low-skilled workers, which are the labor-market segment the most vulnerable to international competition and skill-biased technological changes.[2] A high-minimum wage policy would therefore entail an "income effect" that helps sustaining aggregate demand. The debate is all the less shut down, since the increasing degree of trade and financial liberalization in the recent decades puts more arguments into play. In particular, the easier mobility of production factors opens new opportunities for firms to choose in which country to locate and produce, a dimension that is likely to alter the aggregate performances of minimum wage policy as well. In the paper, we pay a particular attention to this dimension, asking how minimum wage policy affects firms' location decisions in an international setting.

Review of the vast labor-market literature devoted to minimum wage policy yields contrasted results in terms of labor-market performances. The adverse effect of minimum wage obtained in the neoclassical model is questioned in non-competitive frameworks, as shown by Bhaskar & To (1999) in an oligopsonistic model, Cahuc & Zylberberg (1999) in a search-equilibrium model, Manning (1995) in an efficiency wage model or Cahuc & Michel (1996) in a training-enhancing framework. The related empirical literature does not reach a clear-cut conclusion either.[3] But in any case within that strand of literature, reasoning is held for a given production structure, thereby neglecting the key role of endogeneity in firms' location decisions.

Contrasting with the existing literature, the present paper takes into account this latter dimension by analyzing the impact of minimum wage policy on country's attractiveness for foreign investors. We investigate the question in a theoretical new trade theory framework. Initiated by Krugman (1991)'s seminal paper, new trade theory focuses on the determinants of production patterns and firms' location decisions in an international setting. It identifies two major determinants ; relative production costs, and aggregate demands. This framework is thus particularly well-suited to capture the twofold impact of minimum wage on firms' location choices. With respect to the new trade literature, which mostly assumes flexible labor market, the originality of the paper lies in explicitly relating labor market imperfections and endogenous entry of firms. Dewit, Görg & Montagna (2003), Hajkova, Golub, Mizra, Nicoletti & Yoo (2003) or Javorcik & Spatareanu (2005) empirically study the role of labor-market institutions in foreign

[1] As illustrated by the recent increases in the US minimum wages (in 1990, 1991, 1997), the imposition of a minimum wage in the United Kingdom (2000) after its suppression in 1993 or recent successive rises in the French "SMIC" over legal requirements.

[2] See Dolado et al. (2000) or Biscourp & Kramarz (2003)

[3] Papers that focus on "natural experiments" do not get any clear-cut impact of minimum wage shocks on employment (See Card & Krueger (1994) for the US, Machin & Manning (1996) for the UK, and Dolado, Kramarz, Machin, Manning, Margolis & Teulings (1996) in several European countries). Yet, empirical papers on individual data most obtain a significant (and negative) impact of minimum wage on the specific segment of low-skilled workers (see Kramarz & Philippon (2001), Portugal & Cardoso (2006), Laroque & Salanié (1999)).

direct investment (FDI) flows, focusing on employment protection laws. This paper sheds light on another aspect of labor-market institutions, that is minimum wage policy. On this topic, and in the theoretical field, Picard & Toulemonde (2001) provide a notable contribution in a model with wage bargaining. Yet, their analysis is set in partial equilibrium, which prevents from taking into account the income effect of minimum wage policy. In a general equilibrium framework with wage rigidity, Strauss-Kahn (2005) investigates the impact of globalization on the extent of vertical specialization and the employment inequality between skilled and unskilled workers. Unlike this paper, we focus on horizontal FDI flows in minimum wage countries, consistently with empirical evidence suggesting that horizontal motives strongly dominate vertical ones in explaining world-wide FDI flows (Markusen & Matusz (2002)). We explicitly study the impact of cross-country differences in minimum wage policy on location decisions.[4]

With respect to the labor-market literature, we deliberately choose to adopt a simple framework regarding the labor-market functioning. In an otherwise competitive setting, nominal rigidity is introduced through minimum wage constraints. Absent any agglomeration effect, these wage rigidities would be predicted to have negative aggregate effects, because of their depressive impact on labor demand. Conversely, in a general-equilibrium setting with endogenous entry of firms, we show that minimum wage policy has non-trivial effects. A minimum wage increase in the domestic market is shown to have a twofold impact on firms' profits and location decisions. On the one hand, it increases the relative cost of producing in the country. On the other hand, it also affects its aggregate demand. Both elements come into play regarding the final impact on the country's attractiveness. Under Home Market Effect, the income effect may counterbalance the competitiveness loss for national firms and maintain the country's attractiveness. The arbitrage between both effects notably depends on adjustments that occur on the labor market and of the degree of liberalization in international trade.

The rest of the paper is structured as follows. Section 2 presents our general framework which incorporates the main features of the New Trade theory and wage rigidities. After solving the model in general equilibrium, we study the impact of a rise in the domestic minimum wage on firms' entry decisions in Section 3. Last, Section 4 concludes.

2 Theoretical framework

2.1 Main assumptions

The world economy is divided in two countries, Home and Foreign, with foreign variables denoted with a star. The domestic (foreign) country is populated with $\bar{L}$ ($\bar{L}^*$) unskilled and $\bar{Q}$ ($\bar{Q}^*$) skilled workers. As standard in the literature, we assume that workers are perfectly mobile across sectors but immobile across countries. Skilled and unskilled workers only differ by their productivity levels denoted a_Q and a_L, with $a_L < a_Q$. Without loss of generality, productivity levels are assumed to be identical across countries ($a_L = a_L^*$ and $a_Q = a_Q^*$).

The representative household in each country consumes two types of goods, a homogeneous and a differentiated good. They are produced given a sector-specific technology using skilled and unskilled labor. As standard in the New Trade framework, the homogeneous good (denoted by Z) is produced under constant returns to scale in a perfectly competitive environment; it is freely traded across countries to balance the current account. As a consequence, the law of one price holds at the world level, which makes good Z a convenient candidate to serve as numéraire. In the following, all prices are thus expressed in terms of the homogeneous good.

[4]Note that our theoretical framework models entry and exit of firms between two similar countries that only differ in terms of their minimum wage policy. This allows to study the impact of minimum wages on horizontal FDI flows. On the other hand, this framework does not allow to capture the specific dimension of outsourcing linked to the decision of shutting down one entity in a given country, to open a new one abroad.

In the differentiated good sector, monopolistic competing firms produce for both their domestic and export markets, under increasing returns to scale and costly international trade. Varieties produced by firms operating in the Home country are defined over the interval $[0\,;n]$ and indexed by h. Similarly, foreign varieties are defined as $f \in [0\,;n^*]$. The total number of varieties in equilibrium is endogenously determined, as well as firms' location under free entry. Firms enter a country as long as the production is profitable, given a fixed cost of producing (consisting in F units of homogeneous good) and a variable cost that depends on skilled- and unskilled-labor wages. As firms operate under monopolistic competition, the number of produced varieties in equilibrium matches the number of operating firms. In other words, each active firm settles in a single location to serve both markets.

As the exposure of the model further shows, we retain some simplifying assumptions regarding the functioning of the labor market. Labor supply is exogenous (each worker offers one unit of labor to national firms). In each country, the labor market is perfectly competitive and should define equilibrium wages, apart from minimum wages. However, national governments maintain the purchasing power of workers by setting a fixed minimum wage ($\underline{w}$ and $\underline{w}^*$ units of the numéraire good). As long as the minimum wage is binding, labor markets do not clear in equilibrium and some workers are left unemployed.

2.1.1 Households

Within a country, all workers are assumed to belong to the same family, that includes a representative consumer. As a result, the unemployment insurance system can be neglected from the analysis, the redistribution from employed to unemployed workers taking place inside each representative "family".[5] Optimal demand functions are derived at the aggregate national level, by considering the program of the representative consumer. In the following, the domestic household's problem is solved, results being symmetric in the foreign country.

