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INSECURE? THE WAY OUTSOURCING  
AMPLIFIES UNCERTAINTY**

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***INDUSTRIAL ORGANIZATION  
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## ABSTRACT

### Why is a Flexible World More Insecure? The Way Outsourcing Amplifies Uncertainty\*

This Paper presents a macroeconomic model where firms may endogenously outsource part of their production process. We start from the premise that adaptation to uncertainty cannot be contracted upon in the worker-employer relationship. Outsourcing decisions then balance flexibility gains against hold-up costs of opportunistic behaviour by outside contractors. In equilibrium, the degree of outsourcing is shown to depend on the degree of product market competition, contractor's bargaining power, and the volatility of demand shocks. Our main result is that an increase in the degree of outsourcing amplifies the volatility of firm sales and employment; it does not, however, amplify aggregate uncertainty. This theory is therefore a good candidate in explaining the rise in firm level uncertainty witnessed in the US over the past 30 years. It also provides valuable insights on the relation between globalization, technical change, firm level uncertainty and job instability. Finally, we bring our theory's implications to the test. Evidence from firm level data is shown to be largely consistent with the main implications of our theory.

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# 1 Introduction

It is a common view among practitioners of the firm that outsourcing improves corporate flexibility. Because outside suppliers are given stronger incentives to adapt, vertical separation allows to adapt demand shifts in a better way. This paper starts from such premises, to assess the determinants of outsourcing and its links with firm level uncertainty. The main result of our theoretical and empirical investigations is that outsourcing amplifies demand shocks by increasing the firm-level volatility of profits and employment.

An emerging literature documents the recent rise in the uncertainty of corporate environment within industrialized economies (Comin [2000], Thesmar and Thoenig [2000]). Three stylized facts have been established. Firstly there are indirect signs that firm level labor demand fluctuates nowadays more than in the past: There has been an increase in the short run volatility of labor earnings (Gottschalk and Moffit [1994]) and some authors have documented an increase in job turnover, at least for some skill groups in the US (Neumark [2000]), and for all kinds of workers in France (Givord and Maurin [2001]). Consistently with this, workers now perceive their positions as more insecure than ever (OECD [1997]). Secondly more direct evidence about trends in firm level uncertainty is available from the returns to capital. A recent paper by Campbell et al [2001] documents an increase in stock returns volatility over the past four decades, which they interpret as a rising volatility of firm-level cash flows. The third fact is that this rise in uncertainty is not driven by larger aggregate shocks but rather by what seems to be larger idiosyncratic shocks<sup>1</sup>. The interest of our theory is that it pinpoints a common explanation for all these facts: the recent trend in outsourcing and fragmentation of production processes.<sup>2</sup> Therefore, it suggests how globalization, by enabling fragmentation, may have indirectly increased the degree of firm level uncertainty. Moreover, even within relatively closed economies, we believe our theory may provide an explanation of how increased product market competition, or technical change enabling outsourcing, may also have contributed to the rise in uncertainty.

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<sup>1</sup>A striking illustration of this fact is provided by Campbell and al. [2001], who decompose the volatility of stocks return in three parts: a market, an industry, and a firm specific component. Their analysis shows that the increase in stocks returns volatility they witness is fully accounted for by the changes in the last component. To explain this, they end up exploring various hypotheses: a rise in idiosyncratic uncertainty of firm level cash flows seems the most plausible.

With respect to labor market evidence, Gottschalk and Moffit [1994] conclude their analysis by stating that most of the increase in transitory variance of earnings appears to have incurred at the individual level and cannot be linked to any macroeconomic or industry-level changes. More broadly, the literature on US wage inequality documents that a large share (some two thirds) of the recent spread of the wage distribution is accounted for by the so-called “within-group” part (see e.g. June et al [1993]). In other words, wage inequality has risen, even among very similar workers. Three explanations can be put forward. First, workers have become more heterogenous (this is the lead followed by Aghion et al. [2001]). Second, firms have become more heterogenous (the focus of the present paper). Third, there is increased correlation between firm quality and workers quality (Kremer and Maskin [1996]).

<sup>2</sup>This trend has been widely documented in the international trade literature (Feenstra [1998] for example).

Our modelling of outsourcing rests on two core assumptions. The first one is that firms face demand shocks which require adaptation efforts from the workforce. The second one is that these shocks are, at least partially, non verifiable, hence not fully contractible upon information. It is therefore difficult for firms to enforce the ex-post efficient level of efforts undertaken by their workers. By outsourcing some of the production tasks, firms make some of their workers residual claimants on joint output, providing them with the proper incentives to adapt (Grossman and Hart [1986]). In other words outsourcing increases flexibility as it enables firms to switch from ex-ante to ex-post production decisions ( see Jones and Ostroy [1984] for a rigorous analysis of flexibility under uncertainty). However, the bilateral nature of the subcontractor-final producer relation gives rise to a hold up problem. In our model, firms therefore trade off the benefits of flexibility against its costs.

The equilibrium level of outsourcing is shown to depend on the degree of product market competition, final demand uncertainty, and contractor opportunism. In line with the conventional wisdom in business literature the model exhibits a positive relation between product market competition and firm level uncertainty. Indeed, when final demand becomes very sensitive to the price policy of the firm, any ex-post productive inefficiency is highly costly: Hence competition exacerbates the desire for flexibility and outsourcing. Moreover the degree of outsourcing is shown to amplify firm level uncertainty. The intuition is that both parts of the production process are to some extent complement, such that increased flexibility on the subcontractor's side has to be matched with a similar increase on the other (ie. in house production).<sup>3</sup>

General equilibrium analysis then brings two important insights. First, aggregate shocks to the economy are not amplified by the degree of outsourcing - only idiosyncratic shocks are. Hence, in our theory, outsourcing increases idiosyncratic uncertainty, but not aggregate one, consistently with one of the stylized facts mentioned above. Second, because of hold-up inefficiencies, outsourcing is shown to be a positive externality on firm's profits: hence, outsourcing increases profits, and promotes innovation. In turn, if innovation generates uncertainty - as in the model of growth through creative destruction of Aghion and Howitt [1992] for example - then innovation promotes outsourcing. Our model thus generates a positive feedback loop between outsourcing, creative destruction and firm level uncertainty.

The microeconomic predictions of our model are then brought to the test on firm level data. We find a robust positive correlation between various measure of uncertainty and our measure of outsourcing. To test the amplification hypothesis, we then show that firm level sales adapt more to

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<sup>3</sup>The intuition closest to ours can be found in early work by Hartman [1976], who looks at the relation between the firm's ability to adapt to shocks and the degree of substitutability between labor - the adjustable input - and capital, the fixed input.

industry-wide shocks when they outsource a larger part of their production process. Such evidence is robust to various estimation techniques, and extends to measures of labor demand.<sup>4</sup>

This paper builds on two distinct research paths. First, like many others, we build on Grossman and Hart [1986] to model the subcontractor - client relationship. However, our emphasis on flexibility and adaptation takes us closer to a somewhat older literature on outside contracting, starting with Arrow [1975], and Carlton [1979]. This literature's concern however is more on uncertainty in the upstream part of the production process, rather than in final demand volatility. Given our macroeconomic approach, our model may also be related to various contributions that tried to investigate the macroeconomic consequences of outsourcing. Just as we do, Grossman and Helpman [2001,2002] provide a general equilibrium framework with endogenous outsourcing to understand the relation between vertical separation, the extent of competition and trade barriers. Their models rest upon very different microeconomic foundations for the choice of outsourcing, as they do not look at the relation between outsourcing and uncertainty, which is focus of the present paper. Closer to this issue, following intuitions of Means [1932], Basu [1995] proposed a model where firms are clients of each other for their intermediate inputs. With fixed prices of intermediate inputs, macroeconomic shocks are propagated and amplified to all firms through these outsourcing relations, very much like in the basic version of a keynesian multiplier. In Basu's model however, outsourcing is fully exogenous, and the analysis focuses on aggregate fluctuations rather than firm level uncertainty.

Secondly, this paper contributes to the growing debate on the causes and consequences of the rise in corporate uncertainty. This research builds on intuitions expressed two decades ago by Piore and Sabel [1984]. Increased product market uncertainty has compelled firms to reorganize and to adopt more flexible production technologies. Comin [2000] investigates the consequences of this evolution on the productivity slowdown, while Thesmar and Thoenig [2000], Mobius [2000] and Aghion et al. [2001] emphasize both product and labor market issues. Compared to these contributions, the twin novelty of our paper is both to highlight the key role of vertical separation and to provide plausible foundations for the rise in uncertainty. Our theory also has interesting implications on international trade. In this vein, a related contribution is Rodrik [1997,1998]'s analysis of the relation between globalization and volatility. Rodrik's concern, however, is focused the political economy of globalization, while the way globalization increases uncertainty is left not modelled. We believe nonetheless that our theory usefully allows to amend some of his intuitions.

