Fluctuating demand and oligopoly: is strong employment protection legislation detrimental to the domestic industry?

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(Preliminary version, please do not circulate)

April 23, 2012

Abstract

It is often argued that firms need flexibility in order to better face demand uncertainty. As employment protection legislation (EPL) impacts the cost of volume adjustments available to the firms, it constrains volume flexibility that firms can achieve. Weakening EPL could then be thought as a desirable policy, in particular when firms decide where to locate. On the other hand, it is well known that in an oligopolistic setting, flexibility is not necessarily an advantage. The aim of this paper is to analyze the consequences that different EPL across the countries may have on firms location decisions. It shows that the country characterized by the strongest EPL can nevertheless attract firms under demand uncertainty, and highlights the respective and combined roles played by transport costs and strategic interaction.

Keywords: oligopoly, strategic interaction, commitment, flexibility, employment protection, trade costs, firms' location.

JEL classification: L13, D80, F12,F13,F23

Acknowledgement 1 *The author would like to thank Daniel Danau, Bernard Franck, Frederic Gavrel, Isabelle Lebon and CREM-seminar participants for their comments.*

1 introduction

It is often argued that firms need flexibility in order to better face demand uncertainty. Given that the degree of volume flexibility a firm can achieve is constrained by labor flexibility allowed by the employment protection legislation (hereafter EPL), this leads to advocate a relaxation of the employment protection legislation. Further, the question of the effect that EPL might have on firms performance becomes a crucial one as firms choose where to locate.

The aim of this paper is to examine whether a strong EPL employment protection legislation is necessarily detrimental to the domestic industry.

This involves two linked issues.

Does a strong EPL necessarily deter firms from locating in the country where it prevails?

If not, when firms locate in countries with different levels of employment protection, which firm perceives a higher (expected) profit?

Given that international transactions are mainly due to a few large firms (see Bernard et alii, 2007), an oligopolistic setting seems to be the appropriate framework for studying the above questions.

Surprisingly, this question of the link between EPL and location decisions of oligopolistic firms has received very little attention in the theoretical literature.

The very sparse theoretical literature on EPL and location mainly focuses on the effect that EPL has, in the case of an uncertain future shock on market, on location *via* the relocation cost.

Most of these few papers consider a monopoly. Considering entry decision of a single firm (MNE) which future (perfectly integrated) market may collapse, Haaland , Wooton and Faggio (2003) show that worker protection deters potential investment, due to higher exit costs. With close assumptions, but considering a monopoly facing a non catastrophic possible shock on future demand, Dewit, Görg and Montagna (2009) show that, on one side, employment protection deters entry, but, on the other side, it favors domestic anchorage by discouraging relocation. The firm may then choose to locate in the country with the strongest EPL if the cost of setting up a plant in this country is sufficiently low.

More close to our analytical framework, Dewit, Leahy and Montagna (2003) analyze the location and relocation decisions in a duopoly framework with a possible shock on future demand. This allows them to take into account strategic considerations. In particular, when firms offer substitute goods and compete in quantities, employment protection (which yields higher volume adjustment costs for the domestic firm when it changes its output level between the two periods) enables the firm to commit to an high future output level and favors domestic anchorage. Further, in such a framework, strategic agglomeration can occur in this country. This arises if demand uncertainty and specific FDI costs are not too high.

The present paper differs from the above papers in the way that it is devoted to the analysis of the effect of EPL on location of oligopolistic firms under fluctuating demand rather than under an uncertain demand shock. This means that the demand level (the demand intercept) is thought as random in each period but without exhibiting any intertemporal dependence. This means that *postponing the location decision does not provide any additionnal information, since firms face the same uncertainty whatever the date.* Due to this "permanent" uncertainty, the question is neither that of a possible relocation after knowing the demand level, nor that of the optimal date of entering . What is studied is whether volume flexibility, which permits to accommodate such uncertainty and which is allowed by weak EPL, constitutes always a competitive advantage

and further, whether only countries with a weak EPL can attract firms.

The closer literature is that concerned with the tradeoff between flexibility and commitment under uncertainty and strategic substitutes.

As well known by industrial economists, in such competitive setting, flexibility is not necessarily an advantage[1]. For example, when oligopolistic firms compete in quantities on the market of an homogeneous good, there is a first mover's advantage: given that quantities are then strategic substitutes, the higher the first mover's output is, the lower must be the second mover's output in order to avoid a too low price. But, under demand uncertainty, this second mover's disadvantage can be counterbalanced by the informational benefit a firm can get in postponing his production.

Such a tradeoff between commitment and flexibility has been studied by Spencer and Brander (1992). These authors showed that when a duopolistic firm is flexible whereas its competitor is not, the committed firm perceives an higher expected profit than the flexible firm if the demand uncertainty is not too high. However, when firms choose their technologies (flexible or not), such an asymmetric equilibrium (i.e. an equilibrium where firms choose different technologies) does not emerge: firms choose the same technology, which is the flexible one (respectively, non flexible one) when the uncertainty is high (respectively, low) enough[2].

This model can be used to examine the impact of EPL on firms location.

If flexibility can be achieved only in the country with the weak EPL, choosing in which country to locate is the same thing than choosing to be flexible or not. In this case, according to the Spencer-Brander results, there is no room for an asymmetric location equilibrium: firms agglomerate in the country with the strongest EPL if uncertainty is low, and in the other country otherwise.

However, this result holds for a perfectly integrated market (Spencer and Brander considered an unique market). In fact, consumers also locate in some country and they generally do not have the possibility to exert an arbitrage between the markets. Moreover, firms have to bear trade costs to accede to their foreign markets.

The aim of the present paper is to *analyze the impact that different EPL across the countries may have upon the location decisions of oligopolistic firms which face a permanent demand uncertainty on each of the internationally separated markets.* It will show, firstly, that under these assumptions, an asymmetric location equilibrium (an equilibrium with a firm in each country) can emerge -what is not possible in the Spencer-Brander model-, and secondly, that in such an equilibrium, the firm located in the country with the strongest EPL may perceive a higher expected profit than its flexible competitor.

The structure of the paper goes as follows. Section 2 presents the basic model

[1] See, for example, Tirole 1990, for an analysis of strategic interaction under certainty.