Utility of the representative household is an increasing function of her consumption of homogeneous and differentiated goods. As in Strauss-Kahn (2005), we assume the following Cobb-Douglas consumption basket:

$$C(C_X, C_Z) = C_X^{\mu} C_Z^{1-\mu} \qquad 0 < \mu < 1 \tag{1}$$

C_Z is the consumption level of the homogeneous good Z and C_X is a composite good of all consumed varieties of differentiated goods aggregated according to the following CES specification:

$$C_X = \left[\int_0^n c(h)^{\frac{\sigma-1}{\sigma}} dh + \int_0^{n^*} c(f)^{\frac{\sigma-1}{\sigma}} df \right]^{\frac{\sigma}{\sigma-1}}$$

with $\sigma \geq 1$ the constant elasticity of substitution across varieties and $c(h)$ ($c(f)$) the consumption level of a variety produced in the home (foreign) country.

The domestic household finances her consumption expenditures using her labor revenues and residual profits she perceives as the owner of firms. The domestic household's income I (expressed in the numéraire good Z) thus decomposes into:

$$I = w_Q Q + \underline{w} L + \Pi$$

where Q is the employment level of skilled workers and L the employment level of unskilled workers. In the following, the minimum wage is assumed to be binding on the unskilled labor market, while it is set below the equilibrium wage for skilled workers (*i.e.* $w_Q > \underline{w}$). As a

[5] Introducing an unemployment insurance system would not alter our results as long as it is financed by lump-sum taxes on employed workers. Studying its role would be relevant in a setting with endogenous labor supply and distorsive taxes, which is left for further research.

consequence, the labor market for skilled workers clears ($Q = \bar{Q}$) whereas there is some positive level of unemployment for unskilled workers ($L < \bar{L}$). Last, Π are residual profits of local firms, equal to zero in the long run equilibrium when firms are free to enter a national market.

In this setting, the budget constraint for the representative domestic household can be expressed as:

$$\int_0^n p(h)c(h)dh + \int_0^{n^*} p(f)c(f)df + C_Z \leq w_Q\bar{Q} + \underline{w}L \tag{2}$$

where $p(h)$ and $p(f)$ are equilibrium prices for varieties produced in the domestic and foreign country respectively. The minimum wage level affects aggregate demand directly through the purchasing power of low-skilled workers and indirectly through the labor-market equilibria (*i.e.* through w_Q and L).

Maximizing the representative household's consumption (1) under her budget constraint (2) leads to the optimal demand functions:

$$C_X = \mu\frac{I}{P_X} \tag{3}$$

$$C_Z = (1-\mu)I \tag{4}$$

$$c(h) = \left(\frac{p(h)}{P_X}\right)^{-\sigma} C_X, \quad h \in [0;n] \tag{5}$$

$$c(f) = \left(\frac{p(f)}{P_X}\right)^{-\sigma} C_X, \quad f \in [0;n^*] \tag{6}$$

with the associated expenditure-minimizing price index in sector X defined as:

$$P_X = \left[\int_0^n p(h)^{1-\sigma}dh + \int_0^{n^*} p(f)^{1-\sigma}df\right]^{\frac{1}{1-\sigma}}$$

2.1.2 Firms in the homogeneous sector

The homogeneous good sector is perfectly competitive and integrated at the world level. Good Z is produced under a constant-returns-to-scale technology combining skilled and unskilled workers. In the domestic country, the production function is:

$$y_Z = (a_L l_Z)^{\beta}(a_Q q_Z)^{1-\beta} \qquad 0 < \beta < 1$$

with y_Z the production of homogeneous good, obtained from q_Z and l_Z units of skilled and unskilled labor. β is assumed to be identical across countries. Profit maximization in that sector yields a decreasing relation between skilled and unskilled unit labor costs:

$$\frac{w_Q}{a_Q} = \beta^{\frac{\beta}{1-\beta}}(1-\beta)\left(\frac{\underline{w}}{a_L}\right)^{\frac{-\beta}{1-\beta}} \tag{7}$$

with the associated optimal demand functions for unskilled and skilled labor respectively:

$$\underline{w} = \beta\frac{y_Z}{l_Z} \tag{8}$$

$$w_Q = (1-\beta)\frac{y_Z}{q_Z} \tag{9}$$

Equation (7) helps analyzing the expected effects of minimum wage policy in terms of wage dispersion. As shown by equation (7), an increase in the domestic exogenous minimum wage level, presumably designed to sustain low-skilled workers' purchasing power, occurs at the expense of skilled workers, whose wage decreases in terms of numéraire. By raising the marginal cost

of production, such a policy indeed exerts an upward pressure on the equilibrium price for homogeneous good in the domestic country. The domestic wage for skilled workers has to decrease to preserve the law of one price in the homogeneous good market. This perverse effect on skilled wages is consistent with empirical evidence in the labor-market literature, stressing that changes in the minimum wage have a significant impact on wage inequality (see Lee (1999) for evidence on US data).

Situation in the foreign market is symmetric. As the homogeneous good market is perfectly integrated at the world level, the price of good Z is equalized across countries in equilibrium. Given equation (7) and its foreign counterpart, this implies the following relationship linking relative wages for skilled and unskilled workers:[6]

$$\left(\frac{\underline{w}}{\underline{w}^*}\right)^{\beta} = \left(\frac{w_Q^*}{w_Q}\right)^{1-\beta} \tag{10}$$

2.1.3 Firms in the monopolistic sector

In the monopolistic sector, production costs can be decomposed into a fixed and a variable components. To start producing a variety, a firm incurs a fixed cost of F units of homogeneous good that implicitly defines the minimum operating profit firms must achieve for the production to be profitable (see Krugman (1991)). Once entered the market, the firm faces a technological constraint, that combines skilled and unskilled labor according to the following CES specification:

$$y(h) = \left[\alpha^{-\gamma}[a_Q q(h)]^{\frac{\gamma-1}{\gamma}} + (1-\alpha)^{-\gamma}[a_L l(h)]^{\frac{\gamma-1}{\gamma}}\right]^{\frac{\gamma}{\gamma-1}} \qquad \gamma > 0, \quad 0 < \alpha < 1$$

where $q(h)$ and $l(h)$ are the quantities of skilled and unskilled labor used as inputs in the production of $y(h)$ units of variety h. In this expression, α is a weighting parameter that determines the share of value added paid to skilled workers, whereas γ measures the elasticity of substitution between skilled and unskilled labor. Both parameters have a peculiar importance, as they determine the sensitivity of labor demand to changes in the relative cost of unskilled labor (*i.e.* changes in $\underline{w}$).

Once produced, variety h can be sold to the domestic household or exported. Shipping goods abroad entails transportation "iceberg" costs τ *à la* Samuelson (1954): to sell one unit abroad, a firm has to produce $\tau > 1$ units because of a real loss occurring during transport.[7] Let $p(h)$ ($p^*(h)$) denote the price of one unit of variety h sold in the domestic (foreign) market. The profit function of the domestic firm h is then:

$$\pi(h) = p(h)c(h) + p^*(h)c^*(h) - \underline{w}l(h) - w_Q q(h) - F \tag{11}$$

The program of differentiated producers can be decomposed into two steps. First, each firm decides (or not) to enter the domestic or the foreign market. Second, it draws up its production plans by optimally setting prices and quantities to produce. The program can be solved backward by first considering the optimization problem of firms that already entered the market.

Minimizing the total cost function yields the marginal cost of producing one unit of variety h (in terms of the numéraire good):

$$MC(h) = \left[\alpha\left(\frac{w_Q}{a_Q}\right)^{1-\gamma} + (1-\alpha)\left(\frac{\underline{w}}{a_L}\right)^{1-\gamma}\right]^{\frac{1}{1-\gamma}} \tag{12}$$

[6] We ensure that the Non Full Specialization condition holds, *i.e.* that some positive amount of homogeneous good is produced in each country. Skilled labor endowments are thus set below the level required to cover the world demand of good Z.