The roadmap of this paper is fairly simple. The next section highlights the key features of the

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<sup>4</sup>Such evidence is consistent with recent results of Mulhainathan and Scharfstein [2001] from the chemical industry. They find that non integrated firms tend to have production capacity that is more sensitive to demand shocks, though they interpret this piece of evidence differently.

model. Section III exhibits the most important predictions of our theory. Section IV brings the results to the test, using French firm level data over the 1984-1999 period. Section V concludes and provides leads for further research.

## 2 The Framework

We consider the case of perfect vertical specialization (Yi, [2002]): the domestic country imports intermediate goods which are combined with goods produced domestically in order to build final goods<sup>5</sup>. Hence, suppliers are abroad, while producers (those who make part of the product, and assemble all intermediate inputs) are in the home country. Part of this final production is exported. To keep the model simple we restrict our analysis to a static small open economy.

### 2.1 Demand

The product market is broken down into a continuum of differentiated varieties  $i \in [0, 1]$ . Agents maximize:

$$U = \left[ \int_0^1 \tilde{\tau}_i y_i^{\frac{\sigma-1}{\sigma}} di \right]^{\frac{\sigma}{\sigma-1}} \text{ where } \sigma > 1$$

where  $E(\tilde{\tau}_i) = 1$ ,  $Var(\tilde{\tau}_i) = \sigma_\tau^2$ ,  $corr(\tilde{\tau}_i, \tilde{\tau}_j) = 0$  for  $i \neq j$ . These stochastic preferences<sup>6</sup> generate uncorrelated idiosyncratic demand shocks that will be the motivation for outsourcing: for the moment we assume no aggregate uncertainty. There is monopolistic competition between varieties such that demand faced by each firm is:

$$\tilde{d}_i = \frac{D}{P^{1-\sigma}} \tilde{\tau}_i p_i^{-\sigma} \text{ where the price index is: } P = \left[ \int_0^1 \tilde{\tau}_k p_k^{1-\sigma} dk \right]^{1/1-\sigma} \quad (1)$$

where  $D$  stands for the total expenditure dedicated to the purchase of final goods. To simplify exposition, we introduce the following intermediate notation :

$$\tilde{T}_i = \frac{D}{P^{1-\sigma}} \tilde{\tau}_i$$

Finally, we assume that the foreign consumer has similar utility than the domestic one. Consequently:

$$D = D^d + D^f \quad (2)$$

where  $D^d$  is domestic spending and  $D^f$  foreign spending. We use  $D$  as the numeraire.

<sup>5</sup>Most of our results could be obtained in closed economy framework. We consider hereafter an open economy in order to highlight the links between globalization, outsourcing and uncertainty.

<sup>6</sup>Instead of assuming stochastic preferences we could assume that the final goods  $y_i$  are in fact intermediate goods which are used to produce a final good  $U$ . In that case the shocks  $\tau_i$  are technological shocks.

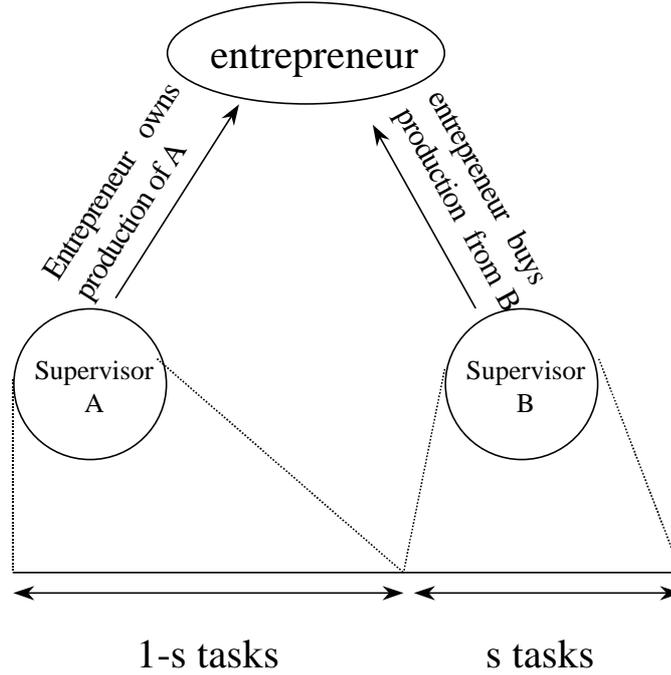


Figure 1: Productive Structure With Outsourcing

## 2.2 Production

Production of a final good  $y_i$  requires a continuum of intermediate tasks  $x_j$  indexed by  $j \in [0, 1]$ . A share  $s$  of these tasks can be outsourced - in the foreign country - whereas the remaining share is produced in-house - domestically. In the following, we call  $s$  the level of fragmentation of the production process. Each intermediate task  $j$  uses two inputs: labor (in quantity  $l_j$ ) and effort (quantity  $e_j$ ) from a supervisor. There are two supervisors, one for in-house production, and one for outsourced production. The supervisor in charge of outsourced tasks owns his production, while it is the entrepreneur owning the final producer that owns the output of the tasks performed in house. This productive structure is summarized in figure 1.

Production technology of the final good is Cobb Douglas in all tasks - each of them produced in quantity  $x_j$ :

$$\ln y_i = \int_0^s \ln(\gamma^{-1} x_j) dj + \int_s^1 \ln x_j dj \quad (3)$$

where  $\gamma > 1$  is an iceberg cost: part of the outsourced tasks is lost in the assembly process. This cost can be interpreted either as a transportation cost or as a trade barrier. Each task  $j$  is produced

by the supervisor in charge of production: for this purpose she can hire a quantity  $l_j$  of labor  $l_j$  and undertakes an effort  $e_j$  through the following Cobb Douglas technology:

$$x_j = l_j^{1-\alpha} e_j^\alpha \quad (4)$$

In the domestic country labor quantity  $L$  is supplied inelastically at wage  $w$ . In the foreign country (where all suppliers are), labor is paid at an exogenous wage  $w^*$ . We assume that the cost of effort  $c$  is the same in both countries. Hence, for each intermediate task the relative unit cost of production between the domestic country and the rest of the world is given by:

$$C/C^* = \left(\frac{w}{w^*}\right)^{1-\alpha} \quad (5)$$

Finally we assume that the population of entrepreneurs and supervisors is exogenously fixed such that there is one entrepreneur and two supervisors (one domestic, the other abroad) for each product in the continuum  $[0; 1]$ .

### 2.3 Modelling Organization: Outsourcing

The use of outsourcing to manage uncertainty is well known to businessmen (see, for the case of IT departments, Lacity et al. [1995]). In the new economy, a well known example of this relation is given by the success of Dell in selling and shipping personal computers to its customers (Magretta [1998]). Dell corporation is the entity that coordinates a very tight network of part makers, that are kept very well informed about the quantities ordered and supposed dates of deliveries. Suppliers are not owned by Dell, but the relation that binds them to the PC assembler is tight: According to Michael Dell the gain of such an organization, which he calls "Virtual Integration", is a reduction in time to market, and therefore a better adaptation to demand changes.

Although important to practitioners, the use of outsourcing to gain flexibility has, however, been somewhat overlooked by the recent literature on vertical integration. Our view of this literature is that it has heavily relied on the very successful lenses of incomplete contract theory, where the basic trade-off is between high powered incentives of ownership and the cost of potential opportunism by an independent contractor (as in Grossman and Hart [1986] and the application of these principles to organizational design by Aghion and Tirole [1994]). Our model is a little bit more precise on the benefits of outsourcing - enhanced flexibility, while the costs of outsourcing we have in mind are very much in the vein of the incomplete contract theory.<sup>7</sup>

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<sup>7</sup>Note that the way we rationalize the role of outsourcing with respect to flexibility improvement is not unique. An alternative, but nearly similar, mechanism relies on product standardization and capacity constraints.

In our model, flexibility is an issue for entrepreneurs because there are random demand shocks (the  $\tilde{\tau}$ 's in equation (1)): it is always better to wait for information disclosure before choosing the levels of efforts. To address this issue, we start with the following two premises: First, these shocks may not be contracted upon, either because they are not verifiable, or simply because they are so many possible states of nature that all of them cannot be included in the labor contract. Second assumption: while effort is fully contractible, it is not possible to rewrite a labor contract once the state of nature is known. Again, there are several justifications to this : there could be adjustment - legal - costs to rewriting the contract, or simply time is lacking to do it.