[2] Such a result of impossibility of asymmetric equilibria comes from the assumption that the committed firm cannot vary ex post its output. If any committed firm could increase ex post and costlesstly its quantity (but not reduce it), only asymetric equilibria would emerge (see Maggi,1996): one firm would choose the non flexible technology whereas the other would choose the flexible one.

and highlights the roles played by transport costs, firms strategic behavior and "total "uncertainty. The third section discusses the results by introducing some alternative assumptions. Subsection 3-1 introduces the possibility for the firm which location enables it to achieve perfect production flexibility, to nevertheless adopt the non flexible technology. Subsection 3-2 discusses what might be expected with less extreme assumptions about flexibility. Particularly, it analyses what would happen if quantity commitment allows some degree of flexibility, in the sense that the firm, though unable to vary its output volume due to the constraints tied to a strong EPL, can choose how allocate its total production between the markets. The last section concludes.

2 the model

The market is that of an homogenous good. Storage option is excluded (due to either non storable characteristic of the good or to prohibitive storage costs).

There are two countries (S and W) whose markets are internationally separated (this means that consumers cannot exert an arbitrage between the two markets).

On each market, demand fluctuates. On market k, the demand function is : $q = a + \varepsilon_k - p$, where q is the quantity, p the price, a strictly positive constant and ε_k a random variable with mean 0 and variance σ_k^2. As usual, the lowest bound of ε_k is assumed to be high enough to exclude shutdown for a flexible firm facing a non flexible rival.

There are two firms, firm A and firm B, which have to choose their locations.

Firms operate on their domestic markets at a zero marginal cost of production and incur an unit trade cost t in serving their foreign markets (this trade cost may be a transport cost). As usual, the set-up cost incurred by a firm in installing a plant abroad is assumed large enough to exclude multiplant firms. For expositional convenience and because potential entry is out of the purpose of this paper, other fixed costs are negleted .

Firms compete in quantities. They are assumed to be risk neutral[3].

The countries differ by their employment protection legislations.

As a prime hypothesis, it is assumed that the technology available for a firm is constrained by the employment protection legislation which applies in its own country. More precisely, in country S - that with a strong employment legislation -, firms cannot adjust their employment levels in response to uncertainty, whereas in country W - that with a weak employment legislation -, the employment level can be adjusted without any cost. This corresponds to the two extreme cases of technological flexibility *à la* Turnovsky (Turnovsky, 1973), and means that it is as if a firm located in country W produced *ex post* (*i.e.* after knowing the value of the demand intercept on each market) whereas a firm

[3]This assumption is justified by the opportunity of portfolio diversification available for shareholders. Moreover, avoiding risk is less crucial in such a model of "permanent" uncertainty" -where good states of nature may precede bad ones or succeed to them - than it would be in a model with a single uncertain shock.

located in country S had to produce *ex ante* (*i.e.* before knowing the value of the demand intercept on each market)

The timing of the game is as follows.

In the first stage, firms simultaneously choose their locations.

The second stage is the quantity stage. It involves two sub-stages. In the first one, firms located in country S, if there are any, choose their quantities *ex ante*. In the begining of the second sub-stage, demands are known, then firms located in country W, if there are any, choose their quantities. Firms then perceive their profits.

As usual, the outcome of the subgame perfect equilibrium is got by backward induction.

2.1 the quantity stage

Given the links between EPL and technology, the competitive structure of the quantity stage depends on the locations chosen in the first stage. There are three kinds of subgames: two yielding a Cournot equilibrium (either flexible Cournot or non flexible Cournot) and one yielding a Stackelberg equilibrium. This latter corresponds to each subgame following heterogenous locations: the firm located in country S choosing its quantity *ex ante* whereas its rivals produces *ex post* and then adjust its quantity to that of the other firm, the former firm becomes a Stackelbreg leader whereas its competitor becomes a Stackleberg follower.

Appendix 1 provides the calculations of equilibria.

2.1.1 The flexible Cournot equilibrium

This equilibrium occurs when both the firms are located in country W.

The equilibrium expected profit of each firm is then:

$$CF = cf + cf_t = [a^2 + (a-t)^2]/9 + (\sigma_S^2 + \sigma_W^2)/9 \tag{1}$$

2.1.2 The non flexible Cournot equilibrium

This equilibrium occurs when both the firms are located in country S.

The equilibrium expected profit of each firm is then:

$$CNF = cnf + cnf_t = [a^2 + (a-t)^2]/9 \tag{2}$$

2.1.3 The Stackelberg equilibrium

This equilibrium occurs when a firm (say firm A) is located in country S whereas the other firm (say firm B) is located in country W.

Indeed, as already mentioned, firm B can adjust its output level to uncertainty whereas firm A has not this possibility and has to produce *ex ante*. So, firm A is the Stackelberg leader and firm B is the follower.

The equilibrium expected profit are then :

- for the leader:

$$L^{RD} = l + l_t = [(a+t)^2 + (a-2t)^2]/8 \tag{3}$$

-for the follower:

$$F^{RD} = f + f_t = [(a+2t)^2 + (a-3t)^2]/16 + (\sigma_S^2 + \sigma_W^2)/4 \tag{4}$$

Superscript RD stands for reciprocal dumping in reference to Brander Krugman work (1983).

2.2 the location stage

In the first stage, firms simultaneously choose their locations. These decisions are taken *ex ante* on the basis of expected profits that will be earned in the second stage for each locations pair.

The following matrix gives the expected profits given the locations (either in country S or W).

		firm B	
		S	**W**
firm A	**S**	CNF, CNF	L^{RD}, F^{RD}
	W	F^{RD}, L^{RD}	$CF, CF,$

There are four cases:

i) if $L^{RD} > CF$ and $F^{RD} > CNF$, there are two location equilibria: (S, W) and (W, S),

ii) if $L^{RD} < CF$ and $F^{RD} > CNF$, the only equilibrium is (W, W),

iii) if $L^{RD} > CF$ and $F^{RD} < CNF$, the only equilibrium is (S, S),

iv) if $L^{RD} < CF$ and $F^{RD} < CNF$, there are two location equilibria:(S, S) and (W, W) but the latter pareto-dominates the former.

We then presume that in this latter case, both firms locate in country W.