[7] Given that our main focus is on location choices in the monopolistic good sector, we do not introduce such transport costs in the homogeneous sector. Modifying this assumption would not drastically affect our results as long as the homogeneous good is produced under constant returns to scale.

and the associated optimal unskilled and skilled labor demands:

$$l(h) = \delta y(h) \quad (13)$$
$$q(h) = (1-\delta) y(h) \quad (14)$$

with δ the share of unskilled workers in the domestic (foreign) marginal cost of producing the differentiated good (δ^* being similarly defined):

$$\delta \equiv (1-\alpha)\left[\frac{\underline{w}}{a_L MC(h)}\right]^{1-\gamma} \qquad 0 < \delta < 1$$

Firm h sets its prices $p(h)$ and $p^*(h)$ so as to maximize its profit (equation (11)) given the optimal marginal cost (12) and the demand for good h from both domestic and foreign households (equation (5) and its foreign counterpart). In the monopolistic framework *à la* Dixit & Stiglitz (1977), firms optimally set prices by applying a constant mark-up over marginal cost, multiplied by the iceberg cost for exported goods. Respectively for domestic and foreign sales, equilibrium prices for variety h are:

$$p(h) = \frac{\sigma}{\sigma-1} MC(h) \equiv p \quad (15)$$
$$p^*(h) = \tau \frac{\sigma}{\sigma-1} MC(h) \equiv \tau p \quad (16)$$

The situation in the foreign country is perfectly symmetric. Moreover, as firms in a given location are confronted with the same constraints, one can suppress indexes h and f in the following.

2.2 The general equilibrium

2.2.1 Free entry and the location of the production

To characterize the model solution, optimal demands and prices are first used to rewrite profits of domestic and foreign firms (equation (11) and its foreign counterpart) as:

$$\pi = \frac{\mu}{\sigma}\left(\frac{I}{\Delta} + \phi\rho^{1-\sigma}\frac{I^*}{\Delta^*}\right) - F \quad (17)$$
$$\pi^* = \frac{\mu}{\sigma}\left(\frac{I^*}{\Delta^*} + \phi\rho^{\sigma-1}\frac{I}{\Delta}\right) - F \quad (18)$$

with:

- $\phi \equiv \tau^{1-\sigma}$ the parameter called "freeness" of trade by Baldwin, Forslid, Martin, Ottaviano & Robert-Nicoud (2005). It increases between 0 and 1 when trade barriers diminish (lower τ) or varieties become less substitutable (higher σ),
- $\rho \equiv MC/MC^*$ the relative cost of producing the differentiated good in the domestic market, that depends on relative unit labor costs for skilled and unskilled workers,
- $\Delta \equiv n + n^*\phi\rho^{\sigma-1}$ and $\Delta^* \equiv n^* + n\phi\rho^{1-\sigma}$ transformations of the price indices in the differentiated good sector.

Equations (17) and (18) deliver useful insights regarding the deep mechanisms of the model. First, they put in evidence a "Home Market Effect" in production (see Martin & Rogers (1995)): *ceteris paribus*, the share of local sales in the profits of monopolistic firms is higher than the share of exports as long as trade costs are strictly positive ($\phi < 1$). This asymmetry implies that, every thing else equal, an increase in domestic demand ($dI > 0$) favors domestic firms more

than foreign ones, leading to an increase in the relative number of firms located in the home country. Second, a cost gap in the differentiated good sector (induced here by cross-country differences in minimum wages) reduces relative profits of firms located in the high-cost country, thus its attractiveness. These cost and demand effects are key elements in the model as their interaction determines where firms ultimately locate in the long run.

To determine the spatial long-run equilibrium, free-entry conditions are used, that draw profits towards zero:

$$\pi = 0 \qquad \text{and} \qquad \pi^* = 0 \tag{19}$$

Combining the expressions for domestic and foreign firms profits (17) and (18) with the zero-profit condition (19) leads to the following relation between aggregate incomes and the total number of active firms in equilibrium:

$$(n + n^*)F = \frac{\mu}{\sigma}(I + I^*) \tag{20}$$

As usual in the Dixit-Stiglitz's framework, the total amount paid to cover fixed costs is proportional to the world expenditure spent in the monopolistic sector.

At this point, three polar cases must be distinguished regarding the spatial distribution of production in equilibrium:

- two corner equilibria in which the production of differentiated good is fully concentrated in a single country (*i.e.* $n = 0$ or $n^* = 0$),
- an interior equilibrium in which some varieties of the differentiated good are produced in both countries ($n > 0$ and $n^* > 0$).

In the interior equilibrium, operating profits are equalized across countries and the relative number of active firms in each country is:

$$\frac{n}{n^*} = \frac{I(1 - \phi\rho^{\sigma-1}) - I^*\phi(\rho^{\sigma-1} - \phi)}{I^*(1 - \phi\rho^{1-\sigma}) - I\phi(\rho^{1-\sigma} - \phi)} \tag{21}$$

Equation (21) underscores the previously discussed determinants of firms' location decisions, namely the cost and demand determinants. In the interior equilibrium, the higher domestic demand (I/I^*), the higher the relative number of firms located in the domestic country (n/n^*), in a convex way because of the Home Market Effect. As well, the lower the relative cost of producing differentiated goods in the Home country (ρ), the higher the relative number of domestic firms.

As shown in Appendix A.1, the interior equilibrium is only sustainable for a small enough cost gap. Outside this interval, production is entirely concentrated in the low-cost country and the number of active firms is simply determined by the corresponding zero-profit condition. Table 1 summarizes the equilibrium pattern of production as a function of the relative cost of producing in each country.

Table 1: Equilibrium pattern of production

Relative marg. cost ρ	$\underline{\rho}$		$\overline{\rho}$		
Productive structure	CE $n^* = 0$	|	IE $n > 0,\ n^* > 0$	|	CE $n = 0$

CE means "Corner Equilibrium", IE "Interior Equilibrium";
$\underline{\rho}$ and $\overline{\rho}$ defined in Appendix A.1.

2.2.2 Market equilibria

The resolution of the model is achieved considering the various market-clearing conditions:

- On the skilled labor market: As the fixed minimum wage is assumed lower than the equilibrium wage for skilled workers ($\underline{w} < w_Q$ and $\underline{w}^* < w_Q^*$), full employment holds in equilibrium on that labor-market segment, hence $Q = \bar{Q}$ and $Q^* = \bar{Q}^*$.