As a consequence the only way to enforce the ex-post required level of effort is to grant the supervisor with a residual claim on total output, i.e. to give up property rights on her segment of production. But in that case the entrepreneur cannot commit not to withdraw its share of intermediate production in the ultimate bargaining stage. In other words outsourcing allows to increase the number of parameters agents take care of while taking their effort decision. Outsourcing allows to include part of the uncertainty into account, and therefore widens the "information set" effectively used in the production process: this really improves the degree of firm's flexibility as defined in the theoretical literature (Jones and Ostroy [1984]).

To recapitulate, *effort levels  $e$  are assumed to be verifiable, while demand shocks  $\tilde{\tau}$  are not.* In addition, contracts specifying the supervisor wages as a function of the undertaken effort  $w(e)$  cannot be modified after  $\tilde{\tau}$  is known. It is therefore impossible for the entrepreneur to promote an effort level that is appropriate to the ex post level of demand  $\tilde{\tau}$ , unless the supervisor is given a credible residual claim on total profits (i.e. ownership). More precisely, the timing of actions is the following:

- *1/ contracting and outsourcing:* the entrepreneur signs a contract with the supervisor  $A$  specifying the required level of effort  $e^A$ , and the supervisor's compensation  $W^A$ . Moreover the entrepreneur chooses the share  $s$  of tasks to be outsourced to supervisor  $B$ . When this is decided, the entrepreneur auctions the supplier's license to an infinity of potential supervisors: this ensures that they pay him the expected profits of doing so.<sup>8</sup>

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Indeed when some inputs cannot be adjusted instantaneously to demand fluctuations, vertical separation allows to transfer part of the demand uncertainty to the subcontractor. Why do subcontracting firms accept to share part of the risk faced by final good producers? One argument is that subcontractors can diversify their risk by selling to various purchasing firms. Of course, for this to be true, subcontractors must produce *general purpose intermediate goods* which are not specific to a particular final good firm.

This approach of the issue is therefore closer to the literature on vertical integration *pre* Grossman and Hart which states that "it is profitable for firms to maintain an internal supply of operation which runs at full utilization, allowing outside suppliers to absorb fluctuations in demand" (quote from Lieberman [1991]; prominent contributions to this literature include Chandler [1977], Carlton [1979] and Porter [1982]).

<sup>8</sup>This assumption, standard in the incomplete contract literature, ensures that  $s$  is chosen such that the optimal joint surplus is maximized, and that the only tradeoff is between opportunism and incentives.

- *2/ Information:* Uncertainty  $\tilde{\tau}$  about the state of the final demand is revealed to everyone (entrepreneurs and supervisors).
- *3/ Effort:* Supervisors  $A$  and  $B$  take efforts  $(e_i^A)_{i>s}, (e_i^B)_{i<s}$ .  $A$  takes into account the contract signed in period 1, that the entrepreneur cannot amend.  $B$  accounts for the impact of her effort on the share of profits she will obtain in period 4. Each unit of effort costs  $c$  units of forgone consumption to each of the supervisors.
- *4/ Bargaining:* After production, the entrepreneur and its contractor bargain over the total surplus. We assume here that there is no secondary market for already produced tasks. Given the Cobb Douglas production technology, this ensures that both parties get 0 if the negotiation fails. It does not, however, in equilibrium. In this case, the employment decision is made cooperatively to maximize operating profits (sales minus labor costs). The supplier (supervisor  $B$ ) gets a fraction  $\varphi$  of profits ( $\varphi < 1$  since the entrepreneur can threaten to leave the negotiation, in which case the supplier gets 0).

This sequence of events pinpoints the costs and benefits of outsourcing for flexibility. For in-house intermediate tasks, the contract specifies ex-ante what will be the level of (verifiable) effort undertaken by the supervisor  $A$ : consequently, the level of production of  $A$  will not - or partially, if shocks are partially contractible - depend on the demand shock  $\tau$ . Hence imperfect contracting induces some irreversible decisions in the production process. For outsourced intermediate tasks,  $B$  will contingent her effort to  $\tau$  as her payment will directly depend on profits. Therefore the more outsourcing there is, the larger is the share of tasks which are effectively chosen after information disclosure: This corresponds to the benefits in term of flexibility. On the other hand, when choosing her effort level,  $B$  does not take into account the share  $1 - \varphi$  of total surplus the entrepreneur will get. This is the hold-up cost.

### 3 Theoretical Results

In this section we present a sketch of the model resolution: all the details are given in appendix. We list our results and propose some extensions.

At the firm level, the decision to outsource is a backward induction problem. At date 4 employment is chosen cooperatively to maximize global operating profits, given effort levels  $e^A$  and  $e^B$ . Using the demand function (1) and production functions (3-4) joint cooperative surplus is given by:

$$\pi(\tilde{T}, e^A, e^B; s) = \max_{l^A, l^B} \left\{ \tilde{T} \{ [l_A^{(1-\alpha)} e_A^\alpha]^{1-s} [\gamma^{-1} l_B^{(1-\alpha)} e_B^\alpha]^s \}^{1-1/\sigma} - w(1-s)l^A - w^*sl^B \right\} \quad (6)$$

In period 3,  $A$  makes the presigned effort  $e^A$ . Supervisor  $B$  knows she can claim  $\varphi\pi$  in the bargaining stage and therefore takes effort  $e_B$  such that

$$\pi_{ST}(\tilde{T}, e^A; s) = \max_{e^B} \left\{ \varphi\pi(\tilde{T}, e^A, e^B; s) - cDse_B \right\} \quad (7)$$

where  $\pi_{ST}$  is supervisor  $B$ 's profit. In the bargaining stage the entrepreneur gets  $(1 - \varphi)\pi$  and pays  $W^A$  to supervisor  $A$ .

At date 1 the entrepreneur sells the production license to supervisor  $B$  at a price  $E[\pi_{ST}(\tilde{T}, e^A; s)]$ . Moreover in-house contractible level of effort  $e_A$  and supervisor's wage  $W^A$  are chosen. In order to satisfy her employee's participation constraint - her outside option is set to zero, we must have:  $W^A = cD(1 - s)e^A$ . Consequently  $e_A$  is given by:

$$V(s) = \max_{e^A} \left\{ \frac{E}{T} \left[ (1 - \varphi)\pi(\tilde{T}, e^A, e^{*B}(\tilde{T}, e^A; s); s) + \pi_{ST}(\tilde{T}, e^A; s) \right] - cD(1 - s)e^A \right\} \quad (8)$$

### 3.1 Firm's Value

The resolution of the programs (6-8) gives the expected value of a vertically separated firm  $V(s)$ . It turns out that it takes the following simple expression:

$$V(s) = \underbrace{\frac{E(\tilde{T}^{\varepsilon(s)})^{1/\varepsilon(s)}}{E(\tilde{T})}}_{\text{flexibility gain}} \cdot \underbrace{\left(\frac{C}{\gamma C^*}\right)^{s(\sigma-1)}}_{\text{cost comparison}} \cdot \underbrace{H(s)}_{\text{hold up cost}} \cdot \underbrace{V^{fc}}_{\text{full flexibility}} \quad (9)$$

where  $\varepsilon(s) = 1/(1 + \alpha(\sigma - 1) \cdot (1 - s))$ .

The four components of profits have simple interpretations, which we provide before turning to the model resolution. In the far end of the right hand side comes  $V^{fc}$ , the expected profit of a fully integrated firm that could without costs adjust all effort levels after knowing the demand shock  $\tilde{\tau}$  :

$$V^{fc} \equiv E_{\tilde{\tau}}(\tilde{T}) \frac{(\sigma - 1)^{\sigma-1}}{\sigma^\sigma} C^{\sigma-1}$$

where  $C$  stands for the unit costs of production (cf.5). This expression is the standard one under imperfect competition in the absence of non contractible inputs.

The penultimate term on the RHS of equation (9) is the "hold up cost of outsourcing". It writes:

$$H(s) \equiv \varphi^{1/\varepsilon(0)} \left[ 1 + \frac{1 - \varphi}{\varphi} \cdot \frac{\varepsilon(s)}{\varepsilon(0)} \right]^{1/\varepsilon(s)}$$

which is a decreasing function in  $s$ . As  $s$  increases, the share of effort that is subject to hold-up by the entrepreneur increases. Although the supervisor's effort level is more "appropriate" to the demand

shock, it does not fully internalize its impact on total profits, but only on a share  $\varphi < 1$  of them. Hence, as the level fragmentation rises, the expected level of effort is too low *on average*, and firm value decreases. As  $\varphi$  increases, this hold-up effect diminishes, as supplier effort comes closer to optimality - ex post effort decision takes account of its effect on all profits. When  $\varphi = 1$ , the supplier takes the whole surplus into account, and potential opportunism by the entrepreneur is not a cost anymore ( $H(s) = 1$ ).