Thus, the location equilibria are:

- one firm locates in each country if $L^{RD} > CF$ and $F^{RD} > CNF$
- both the firms locate in country W if $L^{RD} < CF$
- both the firms locate in country S if $L^{RD} > CF$ and $F^{RD} < CNF$

A Stackelberg equilibrium therefore arises if and only if $\frac{1}{36}\left(14a^2 - 14at - 101t^2\right) \equiv f(t) < \sigma_S^2 + \sigma_W^2 < \frac{1}{8}\left(2a^2 - 2at + 37t^2\right) \equiv g(t)$.

In this equilibrium, the firm located in country S earns a higher expected profit than its competitor if and only if $L^{RD} > F^{RD} \Leftrightarrow \frac{1}{4}\left(2a^2 - 2at - 3t^2\right) \equiv h(t) > (\sigma_S^2 + \sigma_W^2)$, that is if trade costs are not too high.

Figure 1 maps the location equilibria.

($\sigma_S^2 + \sigma_W^2$ is called total uncertainty, a=1))

<insert figure 1 here>

Proposition 2 *When markets are internationally separated,*

1- a dispersion equilibrium (a Stackelberg equilibrium) emerges if and only if parameters are such as $f(t) < \sigma_S^2 + \sigma_W^2 < g(t)$. *(zones 1 and 2 in figure 1)*[4]

In the Stackelberg equilibrium, the higher expected profit is that of the firm located in the country with the strongest EPL (i.e. the Stackelberg leader) if and only if $h(t) > (\sigma_S^2 + \sigma_W^2)$ *(zone 2 in figure 1)*

2- firms agglomerate in country W if and only parameters are such as $\sigma_S^2 + \sigma_W^2 < g(t)$

3- firms agglomerate in country W in the other cases.

2.3 the roles played by strategic interaction, trade costs, and "total uncertainty"

Considering zero trade costs enables us to isolate the combined roles of uncertainty and strategic interaction. It should be noted that the case of null trade costs is similar to that studied in the Spencer-Brander model.[5] As already mentioned, the quantity equilibrium in each subgame results from a trade-off between the strategic advantage tied to quantity commitment and the informational benefit provided by flexibility. So, in each subgame following heterogeneous locations, the committed firm earns a higher expected profit than its flexible rival if the level of uncertainty is low enough. But, when $t = 0$, the firm earning the lower expected profit in the dispersion (*i.e.* Stackelberg) configuration find it better to locate in the same country than its rival, that is, in country W (respectively, S) for high (respectively, low) enough level of total uncertainty, so that only agglomeration equilibria can emerge. These location equilibria are represented on the y- axis in figure 1.

Looking at open-loop equilibria in the quantity stage enables us to isolate the role played by trade costs. Open-loop equilibria rely on the assumption that firms choose their quantities without taking into account the strategic effect of such decisions. As seen above, the strategic impact of quantity decision concerns the committed firm facing a flexible competitor. The open-loop assumption means then that the firm located in country S (say firm A) chooses for market k the quantity which maximizes the expected profit it earns on this market, without anticipating the reaction function of firm B.

Appendix 2 provides the equilibrium calculations under this assumption.

Figure 2 maps the location equilibria resulting from this assumption. This permits to highlight the pure effect of trade costs on location decisions: trade costs favor dispersion equilibrium for a given level of uncertainty, so high enough trade costs counterbalance the informational advantage tied to flexibility.

<insert figure 2 here>

[4] The relative values of t which allow the emergence of the dispersion equilibria are not so high than they might seem. Indeed, the model runs with a marginal cost of producing equal to zero. Taking c as a strictly positive marginal cost of producing would consist in to replace a by $a - c$ in each equation. The x-axis in figure 1 would be $t/(a - c)$ instead of t/a.

[5] The Spencer-Brander model consider a unique market, that corresponds in our model to $t = 0$, $\sigma_S^2 = \sigma_W^2 = \sigma^2$ (then $\sigma_S^2 + \sigma_W^2 = 2\sigma^2$) and to a demand intercept equal to $2a$.

The combined roles of trade costs and strategic interaction work as follows.

As trade costs protect in some extent the domestic market from foreign competition when firms locate in different countries (in the way that they give the domestic firm a cost advantage), the Stackelberg expected profits of both firms are increasing in trade costs. On the other hand, when both the firms locate in the same country, none of them get a cost advantage on its competitor and the competition becomes maximum on each market. As firms have to incur trade costs in serving their foreign markets, the Cournot expected profits are decreasing in trade costs. All that explains why sufficiently large enough trade costs are needed for preventing firms to deviate from Stackelberg duopoly to Cournot duopoly and then to allow the emergence of a Stackelberg equilibrium.

An interesting consequence of this result is tied to transport costs: if trade costs are mainly transport costs, a dispersion equilibrium becomes more likely, given that trade costs are expected to rise due to increasing energy costs.

Concerning the differential in expected profits which arises in the dispersion equilibrium, it should be noted that the domestic market protection due to trade costs is stronger the foreign competitor's output is higher. Therefore, such protection is more beneficial to the Stackelberg follower which tends to produce less than the leader, and explains why $L - F$ is decreasing in trade costs.

Another point meriting to be clarified is why total uncertainty matters whereas the differential in uncertainties does not matter in determining the location equilibria. Understanding this point needs to remark that the expected profit of a flexible firm involves two independent parts. The first part may be called the informational benefit, which Oï (1961) has shown to be increasing in uncertainty. It results from the convexity of the quantity equilibrium profit in the random variable and yields an expected profit increasing in the variance of the random variable. The second part is what Lecostey(1994) called the "comparable certain profit", that is, the profit that would be earned, under the same competitive structure (either Cournot or Stackelberg), by a flexible firm facing a demand which intercept equals the expected value of the random intercept. Trade costs affects only the "comparable certain profit", explaining why the differential in uncertainty does not matter in determining the location equilibria.