- On the unskilled labor market: As long as the minimum wage is binding and endowments large enough, it is not balanced and the effective unskilled employment level in each country (L, L^*) is determined by the optimal labor demands coming from both sectors:[8]

$$\underline{w}L = \underline{w}nl + \underline{w}l_Z = n\delta(\sigma-1)F + \beta y_Z \quad (22)$$

$$\underline{w}^*L^* = \underline{w}^*n^*l^* + \underline{w}^*l_Z^* = n^*\delta^*(\sigma-1)F + \beta y_Z^* \quad (23)$$

- On each of the $(n+n^*)$ differentiated goods markets: Each firm produces the amount just sufficient to cover the demand emanating from the domestic and foreign markets:

$$\begin{aligned} y &= c + \tau c^* \\ y^* &= c^* + \tau c \end{aligned}$$

- On the homogenous good market: Given *i)* the domestic and foreign consumers' optimal demand (equation (4) and its foreign counterpart), and *ii)* the demand for good Z coming from monopolistic firms so as to cover the fixed costs, the resource constraint for the integrated world market of good Z is:

$$y_Z + y_Z^* = (1-\mu)(I + I^*) + (n+n^*)F$$

In the long-run equilibrium, national equilibrium incomes solely depend on the employment level of skilled and unskilled workers: $I = w_Q\bar{Q} + \underline{w}L$ and $I^* = w_Q^*\bar{Q}^* + \underline{w}^*L^*$. Using the labor-market equilibrium conditions (equations (22) and (23)), one can see that they notably depend on the equilibrium productive pattern:

$$I = y_Z + n(\sigma-1)F \quad (24)$$

$$I^* = y_Z^* + n^*(\sigma-1)F \quad (25)$$

3 Minimum wages and the location of production

This section focuses on the effect of a marginal increase in the domestic minimum wage ($d\underline{w} > 0$) regards the spatial distribution of firms, starting from the symmetric equilibrium. In the symmetric equilibrium, minimum wages and labor endowments are identical across countries ($\underline{w} = \underline{w}^*, \bar{Q} = \bar{Q}^*, \bar{L} = \bar{L}^*$). In that case, it is trivial to show that the number of firms entering each market is equalized across countries ($n = n^*$), as well as national incomes ($I = I^*$), employment levels ($L = L^*$), skilled wages ($w_Q = w_Q^*$) and the production of homogenous good ($y_Z = y_Z^*$). We start from the benchmark symmetric equilibrium to investigate the properties of the model following an unilateral increase in the domestic minimum wage ($d\underline{w} > 0$).

Analytical results are derived by differentiating the model in the specific case when unskilled labor is only required in the production of differentiated goods (*i.e.* when $\beta = 0$). In that case, production of homogenous good Z uses skilled labor only. As detailed in Appendix A.3.1, good

[8] The unskilled labor market is not equilibrated in the Walrasian sense and adjustment occurs through quantities.

Z's market equilibrium condition thus implies that skilled wages are equal to the exogenous productivity level $a_Q$ized in both countries and become exogenous. This simplifying assumption has the nice property of allowing analytical derivation of the effects of a domestic minimum wage increase on location decisions in optimum. Results are discussed in Section 3.1. However, it also implies that minimum wage shocks do not spread into the skilled labor market, thereby eliminating part of the story. It is thus removed in Section 3.2, which investigates the effects of a domestic minimum wage increase in the general case where $\beta > 0$.

3.1 With exogenous skilled-labor wages ($\beta = 0$)

In this section, we restrict the use of unskilled workers to the differentiated good sector and assume the homogeneous good to be produced with skilled labor only ($\beta = 0$). Equilibrium skilled wages (expressed in terms of numéraire) equal the productivity level of skilled workers a_Q, as shown by Z-firms' first-order condition (equation (7) with $\beta = 0$). As a result, minimum wage changes have no distorsive effect on the remuneration of skilled workers.

To get insights about the impact of the wage shock on location decisions, the model is differentiated around the symmetric equilibrium. In a first step, we determine the short-run effect of the shock on the profitability of firms already located in both countries (*i.e.* for a given number of existing firms n, n^*). This allows to infer the long-run impact on the spatial distribution of firms in a second step. Moreover, as the fixed cost of producing is set identical across countries, one can restrict the analysis to the impact of the wage shock onto relative operational profits, $\pi_{op} \equiv \pi + F$ and $\pi^*_{op} \equiv \pi^* + F$.

Given the values for I, I^*, p, p^*, P_X and P^*_X in the symmetric equilibrium, one can derive the short-run elasticity of operating profits to $\underline{w}$ in each country. As detailed in Appendix A.3, it can be decomposed in two elements, the Price Competitiveness Effect (PCE hereafter) and the Income Effect (IE hereafter):

$$\left.\frac{d\pi_{op}/\pi_{op}}{d\underline{w}/\underline{w}}\right|_{\dot{n}=\dot{n}^*=0} = \underbrace{-2(\sigma-1)\delta\frac{\phi}{(1+\phi)^2}}_{PCE} + \underbrace{\frac{\sigma-1}{\sigma}\mu\delta(1-\delta)\frac{1-\gamma}{1+\phi}}_{IE} \tag{26}$$

$$\left.\frac{d\pi^*_{op}/\pi^*_{op}}{d\underline{w}/\underline{w}}\right|_{\dot{n}=\dot{n}^*=0} = \underbrace{2(\sigma-1)\delta\frac{\phi}{(1+\phi)^2}}_{PCE} + \underbrace{\frac{\sigma-1}{\sigma}\mu\delta(1-\delta)\frac{\phi(1-\gamma)}{1+\phi}}_{IE} \tag{27}$$

The Price Competitiveness Effect is always negative for domestic firms and positive for foreign ones. The Income Effect may be positive or negative in both countries.

The Price Competitiveness Effect may be rationalized as follows. The domestic policy shock leads to an increase in the cost of unskilled workers. Given that skilled wages are exogenous, the increase in $\underline{w}$ translates into an increase in the relative cost of unskilled labor ($\underline{w}/w_Q$), which entices domestic firms to substitute skilled to low-skilled workers. Yet, as long as both types of labor are not perfect substitutes, firms cannot fully compensate for the relative increase in production costs. By raising the relative cost of producing in the domestic country, the wage shock lowers price competitiveness of domestic firms relative to that of foreign ones, both on the local and export markets. Conversely, foreign firms competitiveness on both markets benefits from the domestic policy shock. For given values of n, n^* and starting from the symmetric equilibrium, one can indeed show that:

$$\frac{d(p/P_X)}{d\underline{w}} > 0, \quad \frac{d(\tau p/P^*_X)}{d\underline{w}} > 0, \frac{d(p^*/P^*_X)}{d\underline{w}} < 0, \frac{d(\tau p^*/P_X)}{d\underline{w}} < 0$$

Absent any income effect, the wage shock would always negatively affect the relative attractiveness of the domestic country, as underlined by Picard & Toulemonde (2001). With free entry of

firms, the relative increase in domestic production costs would entice a larger number of firms to locate and produce abroad. In that respect, the relocation of firms strengthens the negative impact of the minimum wage shock on domestic employment and production obtained in the neo-classical framework with an exogenous number of firms.

However, operating profits are also altered by aggregate demand changes in the domestic country, leading to the Income Effect.[9] Every thing else equal, the domestic wage shock tends to increase aggregate income by raising low-skilled workers' purchasing power. Nevertheless, it also reduces demand for low-skilled labor coming from each domestic monopolistic firm, and aggregate unskilled labor demand as well. Besides, there is no effect on the skilled labor-market segment, given that skilled wages are left unaffected by the minimum wage shock in a context with full employment. As a result, for the existing number of firms, the income effect may be positive or negative. As shown by equations (26) and (27), the (necessary and sufficient) condition for it to be positive is $\gamma < 1$, that is the elasticity of substitution between skilled and unskilled workers should be low. If positive, the income effect increases profits in both countries. However, as shown by comparing both IE terms in equations (26) and (27), the upward pressure is stronger for local firms than for foreign ones because of the Home Market Effect. *Ceteris paribus*, the income effect enhances the domestic country's attractiveness in relative terms.

Short-run analysis of the changes in the profits of domestic and foreign incumbents further allows to derive the effect of the wage shock on the spatial distribution of firms. As firms are free to decide where to locate, the ultimate long-run impact on the relative number of firms located in the home country depends on the short-run changes in profits in the domestic country *relative* to those in the foreign one. Namely, the minimum wage increase leads to a concentration of firms in the domestic country if the short-run elasticity of domestic profits to the wage shock is larger than the elasticity of foreign profits. It is the case if:[10]

$$\underbrace{-4(\sigma-1)\delta\frac{\phi}{(1+\phi)^2}}_{PCE}+\underbrace{\frac{(\sigma-1)}{\sigma}\mu\delta(1-\delta)(1-\gamma)\frac{1-\phi}{1+\phi}}_{IE}>0 \tag{28}$$

Every thing else equal, the price competitiveness effect always benefits to foreign firms, thereby reducing the domestic country's relative attractiveness. On the other hand, as long as the income effect is positive ($\gamma < 1$), it raises domestic attractiveness in relative terms as well because of the home market effect. If strong enough, the income effect may even more than compensate for the price competitiveness loss, in what case the relative number of firms located in the domestic country rises when the minimum wage increases.