The second component in equation (9) is  $C/C^*$ : it corresponds to the relative unit costs of domestic production compared to foreign production (cf. equation (5)). Hence the term  $(C/\gamma C^*)^{s(\sigma-1)}$  corresponds to a standard argument of comparative advantage and, depending on the relative level of domestic wages, as well as the extent of trading costs, it can be decreasing or increasing in  $s$ .

The first term is the most important one, since it highlights the benefits of flexibility. By virtue of Jensen's inequality,  $E(\tilde{T}^{\varepsilon(s)})^{1/\varepsilon(s)}$  is always an increasing function of  $s$ .<sup>9</sup> This property simply states that increasing the level of fragmentation allows to stick in a better way to demand shocks : this is why we labelled this term "flexibility gain". In the following, we assume that shocks have a small variance compared to their means. In this case, using an Arrow-Pratt approximation, we get:

$$\frac{E[\tilde{T}^{\varepsilon(s)}]^{1/\varepsilon(s)}}{E[\tilde{T}]} = \left\{ 1 + \frac{\varepsilon(s) - 1}{2} \sigma_\tau^2 \right\} \quad (10)$$

It is decreasing in  $\sigma_\tau$ , the variance of shocks. Although it is risk neutral, the firm dislikes risk. The fact that some inputs cannot be adapted - this stems in our model from contractual incompleteness, makes the firm behave with respect to uncertainty like a risk averse agent, whose "relative risk aversion" would be  $\varepsilon(s) = 1/(1 + \alpha(\sigma - 1)(1 - s))$ .

When  $\varepsilon(s) = 1$ , profits are insensitive to variance. But as soon as  $\alpha(\sigma - 1)(1 - s) > 0$ , this ceases to be the case. The economic interpretation highlights two important determinants of "risk aversion" in this model. First, notice that the returns to scale of rigid inputs are  $\alpha(1 - s)$  (effort which is not taken by subcontractors). The more prevalent rigid inputs are the more sensitive are profits with respect to uncertainty. Second,  $\sigma - 1$  is a measure of competition. The closer it is to zero, the more insulated the

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<sup>9</sup>**Proof** : Assume  $s > s'$ . In this case,  $\varepsilon(s)/\varepsilon(s') > 1$ . For any random variable  $\tilde{x}$ , Jensen's inequality yields :

$$E(\tilde{x}^{\varepsilon(s)/\varepsilon(s')}) > E(\tilde{x})^{\varepsilon(s)/\varepsilon(s')}$$

Posit

$$\tilde{x} = \tilde{T}^{\varepsilon(s')}$$

In this case, the above inequality rewrites :

$$E(\tilde{T}^{\varepsilon(s)})^{1/\varepsilon(s)} > E(\tilde{T}^{\varepsilon(s')})^{1/\varepsilon(s')}$$

QED

firm is from its competitors. In this case, even facing low demand, the firm enjoys enough monopoly power to switch lower volume into higher prices. The consumer cannot substitute the product for another one. Under monopoly power, shocks are transmitted to the consumer, and profit fluctuations are dampened. In the extreme case where  $\sigma = 1$ , profits are fully insensitive to shocks, as quantities sold are zero, and prices infinite, whatever  $\tilde{\tau}$ . As competition becomes tougher however, substitution prevents firms from adjusting too much their prices. Their profit are more sensitive to shocks.

### 3.2 Macroeconomic Equilibrium and the Determinants of outsourcing

In a first step, we are going to solve for the optimal degree of outsourcing for given macroeconomic conditions, and then clear the markets to compute the macroeconomic equilibrium.

The entrepreneur chooses  $s$  so as to maximize  $V(s)$  given in equation (9). The first order condition of this problem writes:

$$\underbrace{\alpha(\sigma - 1)\varepsilon^2(s)\sigma_\tau^2/2}_{\text{flexibility gain}} + \underbrace{(\sigma - 1)(1 - \alpha) \log \frac{w}{\gamma w^*}}_{\text{Relative labor cost}} = \underbrace{-\frac{H'}{H}(s)}_{\text{Hold-up cost}} \quad (11)$$

As we discussed above, vertical separation results here from a trade-off between flexibility and production cost reduction, and the costs of opportunism due to the bilateral nature of the subcontractor - client relation. Assuming for the moment the second order condition of this problem holds, equation (11) shows that  $s$  is going to depend on  $w$ . Before going any further, we thus need to write down the labor market equilibrium. Doing this, we get:

$$w = \frac{\sigma - 1}{\sigma L} \cdot (1 - \alpha) \cdot (1 - s) \quad (12)$$

where the domestic wage is a decreasing function of the degree of fragmentation  $s$ . The intuition of this effect is clear: a more domestic labor saving production technologies relaxes the labor market equilibrium and pushes domestic wages down.

Now that we know the wage as a function of the equilibrium level of fragmentation, we can compute the optimal level of vertical separation from the combination equations (11) and (12). We plug the equilibrium wage into the marginal benefits of outsourcing part of (11):

$$\alpha(\sigma - 1)\varepsilon^2(s)\sigma_\tau^2/2 + (\sigma - 1)(1 - \alpha) \log \left[ \frac{\sigma - 1}{\sigma L \gamma w^*} \cdot (1 - \alpha) \cdot (1 - s) \right] = -\frac{H'}{H}(s) \quad (13)$$

The LHS is decreasing<sup>10</sup> in  $s$  and the RHS is increasing in  $s$ :. This equation defines an unique equilibrium level of  $s$ . Indeed there is a strategic substitutability in this model, that goes through the

<sup>10</sup>The condition on the parameter values for the LHS of (13) to be decreasing in  $s$  is:

$$\alpha^2(\sigma - 1)\sigma_\tau^2 < 1 - \alpha$$

which is always fulfilled for standard and realistic values of the parameters, e.g.  $\alpha = 1/3$ ,  $\sigma = 5$ ,  $\sigma_\tau$  small.

labor market clearing condition. The more firms outsource, the lower the wage on the domestic labor market, since domestic labor is substituted for foreign labor. As wages go down, the cost advantage of in-house production improves, and it is optimal for any given firm to outsource. This strategic substitutability ensures uniqueness in the set of symmetric equilibria, which are the one we restrict ourselves to.

More interesting are the comparative static properties on outsourcing that one can derive from equation (13). We will describe them before turning to the consequences of outsourcing in the next sections. First, with respect to the level of uncertainty  $\sigma_\tau^2$ : the flexibility term, which represents the marginal flexibility benefit to outsource, is increasing in  $\sigma_\tau^2$ . As uncertainty increases, the chance that a pre-specified effort level is inappropriate rises, which weighs on expected profits. As no other term in (13) depends on uncertainty, one can unambiguously conclude that an exogenous rise in idiosyncratic uncertainty increases the equilibrium level of outsourcing.

Secondly,  $s$  is decreasing when trading costs  $\gamma$  increase. Logically, as iceberg costs increase, the relative cost of outsourcing increases. Very obviously in this model, declining trade barriers or transporting costs are going to foster the reliance of outsourcing among domestic firms. Similarly, though this is less obvious to show, the level of fragmentation increase as  $\varphi$  gets close to 1.<sup>11</sup> Indeed, as the bargaining power of outside contractors increases, they internalize a larger share of total benefits when making their adjustment decisions. This brings ex post effort levels closer to optimality, and therefore weighs on the unit cost effect of ex post hold-up problems.  $H'(s)/H(s)$ , the marginal cost to outsource is reduced, and  $s$  increases. Hence, a closer cooperation - commitment by the entrepreneur to leave a large share of the profits to its contractor - increase reliance on outsourcing. This result has little to do with uncertainty, but is the by-product of the auction process on licence fees that takes place in period 1 (see section above). Were the entrepreneur able to commit not to exert his ownership right in the end - threaten to leave the relation, the relation with the contractor would be more fruitful. He would reap the benefits of outsourcing (incentives) as well as those of integration (no opportunistic behavior), very much in the spirit of Michael Dell's "virtual integration".

The most interesting comparative statics exercise is however on competition  $\sigma$ . The overall net effect of competition is ambiguous, which makes it worthwhile to discuss the various channels of this effect separately. Let us start with those effects not directly related with flexibility. There is first an equilibrium effect of competition onto fragmentation: competition increases aggregate output and

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<sup>11</sup>Formally, this stems from the fact that  $-H'(s)/H(s)$  takes the following form :

$$\log(1+x) - \frac{x}{1+x}$$

which is increasing in  $x$ .

therefore employment - the standard argument that monopolies produce too little. This puts upward pressure on domestic wages, which increase the relative cost advantage of outsourcing. Through factor market competition, outsourcing is therefore increasing in  $\sigma$ . All the other effects of competition we discuss from now stem from the individual optimization problem. First, an increase in competition makes firms more sensitive to their cost level: hence the  $\sigma - 1$  term in front of  $\log \gamma$  and  $\log w/w^*$ . As competition increase, the  $\gamma$  trading cost is heavier to bear, which discourages outsourcing. In addition,  $\sigma - 1$  increases marginal costs to outsource, through the hold-up cost term. Again, this is similar to the effect just described in transport and labor costs. Contractor opportunism increases unit costs, and since competition makes a firm more sensitive to units costs, it increases the apparent cost of outsourcing, and reduces optimal fragmentation.