The model provides the following interesting interpretation that could be used in empirical works. If market integration can be thought as a reduction in trade costs (represented as an horizontal shift in figure 1), it can be expected that an increased market integration favors agglomeration in the country with the lowest EPL when the sectoral uncertainty is high, whereas it results in agglomeration in the country with the strongest EPL when the sectoral demand uncertainty is lower. This is due to strategic behavior of firms, since the reduction of trade costs always favors agglomeration in the country with the lowest EPL, as seen under the open- loop assumption. Unfortunately, the existing empirical works studying the effect of EPL on FDI [6] do not permit to check

[6] Empirical literature conclude generally that the employment protection deters inward

these predictions in so far as firstly, these studies generally work on national aggregate data rather than on sectoral data, and secondly, they never introduce a proxy of (permanent) uncertainty as an explanatory variable.

2.4 section conclusion

In this section, only two extreme cases of flexibility were considered: perfect flexibility -*i.e.* costless *ex post* adjustement in quantities- and whole lack of flexibility -which corresponds to some infinite *ex post* adjusment costs.

This framework enables us to highlights the trade-off between flexibility and strategic commitment without having to introduce additionnal parameters to represent differences in flexibility.

In such a framework very favorable to flexibility,[7] it was shown that the country with the strongest EPL can nevertheless attract firms, and the domestic firm can get an higher expected profit than his foreign (flexible) competitor.

3 alternative or additional assumptions

This section relaxes or alters some assumptions of the above section and and checks whether an equilibrium where some firms locate in the country with the strongest EPL can yet emerge.

3.1 Employment protection legislation and technologies

In section 2, it was assumed that EPL constrained the domestic firms technology: in the country with a strong EPL (country S), volume flexibility was prohibited, whereas in the country with weak EPL (country W), firms were allowed to adjust their output.

However, it can be thought that a firm located in country W might choose to commit itself to some output volume by offering stable contract to its employees and adopting a non flexible technology.[8]

Under such an assumption, two new kinds of equilibria must be taken into account in the quantity stage.

FDI (Görg 2005, Nicoletti Golug Hajkova Mirza Yoo 2003, Javorcik Spatareanu 2005, Dewit Görg Montagna 2009)), favors domestic anchorage (Dewit Görg Montagna 2009) or that there exist a nonlinear effect (u-shaped) between employment protection level and FDI (Radulescu Robson 2003).

[7] The reader could easely check that in such a framework, a monopoly always would choose flexibility (*i.e.* to locate in the country with the weakest EPL) as soon as there was some demand uncertainty.

Further, in a duopolistic setting, the fact that committed firms cannot increase ex post their outputs favors agglomeration equilibria to detriment of dispersion equilibria, as might be expected from comments done in note 2.

[8] The assumption that weak EPL constrains the domestic firms to be flexible relies on the hypothesis that, due to the positive connotation that the term flexibility has, firms' managers may have some difficulties to convince shareholders that it could be better to renounce to flexibility. The present subsection relaxes this assumption.

In the first one, although there is a firm in each country, the firm located in country W adopts a non flexible technology (like its foreign competitor).

The equilibrium is then a (non flexible) Cournot one with some reciprocal dumping and corresponds to the non flexible Cournot equilibrium of appendix 1 with taking $c_A = 0$ and $c_B = t$ on market S and the reverse on market W.

The equilibrium expected profit of a firm is then:

$$CNF^{RD} = [(a-2t)^2 + (a+t)^2]/9$$

Note that $CNF^{RD} > CNF$. Since there is a firm in each country, each of them get a cost advantage on his domestic market due to trade costs and therefore perceives a higher expected profit than it earned in the case described in section 2 where both the non flexible firms locate in country S.

The second kind of equilibrium which may occur is that where both the firms are located in country W but have chosen different technologies. This yields a Stackelberg equilibrium in which expected profit are got by taking $c_A = c_B = 0$ on market W and $c_A = c_B = t$ on market S.

Then the expected profit are:

- for the leader:

$$L = [a^2 + (a-t)^2]/8$$

-for the follower:

$$F = [a^2 + (a-t)^2]/16 + (\sigma_S^2 + \sigma_W^2)/4$$

Note that $L < L^{RD}$ and $F < F^{RD}$ since none of the firm has a cost advantage on any market.

Assuming that the choices of location and that of technology (when this latter is allowed) are made simultaneously, the expected profit matrix to take into account for the location and technoloy stage becomes:

		firm B		
		S	W_F	W_{NF}
	S	CNF, CNF	L, F	CNF^{RD}, CNF^{RD}
firm A	W_F	F^{RD}, L^{RD}	$CF, CF,$	F, L
	W_{NF}	CNF^{RD}, CNF^{RD}	L^{RD}, F^{RD}	CNF, CNF

Strategy W_F (respectively W_{NF}) of a firm denotes that this firm locates in country W and adopts the flexible technology (respectively, the non flexible technology).

Given that $CNF^{RD} > CNF$, there is neither an equilibrium where both firms locates in country W and adopt the non flexible technology, nor an equilibrium where both firms choose to locate in country S..

Moreover, $L < L^{RD}$ and $F < F^{RD}$ imply that there is no equilibrium where both the firms locate in country W and choose different technologies.

There are then three kinds of (location and technology) equilibria:

i) the equilibria are (S, W_F) or $(W_F, S) \Leftrightarrow CNF^{RD} < F$ and $L^{RD} > CF$

$\Leftrightarrow \frac{1}{36}\left(14at - 14a^2 + 37t^2\right) \equiv f_3(t) < \sigma_S^2 + \sigma_W^2 < \frac{1}{8}\left(-2at + 2a^2 + 37t^2\right) \equiv g_3(t)$.

ii) the equilibrium is $(W_F, W_F) \Leftrightarrow L^{RD} < CF \Leftrightarrow g_3(t) < \sigma_S^2 + \sigma_W^2$.[9]

iii) the equilibria are (S,W_{NF}) or $(W_{NF}, S) \Leftrightarrow CNF^{RD} > F^{RD}$ and $L^{RD} > CF \Leftrightarrow \frac{1}{36}\left(-14at + 14a^2 - 37t^2\right) \equiv f_3(t) > \sigma_S^2 + \sigma_W^2$ and $g_3(t) > \sigma_S^2 + \sigma_W^2$.

Figure 3 maps these equilibria.