As shown by equation (28), the balance between the cost and demand effects depends on the parameters γ, δ, μ, and ϕ. Their influence goes by different transmission channels.

- μ, γ and δ affect the response of domestic income to the wage shock ($dI/d\underline{w}$). The lower the elasticity of substitution between skilled and unskilled labor in the differentiated sector (γ), the more limited the substitution of skilled to unskilled workers induced by the relative increase in $\underline{w}/w_Q$ and the stronger the income effect. As well, low δ and high μ tend to favor the income effect every thing else equal.

- The size of trade barriers (ϕ) alters the impact of a change in aggregate income on domestic profits relative to foreign ones in the short run (*i.e.* $d\pi/dI$ relative to $d\pi^*/dI$). The higher ϕ, *i.e.* the lower transport costs, the smaller the benefit of being located in the market

[9] In the special case where skilled wages are ultimately exogenous, foreign aggregate income I^* remains unaffected by the unilateral change in $\underline{w}$ in the short run. This will no longer be the case when $\beta \neq 0$.

[10] See details in Appendix A.3.

whose national income increases.[11] When international trade barriers are low (ϕ high), following the domestic minimum wage shock, more firms choose to enter the foreign market to benefit from an improved price competitiveness, and to export on the domestic market whose income has increased with the minimum wage shock.

This last result is of particular interest for economic policy design in the current context of trade liberalization. A high-minimum wage policy is all the more likely to negatively affect the country's relative attractiveness as international trade is free (ϕ high). In that case indeed, given that skilled labor cost is unaffected by the minimum wage increase, pressures exerted by cost competitiveness motives are more prevalent in the arbitrage faced by firms regarding location choices. This result however relies on the exogeneity of skilled wages, and may accordingly be altered when w_Q adjusts to changes in $\underline{w}$, as investigated in the next section.

3.2 With endogenous skilled wages adjustment ($\beta \neq 0$)

Analysis driven in Section 3.1 has been conducted in the particular case where skilled wages are independent of minimum wage policy, achieved by setting $\beta = 0$. We now depart from that assumption to take into account the potential distorsive effects of minimum wage policy on the whole remuneration structure. As shown by equation (7) when $\beta \neq 0$, an increase in $\underline{w}$ leads to a drop in the equilibrium wage of skilled workers w_Q. Endogenous adjustments of w_Q alter the impact of the wage shock on firms' location decisions, with respect to those derived in Section 3.1.

Taking into account endogenous skilled wages adjustment is therefore likely to enrich the analysis concerning the impact of an unilateral minimum wage increase on location decisions. We investigate that point by relying on numerical simulations of the model, given the calibration of structural parameters displayed in Table 2.

Table 2: Calibration

μ	α	F	a_Q	a_L	γ	β	σ	τ	s_Q
0.55	0.53	1	1	0.86	0.7	0.4	6	1.2	0.5

The share of differentiated goods in the utility function μ is taken from Strauss-Kahn (2005). The value for α is taken from Salanié (2000)'s estimate of the share of skilled workers in the French value-added during the 1990s. The literature delivers contrasted results regards the value of the elasticity of substitution between skilled and unskilled workers. We set $\gamma = 0.7$ based on Gianella (1999).[12] The ratio a_L/a_Q is chosen so as to reproduce the relative productivity level of unskilled workers observed in the data (arbitrarily setting $a_Q = 1$).[13] The value $\tau = 1.2$ lies within the range commonly found in the literature (see Hummels (2001) among others). The elasticity of substitution across varieties $\sigma = 6$ corresponds to a mark-up rate of 20%, consistently with Broda and Weinstein's (2006) estimates. We arbitrarily set the fixed cost of production $F = 1$.[14] The calibration of the share of unskilled labor in sector Z's production β obeys the

[11] Note that the impact of the elasticity of substitution across varieties σ is ambiguous. As σ is high, competition between firms is keener, and the negative PCE stronger. Yet it also strengthens the Home Market Effect by reducing ϕ, raising the (possibly positive) IE.

[12] Note that this calibration meets the condition for the income effect to be positive in the case $\beta = 0$.

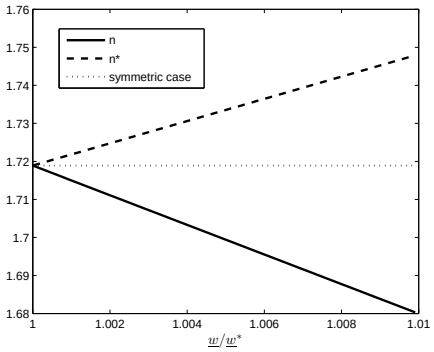
[13] Calibration is based on French data, using information delivered by the OECD-STAN database. Productivity in the services sector is taken as reference for a_L, whereas the productivity of skilled workers corresponds to the productivity in total manufacturing. Reference year is 2000.

[14] Simulation exercises show that the value for F does not play a crucial role in our results.

following technical requirements: *i)* the minimum wage level has to be higher than the unskilled wage that would prevail in the flexible case, for the constraint to be binding on the unskilled labor market, and *ii)* this should not be the case on the skilled-labor market. Meeting the two requirements (namely the second one) imposes some constraint on the calibration of β, which is set to 0.4.[15] Last, and as discussed below, the model's predictions are sensitive to the calibrated value of $s_Q \equiv \frac{\bar{Q}}{\bar{Q}+\bar{L}}$, that is the share of skilled workers in the working population. In what follows, it is set equal to 0.5, which is presumably a lower bond when considering the actual share of minimum-wage workers in OECD countries. We check that the value could be increased without altering qualitative results.

Given calibration summed up in Table 2, the model is simulated to study the effects of an unilateral increase in the domestic minimum wage $\underline{w}$ on optimal firms' location decisions. Figure 1 reports the equilibrium values of n and n^*, for increasing values of $\underline{w}$ relative to $\underline{w}^*$.[16]

Figure 1: Spatial impact of a domestic shock on minimum wages



In the general case with $\beta \neq 0$, one can still rationalize the impact of minimum wage policy on the spatial distribution of firms into a price competitiveness effect (PCE) and an income effect (IE). However, endogenous changes in the remuneration of skilled workers substantially affect both mechanisms. First regarding PCE, the decrease in w_Q reduces domestic monopolistic firms' competitiveness loss induced by the minimum wage increase. Second, the Income Effect is affected by the reduction in the equilibrium wage of skilled workers as well. As previously ($\beta = 0$), the upward pressure on aggregate income induced by the increase in $\underline{w}$ is counteracted by the decrease in unskilled employment. Besides, it is now dampened by the decrease in w_Q under full employment on the skilled labor-market segment. Every thing else equal, endogeneity in w_Q reduces the case of a positive Income Effect with the policy shock.

The final outcome is again driven by the balance between both effects. Simulations show that it is notably affected by the share of skilled workers in the working population (s_Q), according to the following underlying mechanisms:

- The Income Effect is all the more negative as the share of skilled workers is high. With endogenous skilled wages, the remuneration of this labor-market segment is negatively affected by the wage shock (as shown by equation (7)). This is all the more likely to imply a negative income effect as the share of skilled workers in the working population is high.