The most interesting effect of competition applies to the flexibility term which takes a U shaped with respect to competition  $\sigma$ . It first decreases, as competition reduces profits all together, and therefore the gains to outsource. When  $s > 1 - 1/\alpha(\sigma - 1)$  however, the firm's profits become so sensitive to shocks that outsourcing becomes a profitable thing to do. In this model, outsourcing allows firms to adapt quantities more to demand shocks, and keep their prices close to their optimal monopoly price. This effect always dominate is  $\alpha$ , the returns to efforts, is not too large compared to that of labor. In this case, firms want to outsource because of the flexibility in quantities it brings to them.

It turns out that for standard values of the parameters<sup>12</sup>, the positive effects of competition on outsourcing always dominate the negative ones. Hence an increase in competitive pressure magnifies outsourcing.

### 3.3 Outsourcing Amplifies Firm Level Uncertainty

Now that we have discussed the determinants of outsourcing, let us turn to its impact. As we have seen, outsourcing improves flexibility in the sense that it enables to incorporate in the decision of production the realization of the demand shock  $\tau$ . As a direct consequence we expect the firms' production to be more sensitive to demand shocks when outsourcing is magnified. Indeed using (6-9) we can compute

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<sup>12</sup>Totally differentiating equation (13) with respect to  $s$  and  $\sigma$  shows that  $ds/d\sigma > 0$  when the following condition on the parameters is fulfilled:

$$\alpha^2[\sigma_\tau^2 + \frac{1-\varphi}{\varphi} \frac{1}{4}] < \frac{1-\alpha}{\sigma^2 - \sigma}$$

This inequality is true for standard and realistic values of the underlying parameters, e.g.  $\alpha = 1/3$ ,  $\sigma = 5$ ,  $\varphi = 1/2$  and  $\sigma_\tau$  small.

firm level labor demand  $\tilde{l}_i^A$  and operating profits  $\tilde{\pi}_i$  which are respectively given by:

$$\tilde{l}_i^A = \frac{\sigma - 1}{\sigma} \cdot \frac{1}{w} \cdot (1 - \alpha) \cdot (1 - s) \frac{\tilde{\tau}_i^{\varepsilon(s)}}{\int_0^1 \tilde{\tau}_j^{\varepsilon(s)} dj} \quad (14)$$

$$\tilde{\pi}_i = \frac{1}{\sigma \varepsilon(0)} \cdot \frac{\tilde{\tau}_i^{\varepsilon(s)}}{\int_0^1 \tilde{\tau}_j^{\varepsilon(s)} dj} \quad (15)$$

where  $i$  indices the firm.<sup>13</sup> As we know that there is no aggregate uncertainty, the wage  $w$  is deterministic (see equation (12)).

What would be the effect of outsourcing on firm level uncertainty ? First, outsourcing may have an impact on the level of each of the variables ( $\tilde{l}_i^A, \tilde{\pi}_i$ ). In this case, it would automatically increase its variance, as would any size enhancing device (positive externality of any kind). What is more specific to outsourcing here is that it increases variance - of labor demand, profits, sales - *for a given level of activity*. To shave off such level effects for employment and profits, let us compute the ratio of variance to squared mean: It is equivalent at a first order of approximation to the variance of the logarithm. Hence we get:

$$var \log \tilde{l}_i^A = var \log \tilde{\pi}_i = \varepsilon(s)^2 var \log \tilde{\tau} \quad (16)$$

From the above equation we notice two things. The first one is that firm level uncertainty *increases*, even after accounting for size effects. Labor demand, cash flows variance increase as firm outsource more (for example because transport costs  $\gamma$  decrease), even if firms do not grow: we have viewed in the preceding paragraph that outsourcing responded to uncertainty. The point now is that outsourcing actually *amplifies* firm level uncertainty. This is, we believe, one of the key results of this paper. The intuition behind it is fairly straightforward. For a share  $s$  of tasks, supply becomes more elastic to shocks, because outsourcing, by strengthening incentives, improves flexibility. As tasks are not perfect substitutes to each others, increased variance in some tasks commands increased variability in the remaining ones. But, as supervisory effort remains rigid for in-house tasks, there has to be some increased volatility in its substitute, which is here labor. Amplification here is precisely about the increased variability of the in-house segment of production, that is not outsourced itself<sup>14</sup>.

A possible increased reliance of firms on outsourcing<sup>15</sup> is therefore a good candidate to explain the rise in firm level uncertainty documented in the introduction (on both returns to capital and returns

<sup>13</sup>To keep notations as light as possible, we stick here to joint profits  $\tilde{\pi}_i$ , where the results we present are not different for entrepreneurial or contractors profits taken separately, net or gross of effort costs.

<sup>14</sup>All it requires to show up in the equations is *some* degree of complementarity between tasks (only perfect substitutes fully cancel the effect).

<sup>15</sup>which is documented in section III.

to labor sides). This model explicitly addresses the rise in cash flows volatility as documented by Campbell and his coauthors [2001]. According to Gottshalk and Moffit [1994], returns to labor seem to have become more uncertain too, and this rise in uncertainty has nothing to do with industry or economywide shocks. To be fair, our model does not have any predictions on the idiosyncratic volatility of wages, because workers are free to move from one firm to the other. We believe nonetheless that adding reallocation costs - like search frictions, or firm specific human capital - would yield this kind of prediction<sup>16</sup>. What matters ultimately is that labor demand itself becomes more uncertain: whether this translates in wage or employment variance depends on labor market institutions.

The great merit of this amplification effect is that it allows to rationalize the relation between globalization and insecurity. For Rodrik [1997], the key to the political economy of globalization is the uncertainty it creates. Accordingly this is one of the reasons why more open economies have larger governments. These larger government provide voters with the safety nets necessary to make the turbulences of globalization bearable. Globalization brings wealth and uncertainty: willing to enjoy the first as consumers, voters demand to be sheltered from the second as employees (see also Rodrik [1998]). What Rodrik seems to have in mind however is aggregate uncertainty, as modelled by terms of trade shocks. These shocks are large, and open economies are more sensitive to them. The problem with this approach is that as industrialized economies opened to trade, their aggregate fluctuations should have increased, which does not seem to be the case - at least for the US. Does that mean that globalization cannot create employment insecurity. Our model provides a way of reconciling globalization to trade. As transportation costs or barriers to trade  $\gamma$  decline, firms outsource more, which allows them to stick to demand changes in a better way: idiosyncratic uncertainty increases. Remind that the important thing here is that our model allows a *change* in the production function; if we fix  $s$  to zero - fixed production function - a change in  $\gamma$  has no impact whatsoever on firm level uncertainty (see equation (16)).

We are conscious, however, that our theory does not focus on trade openness *per se* but rather on the outsourcing process which is a consequence of it. All the same, the diffusion of Information

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<sup>16</sup>For example the model could be modified in the following way. Consider that: (i) workers must acquire some human capital otherwise their market value is zero (ii) this human capital is specific to a particular firm (iii) the human capital investment takes time and must be decided before information disclosure.

In that case, all firms hire at period 1 the same amount of workers  $L$  and using (14) we get that wages are now firm specific and equal to:

$$\tilde{w}_i^A = \frac{\sigma - 1}{\sigma} \cdot \frac{1}{L} \cdot (1 - \alpha) \cdot (1 - s) \frac{\tilde{\tau}_i^{\varepsilon(s)}}{\int_0^1 \tilde{\tau}_j^{\varepsilon(s)} dj}$$

Hence  $var \log w_i^A = \varepsilon(s)^2 var \log \tilde{\tau}$  which is in line with the evidence pointed out by Gottschalk and Moffit.

Technologies has decreased some of the traditional costs of outsourcing. The coordination of suppliers is made easier through quick transmission and processing of orders, even for customized products. Dell - again - has heavily and successfully relied on IT develop its well oiled, responsive, network of suppliers and transporters. In our model, the "IT effect" corresponds to a decline in  $\gamma$ , as for globalization. We will be able to say a little bit more than this on technology: section 3.5 is going to propose a richer model of the interaction between innovation, trade and outsourcing.