($\sigma_S^2 + \sigma_W^2$ is called total uncertainty,$a = 1$)

Proposition 3 *If weak EPL does not constrain the domestic firms technology,*

- the conditions for emergence of a Stackelberg equilibrium becomes a little stronger, but there yet exist some parameters' values yielding such a dispersion equilibrium (zones 1 and 2 in figure 3)

- firms never agglomerate in country S. But, there arises a new equilibrium. In this equilibrium, firms locate in different countries and the firm located in country W adopts the non flexible technology (zone 3 in figure 3).

3.2 flexibility

3.2.1 Allocation flexibility

In section 2, firms located in country S were assumed to have no volume flexibility and hence to be unable to perceive an informational benefit. For the sake of simplicity, it was assumed that such firms had to choose *ex ante* the quantities they will sell on each market. In fact, firms can choose *ex post* the allocation of their production between the two markets altough they can not adjust their global output volume.[10]

It should be noted that such an allocation flexibility is not valuable for a perfectly flexible firm which is able to adjust *ex post* and costlessly the quantity it produces for each market.

So, let us consider that firms located in country S choose *ex post* the allocation of their output which quantity has been chosen *ex ante*.

In a subgame following heterogenous locations, the firm located in country S (say A) therefore chooses *ex ante* a total quantity q_A and *ex post* q_{SA} for market S and q_{WA} for market W under the constrain that $q_{SA} + q_{WA} = q_A$, whereas the firm located in market W (say B) chooses *ex post* q_{SB} for market S and q_{WB} for market W.

The profit functions are then:

$\pi_A = (a+\varepsilon_S - q_{SA} - q_{SB})q_{SA} + (a+\varepsilon_W - t - (q_A - q_{SA}) - q_{WB})(q_A - q_{SA})$

and $\pi_B = (a+\varepsilon_S - t - q_{SA} - q_{SB})q_{SB} + (a+\varepsilon_W - (q_A - q_{SA}) - q_{WB})q_{WB}$

The first order conditions for maximizing *ex post* profits are then:

[9] If $f_3(t) > \sigma_S^2 + \sigma_W^2 > g_3(t)$, there are three location equilibria: (S,W_{NF}),(W_{NF}, S), and (W_F, W_F), but (W_F, W_F) pareto-dominates the other if and only if $(\sigma_S^2 + \sigma_W^2) > 4t^2$, which is the case in this zone.

[10] The absence of allocation flexibility in the basic model permits to highlight that such a flexibility is not needed for the emergence of the dispersion equilibrium.

- for firm A:

$$(a + \varepsilon_S - 2q_{SA} - q_{SB}) - (a + \varepsilon_W - t - 2(q_A - q_{SA}) - q_{WB}) = 0$$

- for firm B:

$$a + \varepsilon_S - t - q_{SA} - 2q_{SB} = 0$$

$$a + \varepsilon_W - (q_A - q_{SA}) - 2q_{WB} = 0$$

That yields the following *ex post* quantities:

$$\begin{aligned} q_{SA} &= (\varepsilon_S - \varepsilon_W + 3t + 3q_A)/6 \\ q_{SB} &= (6a + 5\varepsilon_S + \varepsilon_W - 9t - 3q_A)/12 \\ q_{WB} &= (6a + \varepsilon_S + 5\varepsilon_W + 3t - 3q_A)/12 \end{aligned}$$

When choosing *ex ante* q_A, firm A anticipates these quantities.
The quantity maximizing its derived expected profit is $q_A = a - t/2$.
This yields the following expected profits in the subgame equilibrium:

$$\begin{aligned} E\pi_A &= (4a^2 - 4at + 9t^2)/16 + (\sigma_S^2 + \sigma_W^2 - 2\rho\sigma_S\sigma_{WS})/18 \equiv L^{AF} \\ E\pi_B &= (4a^2 - 4at + 17t^2)/32 + (13\sigma_S^2 + 13\sigma_W^2 + 10\rho\sigma_S\sigma_{WS})/72 \equiv F^{AF} \end{aligned}$$

where ρ is the correlation coefficient.

In the subgame in which both firms are in country S, the equilibrium expected profits are also modified in the extent that each firm chooses *ex ante* a total quantity to produce and *ex post* the allocation of this production between the two markets.

Given that, and given the transport costs, profits can be written as: $\pi_A = (a+\varepsilon_S - q_{SA} - q_{SB})q_{SA} + (a+\varepsilon_W - t - (q_A - q_{SA}) - (q_B - q_{SB}))(q_A - q_{SA})$ and $\pi_B = (a+\varepsilon_S - q_{SA} - q_{SB})q_{SB} + (a+\varepsilon_W - t - (q_A - q_{SA}) - ((q_B - q_{SB})))((q_B - q_{SB}))$

The first order conditions for maximizing *ex post* profits are then:

- for firm A:

$$(a + \varepsilon_S - 2q_{SA} - q_{SB}) - (a + \varepsilon_W - t - 2(q_A - q_{SA}) - (q_B - q_{SB})) = 0$$

- for firm B:

$$(a + \varepsilon_S - q_{SA} - 2q_{SB}) - (a + \varepsilon_W - t - (q_A - q_{SA}) - 2(q_B - q_{SB})) = 0$$

That yields the following *ex post* quantities in market S:

$$q_{SA} = (\varepsilon_S - \varepsilon_W + t + 3q_A)/6, \quad q_{SB} = (\varepsilon_S - \varepsilon_W + t + 3q_B)/6$$

Firms choose simultaneously their quantities, q_A and q_B , which maximizise their expected profits.

These optimal quantities are $q_A = \frac{2}{3}a - \frac{1}{3}t$ and $q_B = \frac{2}{3}a - \frac{1}{3}t$:

The equilibrium expected profits are:

$$E\pi_A = E\pi_B = (2a^2 - 2at + t^2)/9 + (\sigma_S^2 + \sigma_W^2 - 2\rho\sigma_S\sigma_{WS})/18 \equiv CAF$$

The expected profits matrix available for the first stage decisions becomes then:

		firm B	
		S	***W***
firm A	***S***	CAF, CAF	L^{AF}, F^{AF}
	W	F^{AF}, L^{AF}	CF, CF

An heterogenous location equilbrium emerges $\Leftrightarrow$ $L^{AF} > CF$ and $F^{AF} > CAF$ i.e. $\Leftrightarrow$

$\frac{1}{36}\left(-28at + 28a^2 - 121t^2\right) \equiv f_4(t) < \left(\sigma_S^2 + \sigma_W^2 + 2\rho\sigma_S\sigma_{SW}\right) < \frac{1}{8}\left(-4at + 4a^2 + 65t^2\right) \equiv g_4(t)$

In this equilibrium, the leader expected profit is the higher $\Leftrightarrow$ $\frac{1}{4}(2a - t)^2 \equiv h_4(t) > \left(\sigma_S^2 + \sigma_W^2 + 2\rho\sigma_S\sigma_{SW}\right)$

Figure 4 maps these equilibria.