[15] Precisely, we solve the program as follows. First, the model is solved without imposing any minimum wage constraint, leading to equilibrium wages $\{w_L^E, w_Q^E\}$ on both unskilled and skilled labor markets (for exogenous values of $\bar{L}$ and $\bar{Q}$). We then impose a minimum wage level $\underline{w}$ that is 1% superior to w_L^E, checking that $\underline{w} < w_Q^E$.

[16] As for the symmetric equilibrium, for each value of $\underline{w}$ departing from $\underline{w}^*$, we check that the model's solution is the interior one, and that minimum wages values are still binding as required.

- The Price Competitiveness Effect is shown to be sensitive to s_Q as well. Namely, the lower s_Q, the less negative the competitiveness loss induced by the minimum-wage shock. This is because, under decreasing marginal productivity of labor the equilibrium wage of skilled workers decreases relatively more when the supply of skilled workers $\bar{Q}$ (hence s_Q) is small. Would the endogenous decrease in w_Q be strong enough, the minimum wage shock could even imply a positive PCE. However, simulation results suggest that this is the case for an implausibly low share of skilled workers in the population.

For reasonable values of the parameter s_Q, the PCE induced by the minimum wage shock remains negative, and is reinforced by a negative IE. Accordingly, the minimum wage increase reduces the domestic country's attractiveness, as shown in Figure 1 where n/n^* decreases all the more since $\underline{w}/\underline{w}^*$ rises.

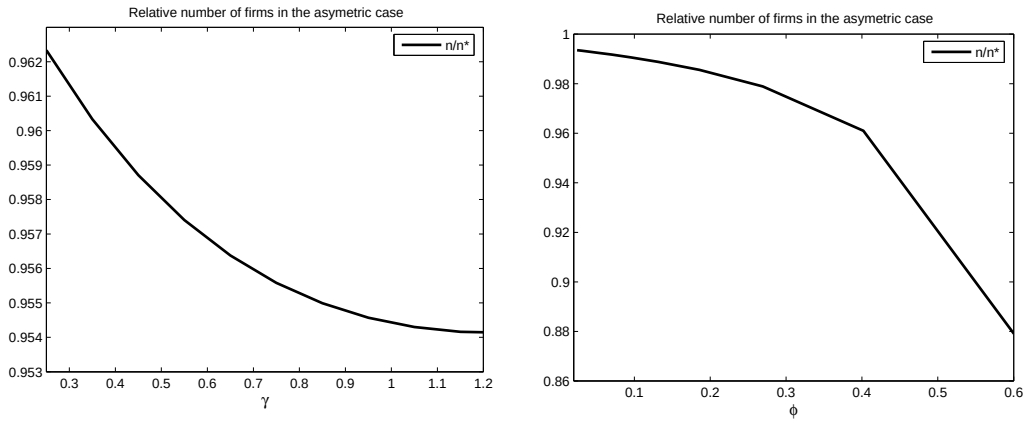
When w_Q adjusts to changes in $\underline{w}$, the minimum-wage shock is thus more likely to induce an attractiveness loss for the high minimum-wage country because the positive impact on unskilled workers' income is partially compensated by a drop in the remuneration of skilled workers. Next section asks how these results are affected by changes in other key parameters of the model.

3.3 Sensitivity analysis

Section 3.1 derives analytical conditions under which an unilateral increase in $\underline{w}$ positively influences the propensity of firms to locate in the high-minimum wage country. According to equation (28), it namely depends on *i)* the degree of substitution between skilled and unskilled workers in the differentiated sector (γ should be low), and *ii)* the size of trade costs (τ should be high). By symmetry, this section investigates the results sensitivity to both parameters under endogenous skilled wages.

To that aim, we simulate the model for increasing values of γ and ϕ and look at how it affects the relative number of firms located in the domestic country when its minimum wage is 1% higher than in the foreign country. Other structural parameters are calibrated as reported in Table 2. Results are illustrated in Figure 2.

Figure 2: Sensitivity analysis



Sensitivity analysis to γ: We first investigate the role of the elasticity of substitution between skilled and unskilled labor in the differentiated good sector.

As displayed in the left-panel of Figure 2, the ratio n/n^* is all the lower as γ is high. This is consistent with our previous analytical results derived in Section 3.1, according to which the case of an attractiveness gain for the high-minimum wage country becomes less and less likely as skilled and unskilled workers become more substitutable. Similar mechanisms are at work with

endogenous skilled wages. The income effect is all the more negative as γ is high and the home country's relative attractiveness as well.

Sensitivity analysis to ϕ: Section 3.1 makes clear that, with exogenous skilled wages, a increase in $\underline{w}$ all the more reduces the home country's attractiveness as trade costs are low, *i.e.* as ϕ is high. This is still the case when endogenous skilled wage adjustments are taken into account, as shown by the sensitivity analysis to ϕ reported in the right-panel of Figure 2.

As in the case with exogenous skilled wages, the attractiveness loss of the high minimum-wage country is all the stronger since international trade is liberalized: the ratio n/n^* decreases with ϕ. First, trade liberalization makes the cost-competitiveness of firms more prevalent in international competition. Every thing else equal, the negative PCE induces firms to locate in the low-cost country. Second, with endogenous skilled wages, this effect is strengthened by the negative income effect in the home country. For both price-competitiveness and market potential motives, firms are all the more enticed to settle in the foreign country as international trade is free.

4 Conclusion

Using insights of the labor-market literature and the new trade theory, the paper contributes to the living debate on the controversial effects of labor-market policies on attractiveness for FDI. Precisely, our theoretical framework puts into evidence the link between minimum wage policy and the rationale behind firms' location choices in an international setting. In that framework, we show that the impact of a minimum wage increase on the country's attractiveness is far from being trivial. Firms' location decisions are affected through both the negative cost effect of the wage shock, and the possibly positive effect on aggregate demand. The final effect crucially depends on adjustments on the labor market. Precisely, we show that it depends on *i)* the extent to which skilled wages adjust to minimum wage changes, *ii)* the magnitude of the substitution effects between skilled and unskilled workers, and *iii)* the share of skilled labor among workers. Namely, when neglecting the distorsive effects on the remuneration of skilled workers, the minimum wage shock may benefit to the home country in terms of attractiveness, because it increases aggregate demand. However, for reasonable parameter values, this is no longer the case when endogenous changes in the equilibrium wage for skilled workers are taken into account. Last, our overall results suggest that the perverse effect of a high-minimum wage policy on the country's attractiveness for FDI is strengthened in a world of increasing free trade. This explains the increasing interest of political and economic circles in the question of the efficiency of national labor-market institutions in a more and more globalized world.

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A Appendix

A.1 The interior equilibrium

In the interior equilibrium, the relative number of firms in each country is jointly determined by the nullity of (17) and (18) and the relative number of active firms in each country is:

$$\frac{n}{n^*} = \frac{I(1-\phi\rho^{\sigma-1}) - I^*\phi(\rho^{\sigma-1}-\phi)}{I^*(1-\phi\rho^{1-\sigma}) - I\phi(\rho^{1-\sigma}-\phi)}$$

This relation is only valid in the interior equilibrium, *i.e.* for $n/n^* > 0$. It is the case if both

$$I(1-\phi\rho^{\sigma-1}) - I^*\phi(\rho^{\sigma-1}-\phi) > 0 \tag{29}$$

and

$$I^*(1-\phi\rho^{1-\sigma}) - I\phi(\rho^{1-\sigma}-\phi) > 0 \tag{30}$$

Manipulating equation (29) yields that:

$$\begin{aligned} & I(1-\phi\rho^{\sigma-1}) - I^*\phi(\rho^{\sigma-1}-\phi) > 0 \\ \Leftrightarrow\ & \rho^{\sigma-1} < \frac{I+\phi^2 I^*}{\phi(I+I^*)} \equiv \overline{\rho} \end{aligned}$$