What about the effect of competition on uncertainty in our model ? Two counterbalancing effects are at work. The first one negatively links competition and uncertainty and results from a standard argument in an imperfect competition setup. Going back to equation (16), a salient fact is that, for a given level of outsourcing  $s$ , competition actually *decreases* firm level uncertainty, as long as "rigid" inputs matter. Analytically, this stems from the fact that  $\varepsilon(s)$  is a decreasing function of  $\sigma - 1$  if  $\alpha > 0$ . The intuition for this goes as follows: the existence of rigid inputs makes ex-post costs of production sensitive to quantities sold. In case of high demand, firms produce more, and need to charge more in order to recoup their costs. In case of low demand, firms produce less, and can cut their prices as their marginal productivity goes up. As competition increases however, firms become more constrained on their price policies: facing a positive demand shock, they cannot raise their prices as much as they used to. This prevents them from dampening the impact of demand fluctuations on their margins. Output is more stable. The second effect is specific to our framework and predicts a positive impact of competition on uncertainty. Indeed taking in account the endogenous response of outsourcing, an increase in competition may increase outsourcing and therefore amplifies uncertainty (see discussion above).

The last result of this section concerns the impact of outsourcing on the firm's pricing policy. To discuss it, we start computing the ratios of variance to squared mean for prices and quantities; At the first order of approximation, they are equal to:

$$var \log \tilde{p}_i \simeq \left( \frac{1}{\sigma - 1} (1 - \varepsilon(s)) \right)^2 var \log \tilde{\tau} \quad (17)$$

$$var \log \tilde{y}_i \simeq \left( \frac{1}{\sigma - 1} (\sigma \varepsilon(s) - 1) \right)^2 var \log \tilde{\tau} \quad (18)$$

As the level of fragmentation rises, firms uses smoother prices, and more varying quantities. The logic of outsourcing is that firms rely more and more on flexible inputs such that their ex-post costs of production depend less and less on quantities sold: consequently, they can adjust in an easier way their quantities to demand shocks without incurring ex-post productive inefficiencies. Hence fragmentation and outsourcing induce a switch from price volatility towards quantity volatility.

Aside from its microeconomic predictions, our model thus proposes an explanation of the rise in corporate uncertainty. On the empirical side, one would like to know whether the rise of outsourcing is visible in the data, and whether is possible to observe the amplification mechanism at the firm level. This is the goal of our empirical section 3. On theoretical side, what remains to be checked is whether outsourcing also amplifies aggregate uncertainty - which would contradict the facts established by Campbell et al. [2001] and Gottschalk and Moffit [1994] which show that the rise in firm level uncertainty is entirely due to idiosyncratic volatility. The next section addresses this issue.

### 3.4 Merits of Macroeconomic Modelling I: Aggregate vs idiosyncratic Uncertainty

This section seeks to see whether aggregate uncertainty is also amplified by outsourcing. To answer this, we need to amend the model somewhat and assume that firm level demand shocks now have two components: an idiosyncratic and an aggregate one. For each firm  $i$ , the demand shock is given by:

$$\tilde{\tau}_i = \tilde{\delta}_C \cdot \tilde{\delta}_i \quad (19)$$

where  $\tilde{\delta}_C$  is a component common to the whole industry and  $\tilde{\delta}_i$  is the idiosyncratic component such that  $E(\tilde{\delta}_C) = E(\tilde{\delta}_i) = 1$ ,  $Var(\tilde{\delta}_C) = \sigma_C^2$ ,  $Var(\tilde{\delta}_i) = \sigma_I^2$  and  $corr(\tilde{\delta}_i, \tilde{\delta}_j) = 0$  for  $i \neq j$ . We restrict our analysis to a multiplicative form for uncertainty such as given by (19) in order to simplify exposition. Instead of using the multiplicative form of (19), we also tried to solve the model in the case where idiosyncratic and aggregate shocks are additively separable:  $\tilde{\tau}_i = \tilde{\delta}_C + \tilde{\delta}_i$ . For small shocks - around their means, the results we present below stay robust.<sup>17</sup>

The inclusion of aggregate uncertainty makes the model a little bit more complicated to solve, but it remains analytically tractable. Indeed, firm level demand is now subject to a direct exogenous shock  $\tilde{\tau}_i$  as well as an "indirect" shock through  $\tilde{P}$ , the price index, which is now stochastic and endogenously given by equilibrium conditions. Contrary to the basic framework, decisions to outsource are now closely related to expected uncertainty in aggregate prices. Once this has been taken into account, analytical solutions remain close to those of the previous model (see the appendix where all the details are provided). In particular, the equilibrium level of outsourcing is now given by:

$$(\sigma - 1)\alpha\varepsilon^2(s)\sigma_I^2/2 + (1 - \alpha).(\sigma - 1).[\log(w/\gamma w^*)] = -\frac{H'}{H}(s) \quad (20)$$

where  $w$  is still given by (12). Note that this equation does not include the variance of aggregate uncertainty: only idiosyncratic shocks matter in the decision to outsource. The driving force behind this result is that outsourcing does not allow firms to shelter themselves from aggregate uncertainty.

<sup>17</sup>The details of the computations are available on request from the authors.

Take the case where a firm faces both a large aggregate and a large idiosyncratic shock. Because aggregate demand is high, labor demand is large and so are labor costs. Even if the firm is more flexible, it is still going to face labor costs as large as the others. Since under imperfect competition what matters for relative market share is relative productivity, outsourcing will not help firms to gain an advantage. In other words, outsourcing is here to channel labor from low demand firms to high demand firms. It provides the latter an advantage as long as it indeed faces higher demand. Aggregate shocks cannot be sheltered from using outsourcing. From a technical viewpoint, note that demand uncertainty features two components  $\tilde{\tau}_i$  and  $\tilde{P}^{\sigma-1}$  where the aggregate shock  $\tilde{\delta}_C$  appears in both of them. When solving for the equilibrium ex-post value of the Price index  $\tilde{P}$ , it turns out that  $\tilde{\delta}_C$  cancels out and that the “apparent” demand uncertainty simply reduces to  $\tilde{\delta}_i$ . Put differently, aggregate shocks turn into aggregate changes in prices, but do not impact real quantities.

Hence, aggregate fluctuations do not matter for outsourcing decisions. However, does outsourcing amplify fluctuations in aggregate production and in firm level cash-flows and labor demands? To see this, we can compute the level of aggregate production for a given equilibrium level of fragmentation  $s$ :

$$\tilde{Y} = \left( \frac{\sigma-1}{\sigma} C^{1-s} C^{*s} \right)^{-1} \cdot H(s)^{\frac{1}{\sigma-1}} \cdot \left( E[\tilde{\delta}_I^{\varepsilon(s)}] \right)^{\frac{1}{(\sigma-1)\varepsilon(s)}} \cdot \tilde{\delta}_A^{\frac{1}{\sigma-1}}$$

As argued in section 3.3 we measure the degree of aggregate uncertainty with:

$$\text{var} \log \tilde{Y} = \frac{1}{\sigma-1} \text{var} \log \tilde{\delta}_A$$

We thus see that fluctuations in aggregate production are not amplified by the equilibrium degree of outsourcing. Moreover, we can compute the ex-post equilibrium value of cash-flows and labor demands. It appears that they have exactly the same analytical form than in the basic framework and their variance (controlled for size effect) is equal to:

$$\text{var} \log l^A = \text{var} \log \tilde{\pi} = \varepsilon(s)^2 \text{var} \log \tilde{\delta}_I$$

Hence the increase in firm level uncertainty induced by outsourcing and fragmentation is only driven by the idiosyncratic component: The aggregate uncertainty plays no role here which is very much in line with the evidence established by Campbell et al. [2001] and Gottschalk and Moffit [1994].

The driving force behind these results is the assumption of imperfect competition. Indeed outsourcing does not give to firms a comparative advantage to deal with aggregate uncertainty, as they all share the same product market. Since only comparative advantage matters, outsourcing does not allow to adapt to aggregate fluctuations in a better way. Idiosyncratic fluctuations are, however,

still amplified by outsourcing, and the variances of profits and labor demand take exactly the same functional forms as in equations (17) and (18).

### 3.5 Merits of Macroeconomic Modelling II: Uncertainty is Innovation

Following Schumpeter's insights on innovation, some contributions in growth theory have formalized growth as a process of creative destruction. In these model - pioneered by Aghion and Howitt [1992], innovation improves product quality. Incumbents produce a certain good, at a given quality. Then, an innovator comes up with a better idea. She enters the market, and destroys the market shares of the incumbent through aggressive price war. The possibility of innovation therefore represents a threat over incumbents which is uncertain (ideas do not come as planned but randomly). In this section, we explore the impact of making uncertainty endogenous.