($\sigma_S^2 + \sigma_W^2 + 2\rho\sigma_S\sigma_{SW}$ is called total uncertainty, $a = 1$)

Proposition 4 *Allocation flexibility allows a committed firm to get an informational benefit increasing in the negative correlation between demands. Thus, allocation flexibity enhances expected profits earned by committed firms (Stackelberg leader or non flexible Cournot competitor) and reduces that of Stackelberg follower.*

There exist some parameters values which yield such asymmetric location equilibria (zones 1 and 2 in fig 4).

At any asymmetric location equilibrium, the committed firm may get an higher expected profit than its flexible competitor (this occurs in zone 2 in fig 4).

At any asymmetric location equilibrium , the output of the committed firm ($a - t/2$) is always higher than the expected quantity produced by its flexible competitor ($a/2 - t/4$).

3.2.2 costly flexibility or imperfect flexibility

In section 2, firms located in country W were assumed to be able to adjust *ex post* their output without any constrain nor additional cost, while firms located in country S were assumed to be unable to do any *ex post* quantity adjustment.

The present subsection will discuss these assumptions.

Numerous papers in labour economics assume asymmetric adjustment costs in order to represent that, under weak EPL, firing is easier (or less costly) than hiring, especially for skilled labor or when labor market is tight. Such an assumption might be relaxed for non skilled labour or when unemployment rate is high. Moreover, from a theoretical point of view, the assumption of asymmetric adjustment costs seems to be relevant when there is an intertemporal

dependence between the random values. The aim of the present paper is to analyze what happens under fluctuating demand, fluctuating demand meaning here that the random values of demand are not temporally dependant. Thus, this framework is not designed for analyzing adjustments undertaken after a single shock nor -when relevant- these occurring once this shock has disappeared. Rather, this framework can be thought as consistent with the facts having led to experience rating in some countries of United States.

A second possible way for taking into account imperfect flexibility is to assume that flexibility leads to an increased marginal cost. Two alternative interpretations are possible. The first follows Stigler idea that "flexibility is not a free good" (Stigler , 1939). The higher marginal cost associated with flexibility can be assumed to result from transaction costs or some additional organization costs and/or higher wages to pay to temporary workers. The second possible interpretation assumes that firms located in the country with the stronger EPL adopt a more capital intensive technology which yields lower cost in varying ex ante production (thus, a lower marginal cost) in return for an higher fixed cost. Whatever the interpretation, when firms locate in different countries, the non flexible firm gets an additional strategic advantage on its flexible competitor. This advantage adds on that tied to the commitment value, and leads to an higher differential in expected profits in favor to the leader ($L^{RD} - F^{RD}$ is then higher than it was in the basic model of section 2). From their part, the expected profits earned in the flexible Cournot model (CF) become lower (due to increased marginal costs of producing) whereas these earned in the non flexible Cournot model (CNF) remain unchanged. So, if the higher marginal cost of producing with the flexible technology is not tied to a lower fixed cost, the non flexible Cournot equilibrium is more likely to appear in detriment to both Stackelberg and flexible Cournot equilibria, and the differential in expected profits between the leader and the follower is increased (when the Stackelberg equilibrium emerges). Taking into account the eventual additional fixed cost associated with the non flexible technology- fixed cost which matters only in the location stage- leads to temperate these conclusions.

4 conclusion

This paper analyzed the effect that different employment protection legislations (EPL) across countries have on location of oligopolistic firms facing fluctuating demands.

It yielded three main results.

The first is that the country with the strongest EPL may attract firms (either in an agglomeration equilibrium, or in an asymmetric location equilibrium).

The second is that, when firms have chosen to locate in countries with different strengths of EPL, the firm located in the country with the strongest EPL may earn a higher expected profit than its foreign competitor.

The third is that in any asymmetric location equilibrium, the output level -and thus the employment level- is always higher in the country with the stronger

EPL.

Strategic considerations from the firms play an important role in the differential in expected profits which exists in the asymmetric location equilibria such as in the existence of such equilibria. As a general rule as suggested in section 3, it should be noted that everything that increases the differential in expected profits which arises in the asymmetric equilibrium makes such an equilibrium less likely to emerge.

All these results were obtained in an oligopoly setting. As it is well established that international transactions (exports, FDI) are mainly due to a few large firms, such a framework seems to be appropriate. Moreover, it should be noted that the core problem addressed here is how EPL constraints the accommodation ability of firms facing a "permanent" demand uncertainty (which was called a fluctuating demand) and not their ability to adapt to a single shock of significant magnitude. This may disturb the reader more familiar with the latter problem.

In this model, a stage where countries could choose their EPL levels has not been introduced. The reason is that a level of EPL is chosen for the whole country: it applies to all industries, oligopolistic industries as well as to more competitive ones, industries subject to a high level of demand uncertainty as well as industries characterized by a low uncertainty. Thus, the partial equilibrium framework adopted here does not allow examining the stage of choice of EPL. For such a purpose, a general equilibrium framework would be needed.

Thus, the present paper does not result in recommendations in terms of economic policy. However, it invites analysts and policy makers to also take into account of the consequences which may arise from the oligopolistic nature of international competition.