Besides, after some calculus on equation (30), you get that:

$$\begin{aligned} & I^*(1-\phi\rho^{1-\sigma}) - I\phi(\rho^{1-\sigma}-\phi) > 0 \\ \Leftrightarrow\ & \rho^{\sigma-1} > \frac{\phi(I+I^*)}{\phi^2 I+I^*} \equiv \underline{\rho} \end{aligned}$$

Taken together, this means that condition (21) holds if and only if:

$$\frac{\phi(I+I^*)}{\phi^2 I+I^*} < \quad \rho^{\sigma-1} \quad < \frac{I+\phi^2 I^*}{\phi(I+I^*)}$$

For this to hold, one has to ensure that it is always the case that:

$$\frac{\phi(I+I^*)}{\phi^2 I+I^*} < \frac{I+\phi^2 I^*}{\phi(I+I^*)}$$

that is:

$$\begin{aligned} & [I+\phi^2 I^*][\phi^2 I+I^*] > \phi^2(+ + I^*)^2 \\ & \Rightarrow I^* I(1-\phi^2)^2 > 0 \end{aligned}$$

Provided that both aggregate incomes are positive, it it always true that $\frac{\phi(I+I^*)}{\phi^2 I+I^*} < \frac{I+\phi^2 I^*}{\phi(I+I^*)}$.

As long as $\rho^{\sigma-1} < \frac{\phi(I+I^*)}{\phi^2 I+I^*}$, production is entirely concentrated in the domestic (low minimum wage) country (i.e. $n^* = 0$). This corner equilibrium is stable because no foreign firm has an incentive to enter the foreign market:

$$\begin{aligned} E\left\{\Pi^*(f)|n^*=0\right\} &= \frac{\mu}{\sigma}\left(\frac{I^*}{n\phi\rho^{1-\sigma}} + \phi\rho^{\sigma-1}\frac{I}{n}\right) - F \\ &= \frac{F}{I+I^*}\left(\frac{I^*+\phi^2 I}{\phi\rho^{1-\sigma}} - (I+I^*)\right) \end{aligned}$$

which is negative, provided that $\rho^{\sigma-1} < \frac{\phi(I+I^*)}{\phi^2 I+I^*}$.

On the other hand, if $\rho^{\sigma-1} > \frac{I+\phi^2 I^*}{\phi(I+I^*)}$, production is entirely concentrated in the foreign country (i.e. $n = 0$), as the production in the domestic country is unprofitable:

$$\begin{aligned} E\left\{\Pi(h)|n=0\right\} &= \frac{\mu}{\sigma}\left(\frac{I}{n^*\phi\rho^{\sigma-1}} + \phi\rho^{1-\sigma}\frac{I^*}{n^*}\right) - F \\ &= \frac{F}{I+I^*}\left(\frac{I+\phi^2 I^*}{\phi\rho^{\sigma-1}} - (I+I^*)\right) \end{aligned}$$

which is negative, provided that $\rho^{\sigma-1} > \frac{I+\phi^2 I^*}{\phi(I+I^*)}$.

A.2 The general equilibrium in the corner equilibrium

This section details one of the two corner equilibria, when $n = 0$ and $n^* > 0$. The second one (when $n^* = 0$ and $n > 0$) can be inferred by symmetry. As soon as:

$$\rho^{\sigma-1} > \frac{1+\phi^2 I^*}{\phi(I+I^*)}$$

the relative marginal cost is so low in the foreign country, that all firms are enticed to enter the foreign market to produce and serve it. The number of differentiated varieties produced in the domestic country becomes null. As a result, $n = 0$ while $n^* > 0$.

In such a corner equilibrium, the general equilibrium solution is defined by the following system:

$$\begin{aligned} w_Q &= a_Q \beta^{\frac{\beta}{1-\beta}}(1-\beta)\left(\frac{w}{a_L}\right)^{\frac{-\beta}{1-\beta}} \\ w_Q^* &= a_Q \beta^{\frac{\beta}{1-\beta}}(1-\beta)\left(\frac{w^*}{a_L}\right)^{\frac{-\beta}{1-\beta}} \\ I &= y_Z \\ I^* &= y_Z^* + n^*(\sigma-1)F \\ MC_X^* &= \left[\alpha\left(\frac{w_Q^*}{a_Q}\right)^{1-\gamma} + (1-\alpha)\left(\frac{w^*}{a_L}\right)^{1-\gamma}\right]^{\frac{1}{1-\gamma}} \\ n^* &= \frac{\mu}{\sigma}\frac{I+I^*}{F} \\ y_Z + y_Z^* &= (1-\mu)(I+I^*) + n^* F \end{aligned}$$

A.3 Minimum wage shocks and location decisions under exogenous skilled wages

A.3.1 The case of exogenous skilled wages ($\beta = 0$)

In the following, we derive analytical results in the special case where unskilled workers are only in use in the differentiated good sector, whereas good Z is entirely produced from skilled workers. Analytically, this is achieved by setting β equal to 0. This is a convenient case to study because equilibrium skilled wages are then equalized across countries and insensitive to minimum wage shocks. In that case indeed, Z-firms' first-order condition in both countries (equation (7) and its foreign counterpart) yield:

$$1 = \frac{w_Q}{a_Q} = \frac{w_Q^*}{a_Q} \Leftrightarrow w_Q = w_Q^* = a_Q$$

Moreover, as unskilled workers are only employed by differentiated good producers, labor-market equilibria imply:

$$\begin{aligned} \underline{w}L &= n\delta(\sigma-1)F \\ \underline{w}^*L^* &= n^*\delta^*(\sigma-1)F \end{aligned}$$

with δ and δ^* defined as in the general case.

A.3.2 Symmetric equilibrium

In the symmetric equilibrium, minimum wages and labor endowments are set identical across countries ($\underline{w} = \underline{w}^*, \bar{Q} = \bar{Q}^*, \bar{L} = \bar{L}^*$). As a consequence, the number of firms entering each market is identical in both countries, *i.e.* the equilibrium is an interior one. From equations (20), (21), (24) and (25), we characterize the symmetric equilibrium as follows:

$$\begin{aligned} n = n^* &= \frac{\mu}{\sigma-\mu(\sigma-1)\delta}\frac{\bar{Q}}{F} \\ I = I^* &= \frac{\sigma}{\sigma-\mu(\sigma-1)\delta}\bar{Q} \\ Q = Q^* &= \bar{Q} \\ L = L^* &= \frac{\mu(\sigma-1)\delta}{\sigma-\mu(\sigma-1)\delta}\frac{\bar{Q}}{\underline{w}} \end{aligned}$$

In that case, as trade flows of differentiated goods are balanced, each country produces the quantity of homogeneous good necessary to cover the representative household's consumption and the fixed costs paid by domestic firms:

$$y_Z = y_Z^* = C_Z + nF$$

A.3.3 Impact of a minimum wage shock

After writing operating profit of domestic firms as follows:

$$\pi^{op} = \frac{py}{\sigma} = \frac{\mu}{\sigma}\left[\left(\frac{p}{P_X}\right)^{1-\sigma} I + \left(\frac{\tau p}{P_X}\right)^{1-\sigma} I^*\right] \tag{31}$$

we can decompose the short-term effect of the wage shock on domestic firms' operational profits in two elements:

$$\begin{aligned} \frac{d\pi^{op}/\pi^{op}}{d\underline{w}/\underline{w}} = & \underbrace{\frac{d\pi^{op}/\pi^{op}}{dI/I}\frac{dI/I}{d\underline{w}/\underline{w}}}_{\text{Income Effect}} \\ + & \underbrace{\frac{d\pi^{op}/\pi^{op}}{d(p/P_X)/(p/P_X)}\frac{d(p/P_X)/(p/P_X)}{d\underline{w}/\underline{w}} + \frac{d\pi^{op}/\pi^{op}}{d(\tau p/P_X^*)/(\tau p/P_X^*)}\frac{d(\tau p/P_X^*)/(\tau p/P_X^*)}{d\underline{w}/\underline{w}}}_{\text{Price Competitiveness Effect}} \end{aligned}$$