In order to keep the analysis simple, we will simplify the innovation process as much as possible. We posit that a research sector produces patents that gives the exclusive right to produce in a given industry  $i$ . Once a firm has purchased a patent from the research lab, it enters industry  $i$ , displaces the incumbent, and produces there as a monopoly. The new firm is neither more productive, nor does its product yields higher utility. These extreme assumption are made to insulate firms from the monopolistic competitors, so as to keep the functional forms derived in section 3.2. Hence, each firm's profit does not depend on the distribution of qualities produced by other firms. The key insights derived here would, we believe, be robust to a more sophisticated modelling (Aghion Howitt [1998]), but this is beyond the purpose of this short extension.

Time is discrete, the discount rate is  $\rho$ , and outsourcing decisions are taken each period, so that the dynamic model is equivalent to the static one. At each date, firms choose to outsource before the resolution of uncertainty. What uncertain is whether the firm is still going to be able to produce, i.e. whether an innovator has arrived. If an innovator does arrive, we just assumes that it outsources as others do. In the next round, it is going to choose.<sup>18</sup> This occurs with probability  $\theta$ . Hence, idiosyncratic uncertainty  $\tilde{\tau}$  writes:

$$\begin{aligned}\tilde{\tau} &= 1 \text{ with probability } 1 - \theta \\ \tilde{\tau} &= 0 \text{ with probability } \theta\end{aligned}$$

The rate of innovation depends on the research effort of R&D firms. These look for new patents using researchers. Hiring  $l^{RD}$  researchers endows the laboratory with the probability of finding each period

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<sup>18</sup>This is innocuous: it simplifies the exposition of the value functions, but does not affect the mechanisms we highlight here.

$l^{RD}/b$ . The economy is closed, such that  $w = w^*$ : contractors use domestic labor. There are no transport costs ( $\gamma = 1$ ). This is all for the model exposition.

Each date, before knowing whether an innovation has been found or not, the firm chooses how much of its production process to outsource. Using equation (11) without the Arrow Pratt approximation, it is easily shown that this decision can be stated as:

$$\underbrace{\alpha(\sigma - 1) \log \frac{1}{1 - \theta}}_{\text{Flexibility}} = \underbrace{-\frac{H'}{H}(s)}_{\text{Hold-up cost}}$$

the marginal gain of outsourcing is increasing in  $\theta$ . As it is a constant function of  $s$ , and as hold-up costs are convex, the second order condition of the problem is automatically satisfied. The solution of this equation is called  $s(\theta)$ . As the marginal flexibility gain is increasing in  $\theta$ , so is  $s$ . Firms facing a greater threat of being driven out of the market outsource more: vertical separation is a response to a more competitive and innovative environment.

What does in turn determines  $\theta$ ? Firms expected values are given by :

$$EV \simeq \underbrace{\frac{1}{\rho + \theta}}_{\text{standard}} \underbrace{\frac{1}{\sigma} \left( \varphi + (1 - \varphi) \frac{\varepsilon(s)}{\varepsilon(0)} \right)}_{\text{externality}}$$

which have two components: the first one is standard in models of imperfect competition. The second component is a between-firm externality due to outsourcing, and is tightly related to the hold-up cost in the contracting relationship. Recall that contractors choose effort levels that are, on average too low, because they fear opportunistic behavior from the firm. This pushes up unit costs, and therefore the aggregate price level. To any single firm, demand and therefore profits increase. This externality is stronger when competition increases because it makes demand more sensitive to overpricing by the others. Note that this externality is positive on profits, but negative on aggregate production.

Free entry in the R&D industry ensures that profits in this sector vanish to zero; hence:

$$EV = bw$$

Combined with free entry in R&D industry, the labor market equilibrium is going to give us the equilibrium level of innovation :

$$L = (\sigma - 1) \cdot (1 - \alpha) \cdot \underbrace{\frac{b(\rho + \theta)}{\varphi + (1 - \varphi)\varepsilon(s)/\varepsilon(0)}}_{\text{manufacturing labor demand}} + \underbrace{b\theta}_{\text{R\&D}} \quad (21)$$

where the first term represents manufacturing labor demand. Contractors as well as entrepreneur hire labor within the domestic labor market, so the  $(1 - s)$  term present in equation (12) is not here

anymore. It is decreasing in  $EV$ , as increased firm value raise R&D activity, and therefore wages. From equation (21), we see that  $\theta$  is increasing in  $s$ . Indeed, an increase in  $s$  generates higher profits, which stimulates research and innovation, measured by  $\theta$ . The "outsourcing externality" discussed above thus generates a positive relation between innovation and outside contracting. We call  $\theta(s)$  this relation.

The equilibrium  $(s, \theta)$  is described by the two non decreasing function  $s(\theta)$  and  $\theta(s)$ . Consequently multiple equilibria may arise. In other words our theory of outsourcing generates a circular causation between outsourcing and innovation. An increase in innovation generates uncertainty, which promotes outsourcing. In turn outsourcing, by increasing flexibility, has a positive externality on profits, which pushes entry, and innovation up. Whether the model displays multiple equilibria depends on the parameters, as well as on functional forms. What is important here is that the model exhibits multiplier effects: a small reduction in innovation costs may generate a larger than expected rate of innovation, through the positive feedback of outsourcing. A natural prediction of this model is that we should observe that industries that innovate the most are the ones that outsource the most.

## 4 Empirical Evidence

Our core result is that a greater reliance on outsourcing increases the return to adjust in house production. We should therefore expect that a firm that rely more on intermediate inputs are in a position to adapt more to demand shocks. To test these implications, we use firm level data from three French surveys. Our main source of information is a fiscal database used by the French administration to levy the corporate tax: for all French firms whose total sales exceed 3,5 million Francs, it provides us with detailed accounting variables such as sales, value added, fixed assets, as well as employment. The period is 1984-1999. The second source is ACEMO, a quarterly survey conducted each year between 1987 and 1997 by the Ministry of Labor on some 12,000 firms. This dataset provides us with quarterly employment, short term contracts, part time workers and interim employment: we extract employment based measures of uncertainty. Last, we will be using the 1982-1999 waves of the French Labor Force Survey, in order to get industry level measures of employment turnover and flexibility.

### 4.1 Macroeconomic Evidence

#### 4.1.1 Trends in Outsourcing

Our theory relates externalization, firm level output and labor demand volatility. Do recent macroeconomic trends motivate the construction of such a theory ? Using French National Accounts, we are in a position to compute the ratio of intermediate input consumption to total value added (GDP).

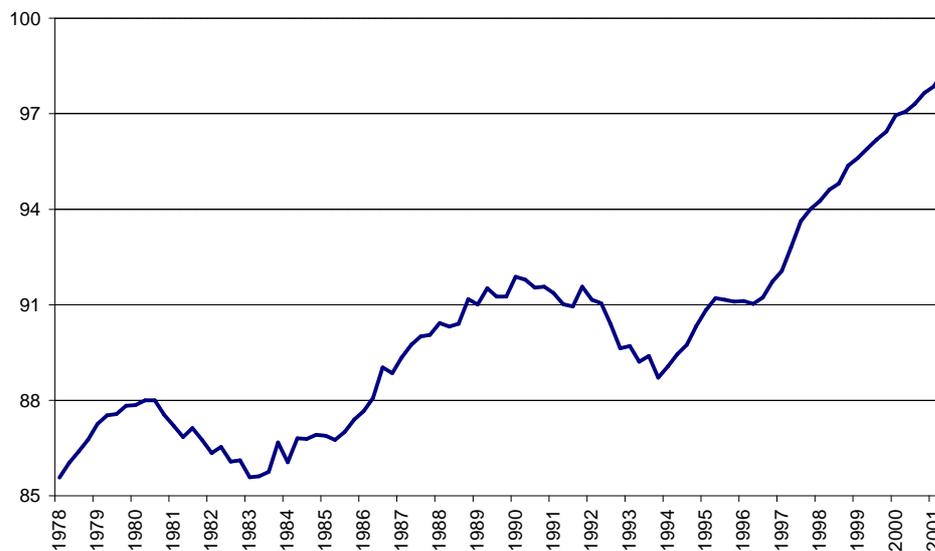


Figure 2: Consumption of Intermediary Inputs : 1978 - 2000

This trend is plotted in figure 1. Thus measured, economywide externalization increases on a constant trend throughout the 1980s and 1990s, from 85% up to almost 100% of GDP. Around this trend, this aggregate measure of externalization exhibits cyclical movement, going up in periods of booms (i.e. the late 1980s and the late 1990s), and down during economic slowdowns.