5 appendix 1: Stackelberg and Cournot equilibria with (or without) asymmetric costs

Denote π_i the profit function of firm i on market k , q_i (respectively q_j) the firm i's (respectively firm j's) output, ε_k the demand intercept on market k, c_i the firm i's marginal cost incurred in serving market k (including production cost and, when relevant, trade cost).

$$\pi_i = (a + \varepsilon_k - c_i - q_i - q_j)q_i, j \neq i$$

5.1 Cournot équilibrium

5.1.1 Flexible Cournot equilibrium

In the flexible Cournot equilibrium, firms choose their quantities *ex post* (*i.e.* after knowing ε_k) and simultaneously

$$q_i = R_i(q_j) = \arg\max_{q_i} \pi_i = (a + \varepsilon_k - c_i - q_j)/2,\ j \neq i,\ i = 1, 2$$

The equilibrium quantity of firm i is then:

$$q_i = (a + \varepsilon_k - 2c_i + c_j)/3$$

Its equilibrium expected profit is

$$E(\pi_i) = (a - 2c_i + c_j)^2/9 + \sigma_k^2/9$$

5.1.2 Non flexible Cournot equilibrium

In the non flexible Cournot equilibrium, firms choose their quantities *ex ante (i.e.* before knowing ε_k) and simultaneously.

Firm i maximizes its expected profit ($E\pi_i = (a - c_i - q_i - q_j)q_i$, $j \neq i$) given the output of firm.j.

$$q_i = R_i(q_j) = \arg\max_{q_i} E\pi_i = (a - c_i - q_j)/2,\ j \neq i,\ i = 1, 2$$

The equilibrium quantity of firm i is:

$$q_i = (a - 2c_i + c_j)/3$$

Its equilibrium expected profit is

$$E(\pi_i) = (a - 2c_i + c_j)^2/9$$

5.2 Stackelberg equilibrium

In the Stackelberg equilibrium, the leader is the non flexible firm (say A) and the follower is the flexible firm (say B).

Firm B chooses its quantity *ex post (i.e.* after knowing ε_k) given q_A

$$q_B = R_B(q_A) = \arg\max_{q_B} \pi_B = (a + \varepsilon_k - c_B - q_A)/2$$

Firm A anticipates that. Its expected profit is then:

$E\pi_A = E([a+\varepsilon_k - c_A - q_A - R_B(q_A)]q_A) = [a - c_A - q_A - (a - c_B - q_A)/2]q_A = \frac{1}{2}q_A\left(a - 2c_A + c_B - q_A\right)$.

As firm A cannot adjust its production *ex post*, it has to choose its output *ex ante (i.e.* before knowing ε_k).

Firm A's output choice is then :

$$q_A = \arg\max_{q_A} E\pi_A = (a + c_B - 2c_A)/2$$

The follower's equilibrium quantity is then

$$q_B = R_B(q_A) = (a + 2\varepsilon_k + 2c_A - 3c_B)/4$$

The equilibrium expected profit are:

$$E(\pi_A) = (a + c_B - 2c_A)^2/8$$

$$E(\pi_B) = (a + 2c_A - 3c_B)^2/16 + \sigma_k^2/4$$

5.3 expected profit in the quantity stage equilibrium

Given the above calculations, and assuming that markets are separed (segmentated), that marginal cost of producing are equal to 0, and that the unit cost for serving foreign market is t, the following expected profit are obtained in the output stage equilibrium, according to the firm's competitive status (row) and the market (colomn):

firm's competitive status	home market	foreign market
flexible Cournot competitor	$cf = (a)^2/9 + \sigma_k^2/9$	$cf_t = (a-t)^2/9 + \sigma_k^2/9$
non flexible Cournot competitor	$cnf = (a)^2/9$	$cnf_t = (a-t)^2/9$
Stackelberg leader	$l = (a+t)^2/8$	$l_t = (a-2t)^2/8$
Stackelberg follower	$f = (a+2t)^2/16 + \sigma_k^2/4$	$f_t = (a-3t)^2/16 + \sigma_k^2/4$

6 appendix 2: openloop equilibria

The question here is to determine if an equilibrium where firms locate in different countries is due to the strategic behavior of the firm located in country S.

To study that, let us consider an openloop assumption in each subgame where firms locate in different countries.

This assumption means that the firm moving *ex ante* chooses its quantity without being aware of the strategic effect that its commitment has on its flexible competitor's output. That is, when there is a firm in each country, the firm located in country S (say firm A) chooses for market k the quantity which maximizes the expected profit it earns on this market, without anticipating the reaction function of firm B. .

$$E\pi_A = E(a + \varepsilon_k - c_A - q_A - q_B)q_A = (a - c_A - q_A - E(q_B))q_A$$

$$q_A = \arg\max E\pi_A = (a + \varepsilon_k - c_A - E(q_B))/2$$

From its part, firm B's reaction function remains unchanged:

$$q_B = R_B = (a + \varepsilon_k - c_B - q_A)/2$$

so that .

$$E(q_B) = (a - c_B - q_A)/2$$

So, in the quantity equilibrium, the (expected) outputs on market k are $q_A = (a + c_B - 2c_A)/3$ and $E(q_B) = (a - c_A + 2c_B)/3$.

Given the trade costs, the total expected profits earned in this subgame are:

- for the committed firm: $\left[(a+t)^2 + (a-2t)^2\right]/9 = CNF^{RD}$,

- for the flexible firm firm: $\left[(a+t)^2 + (a-2t)^2\right]/9 + (\sigma_H^2 + \sigma_L^2)/9 \equiv CF^{RD}$.

The matrix of expected profits available for the first stage decisions becomes then:

		firm B	
		S	W
firm A	S	CNF, CNF	CNF^{RD}, CF^{RD}
	W	CF^{RD}, CNF^{RD}	CF, CF

As $CF^{RD} > CNF$, the location equilibria are:

- (S, W) and $(W, S) \Leftrightarrow CNF^{RD} > CF \Longleftrightarrow 4t^2 > (\sigma_S^2 + \sigma_W^2)$

- $(W, W) \Leftrightarrow CNF^{RD} < CF \Longleftrightarrow 4t^2 < (\sigma_H^2 + \sigma_L^2)$

So, if the committed firm does not take into account the strategic effect of its quantity when choosing its output, the only equilibria which emerge are these where firms locate in different countries $\Longleftrightarrow 4t^2 > (\sigma_S^2 + \sigma_W^2)$.

In such equilibria, the committed firm perceives a lower expected profit than its flexible competitor ($CF^{RD} > CNF^{RD}$).