Totally differentiating (31) around the symmetric equilibrium derived in A.3.2, we get:

$$\begin{aligned}
\frac{d\pi^{op}/\pi^{op}}{dI/I} &= \frac{\left(\frac{p}{P_X}\right)^{1-\sigma} I}{\left(\frac{p}{P_X}\right)^{1-\sigma} I + \left(\frac{\tau p}{P_X^*}\right)^{1-\sigma} I^*} =^{ES} \frac{1}{1+\phi} \\
\frac{dI/I}{d\underline{w}/\underline{w}} &= \frac{I-\bar{Q}}{I}(1-\gamma)(1-\delta) =^{ES} \frac{\mu\delta}{1+\phi}\frac{\sigma-1}{\sigma}(1-\gamma)(1-\delta) \\
\frac{d\pi^{op}/\pi^{op}}{d(p/P_X)/(p/P_X)} &= (1-\sigma)\frac{\left(\frac{p}{P_X}\right)^{1-\sigma} I}{\left(\frac{p}{P_X}\right)^{1-\sigma} I + \left(\frac{\tau p}{P_X^*}\right)^{1-\sigma} I^*} =^{ES} \frac{1-\sigma}{1+\phi} \\
\frac{d(p/P_X)/(p/P_X)}{d\underline{w}/\underline{w}} &= \frac{n^*\phi\delta}{n\rho^{1-\sigma}+n^*\phi} =^{ES} \frac{\phi\delta}{1+\phi} \\
\frac{d\pi^{op}/\pi^{op}}{d(\tau p/P_X^*)/(\tau p/P_X^*)} &= (1-\sigma)\frac{\left(\frac{\tau p}{P_X^*}\right)^{1-\sigma} I^*}{\left(\frac{p}{P_X}\right)^{1-\sigma} I + \left(\frac{\tau p}{P_X^*}\right)^{1-\sigma} I^*} =^{ES} \frac{\phi(1-\sigma)}{1+\phi} \\
\frac{d(\tau p/P_X^*)/(\tau p/P_X^*)}{d\underline{w}/\underline{w}} &= \frac{n^*\delta}{n\phi\rho^{1-\sigma}+n^*} =^{ES} \frac{\delta}{1+\phi}
\end{aligned}$$

This allows us to derive the expression of domestic profits to the domestic minimum wage around the symmetric equilibrium:

$$\frac{d\pi^{op}/\pi^{op}}{d\underline{w}/\underline{w}} =^{ES} -2(\sigma-1)\delta\frac{\phi}{(1+\phi)^2} + \frac{\sigma-1}{\sigma}\mu\delta(1-\delta)\frac{1-\gamma}{1+\phi}$$

which is positive if:

$$\mu(1-\delta)(1-\gamma) > \sigma\frac{2\phi}{1+\phi}$$

Using the same reasoning as previously, we can decompose the effect of the wage shock on the foreign firms' profits (in the short run), in two elements:

$$\begin{aligned}
\frac{d\pi^{op\,*}/\pi^{op\,*}}{d\underline{w}/\underline{w}} &= \underbrace{\frac{d\pi^{op\,*}/\pi^{op\,*}}{dI/I}\frac{dI/I}{d\underline{w}/\underline{w}}}_{\text{Income Effect}} \\
&+ \underbrace{\frac{d\pi^{op\,*}/\pi^{op\,*}}{d(\tau p^*/P_X)/(\tau p^*/P_X)}\frac{d(\tau p^*/P_X)/(\tau p^*/P_X)}{d\underline{w}/\underline{w}} + \frac{d\pi^{op\,*}/\pi^{op\,*}}{d(p^*/P_X^*)/(p^*/P_X^*)}\frac{d(p^*/P_X^*)/(p^*/P_X^*)}{d\underline{w}/\underline{w}}}_{\text{Price Competitiveness Effect}}
\end{aligned}$$

where:

$$\begin{aligned}
\frac{d\pi^{op\,*}/\pi^{op\,*}}{dI/I} &= \frac{\left(\frac{\tau p^*}{P_X}\right)^{1-\sigma} I}{\left(\frac{\tau p^*}{P_X}\right)^{1-\sigma} I + \left(\frac{p^*}{P_X^*}\right)^{1-\sigma} I^*} =^{ES} \frac{\phi}{1+\phi} \\
\frac{dI/I}{d\underline{w}/\underline{w}} &= \frac{I-\bar{Q}}{I}(1-\gamma)(1-\delta) =^{ES} \frac{\mu\delta}{1+\phi}\frac{\sigma-1}{\sigma}(1-\gamma)(1-\delta) \\
\frac{d\pi^{op\,*}/\pi^{op\,*}}{d(\tau p^*/P_X)/(\tau p^*/P_X)} &= (1-\sigma)\frac{\left(\frac{\tau p^*}{P_X}\right)^{1-\sigma} I}{\left(\frac{\tau p^*}{P_X}\right)^{1-\sigma} I + \left(\frac{p^*}{P_X^*}\right)^{1-\sigma} I^*} =^{ES} \frac{(1-\sigma)\phi}{1+\phi} \\
\frac{d(\tau p^*/P_X)/(\tau p^*/P_X)}{d\underline{w}/\underline{w}} &= \frac{-n^*\rho^{1-\sigma}\delta}{n\rho^{1-\sigma}+n^*\phi} =^{ES} \frac{-\delta}{1+\phi} \\
\frac{d\pi^{op\,*}/\pi^{op\,*}}{d(p^*/P_X^*)/(p^*/P_X^*)} &= (1-\sigma)\frac{\left(\frac{p^*}{P_X^*}\right)^{1-\sigma} I^*}{\left(\frac{\tau p^*}{P_X}\right)^{1-\sigma} I + \left(\frac{p^*}{P_X^*}\right)^{1-\sigma} I^*} =^{ES} \frac{1-\sigma}{1+\phi} \\
\frac{d(p^*/P_X^*)/(p^*/P_X^*)}{d\underline{w}/\underline{w}} &= \frac{-n\phi\rho^{1-\sigma}\delta}{n\phi\rho^{1-\sigma}+n^*} =^{ES} \frac{-\phi\delta}{1+\phi}
\end{aligned}$$

As a result, we get:

$$\frac{d\pi^{op\,*}/\pi^{op\,*}}{d\underline{w}/\underline{w}} =^{ES} 2(\sigma-1)\delta\frac{\phi}{(1+\phi)^2} + \frac{\sigma-1}{\sigma}\mu\delta(1-\delta)\frac{\phi(1-\gamma)}{1+\phi} > 0$$

In the long-run, the impact of the wage shock on the country's attractiveness is determined by its *relative* effect on domestic and foreign operational profits. Namely, the relative number of domestic firms increases if the elasticity of operational profits to the shock is higher than the elasticity of foreign profits:

$$-2(\sigma-1)\delta\frac{\phi}{(1+\phi)^2}+\frac{\sigma-1}{\sigma}\mu\delta(1-\delta)\frac{1-\gamma}{1+\phi}>2(\sigma-1)\delta\frac{\phi}{(1+\phi)^2}+\frac{\sigma-1}{\sigma}\mu\delta(1-\delta)\frac{\phi(1-\gamma)}{1+\phi}$$

$$\Leftrightarrow -4(\sigma-1)\delta\frac{\phi}{(1+\phi)^2}+\frac{\sigma-1}{\sigma}\mu\delta(1-\delta)(1-\gamma)\frac{1-\phi}{1+\phi}>0$$

We obtain equation (28).