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8 figures

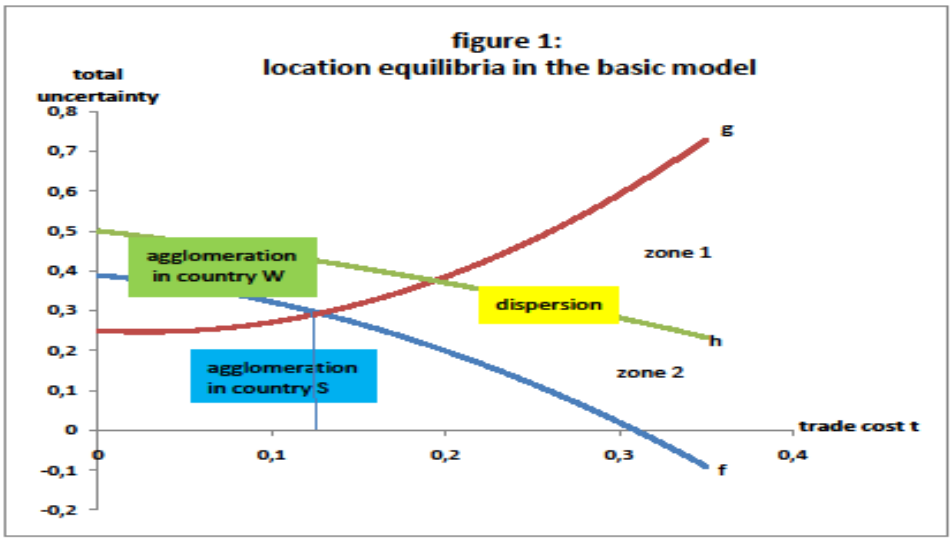
figure 1:
location equilibria in the basic model
total uncertainty
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
-0,1
-0,2
0
0,1
0,2
0,3
0,4
trade cost t
g
h
f
zone 1
zone 2
agglomeration in country W
dispersion
agglomeration in country S

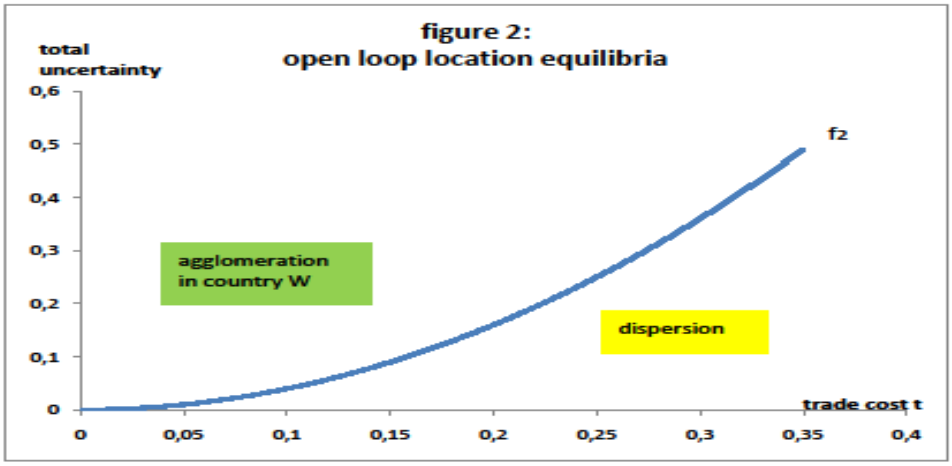
figure 2:
open loop location equilibria
total uncertainty
0,6
0,5
0,4
0,3
0,2
0,1
0
0
0,05
0,1
0,15
0,2
0,25
0,3
0,35
0,4
trade cost t
f2
agglomeration in country W
dispersion

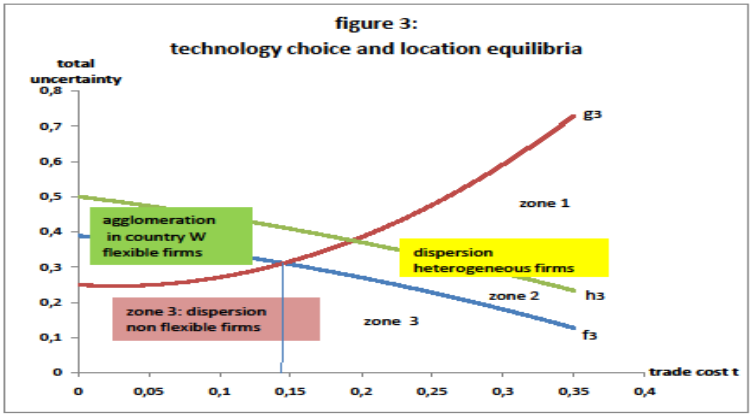
figure 3:
technology choice and location equilibria
total uncertainty
0,8
0,7
0,6
0,5
0,4
0,3
0,2
0,1
0
g3
zone 1
agglomeration in country W flexible firms
dispersion heterogeneous firms
zone 2
h3
zone 3: dispersion non flexible firms
zone 3
f3
trade cost t
0
0,05
0,1
0,15
0,2
0,25
0,3
0,35
0,4

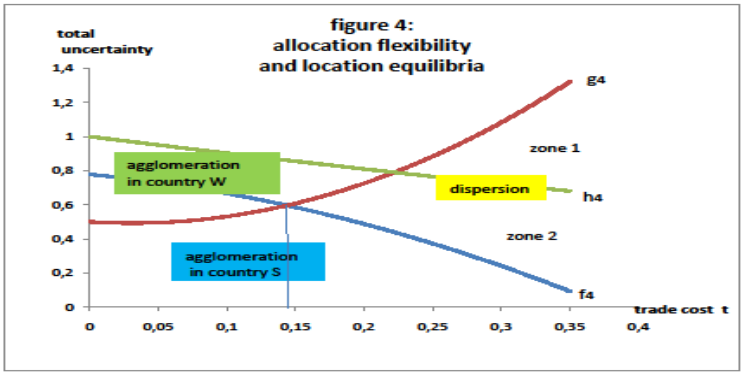
figure 4:
allocation flexibility
and location equilibria
total uncertainty
1,4
1,2
1
0,8
0,6
0,4
0,2
0
g4
zone 1
agglomeration in country W
dispersion
h4
zone 2
agglomeration in country S
f4
trade cost t
0
0,05
0,1
0,15
0,2
0,25
0,3
0,35
0,4