Hence, French macro data display a very clear acceleration in average reliance on external production in the 1990s. This aggregate evolution however conceals a considerable intra industry heterogeneity. To get an idea of composition effects, consider the industry breakdown laid out in table 1. The most impressive figures are to be found in the automobile industry, where the share of intermediary inputs in total sales has increased by 14,9 percentage points between 1978 and 2000. Then come consumer goods and food processing where average reliance on intermediate input has increased by some 9,5 percentage points. In three industries, this figure has decreased (energy, equipment and agriculture). Most of the others have experienced a positive, significant, increase. The timing of these changes varies across industries. In most manufacturing industries, as well as financial services and transportation, most of the increase occurred in the 1980s. A slight acceleration of externalization in the 1990s is sensible, albeit moderate, in real estate, trade and construction.

Table 1- Trends in Outsourcing : Breakdown by Industry

	1978-2000	1978-1990	1990-2000
Agriculture	-3.5	-4.6	0.8
Food Processing	9.5	7.3	2.2
Consumer Goods	9.7	8.7	1.0
Automobile	14.9	7.3	7.6
Equipement Goods	-3.8	-4.2	0.4
Intermediate Goods	6.8	9.2	-2.4
Energy	-17.3	-15.6	-1.7
Construction	3.5	1.3	2.2
Trade and Repair	0.2	-0.8	1.0
Transportation	3.4	2.4	1.0
Financial Services	7.6	7.9	-0.4
Real Estate	0.6	-0.2	0.9
Corporate Services	-2.6	0.0	-2.6
Household Services	4.2	3.9	0.4
Education and Health	0.3	0.0	0.3
All Economy	2.9	1.3	1.6

Reading: Between 1978 and 2000, total purchase of intermediate inputs by firms in the food processing industry has increased by 7.3 points of total production.

Hence, although there seems to be considerable heterogeneity in behaviors across sectors, there is in macro data a clear trend for most industries to decrease the share of in-house value added in total sales.

#### 4.1.2 The Rise in Uncertainty

Let us now turn to aggregate measures of labor demand uncertainty. Figure 2 plots the trend in French firms' use of "flexible" labor over the past 20 years. The top line corresponds to the percentage of workers hired under fixed term contracts over total employment, as computed from the 1982 - 1999 waves of the French Labor Force Survey. The bottom line is the share of interim workers in total employment. The share of workers employed under FTC is multiplied by 3 over the period (it goes up from 2 to 6% of total employment). This figure is of course more impressive when we focus at employees that have less than 6 month seniority. Among them, FTCs account for more than 28% in 1999, against 17% in 1982. Interim employment figure, albeit smaller, display evolutions that have the same order of magnitude. The fact that the increase in FTC reliance could be triggered by regulatory changes is unlikely, given the timing of these events (Givord et Maurin [2001]). The first law that made FTC possible was very restrictive and was enacted in 1978. In 1986, the newly elected conservative government then relaxed many of the constraints previously associated with hiring

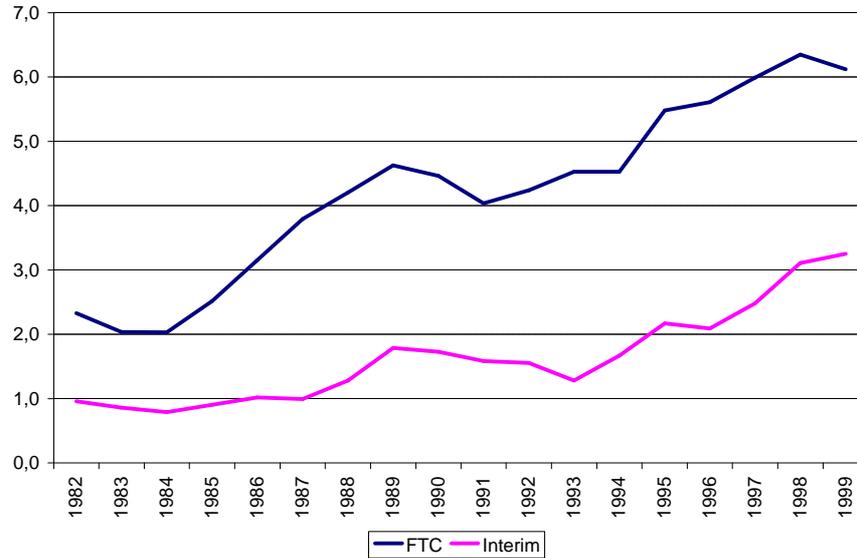


Figure 3: Firms' Use of Flexible Labor : 1982-2001

under FTCs. In 1990, the socialist government reintroduced some marginal limitations (like a slight increase in the associated end-of-contract redundancy payment). All in all, the use FTCs experienced a marked increase over the 1986-2001, in spite of limitations introduced in 1990. As far as the 1980s are concerned, the trend does not exhibit any break in 1986.

This heuristic reasoning is confirmed by quantitative findings by Givord and Maurin [2001], who show that job loss probability increased between the 1980s and the 1990s, even after proper accounting for macroeconomic fluctuations, and the two regulatory changes recalled above. This trend toward increased job turnover has also been documented by Neumark [2000], which records a significant increase in involuntary job loss in all developed economies. In a widely cited paper, Gottshalk and Moffit [1994] have shown a marked increase in earnings instability since the early 1980s: this evolution could be consistent with a rise in job turnover, and a more frequent loss of firm specific human capital. In the US, those demographic groups that were the more exposed to firm specific human capital, like middle aged, skilled men, have experienced a downward trend in job security - as measured by the probability of keeping one's job from one year to the other. However, aggregate evidence on the trend in job instability is more mixed: the share of workers with less than 1 year does not seem to have increased in the United States (Jaeger and Stevens [1999]), nor in France (according to the Labor Force Survey, even the whole seniority distribution is stable across the 1982-2000 period). Nor does evidence from firm level data find a clear increase in the volatility of labor demand. Gross job creation

and Destruction figure as those from Davis and Haltiwanger [1992] do not display any clear trend.

## 4.2 Microeconomic Evidence

### 4.2.1 Empirical Framework

At the microeconomic level, our theory predicts that externalization should respond to and at the same time increase the variance of sales. While causality is difficult to trace here (we do this in the last sub-section of this part), our model predicts an unambiguous correlation between the degree of externalization and (1) the variance of sales and (2) the variance of employment. To see how, consider a firm endowed with the following production technology:

$$\tilde{R} = \tilde{A}Q^s K^{\beta(1-s)} L^{(1-s)\alpha} \quad (22)$$

where  $\tilde{R}$  stands for revenue,  $Q$  for intermediary inputs,  $K$  for capital and  $L$  for labor.  $s$  is the share of intermediary inputs in total sales.  $\alpha$  is labor's share in value added.  $\tilde{A}$  is a random variable shock standing for a demand shock. This analytical form for  $\tilde{R}$  can be derived from the demand function and the production technology chosen in the theoretical section except for the capital that we omitted for expositional simplicity. We assume that  $K$  is chosen before  $\tilde{A}$  is known, while  $L$  and  $Q$  are chosen afterwards. In such a context, it is straightforward to show that the ex ante variance of firm level employment is given by:

$$var \log L = \frac{1}{(1-s)(1-\alpha)} var \log \tilde{A} \quad (23)$$

$$var \log \tilde{R} = \frac{1 - (1-s)(1-\alpha)}{(1-s)(1-\alpha)} var \log \tilde{A} \quad (24)$$

Hence, for a given level of demand uncertainty ( $var \log \tilde{A}$ ), employment and sales fluctuations increase in both the share of intermediate inputs and the share of labor in value added.

### 4.2.2 Outsourcing and Uncertainty : Evidence From Correlations

For a start, we use the fiscal dataset described above allows to compute firm level variance of the year to year change in  $\log(\text{sales})$ , using all observations we have for a given firm between 1984 and 1999. Simultaneously, we compute the share of sales accounted for by intermediate consumption at the firm level, and take the average over the 1984-1999 period. We then regress this measure of externalization on the variance of sales, controlling for firm size. Results are displayed in the first column of table 2. They show a strong correlation at the firm level between externalization and the variance of sales.<sup>19</sup>

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<sup>19</sup>What counts here is to compute the variance of the unexpected sales changes. Computing  $var(\log(\text{sales}))$  implicitly implies that only an average firm level effect of  $\log(\text{sales})$  may be forecast by the firms' managers. There could however

Table 2 - Reliance on Flexible inputs and Sales Variance

	IC / Sales	
$var(\log(\text{sales}))$	11.2 (1.9)	3.6 (1.6)
$\log(\text{sales})$	-0.2 (0.1)	-2.7 (0.4)
Industry effects	yes	no
Firm effects	no	yes
Nb obs.	7,398	12609

Reading: All estimates are multiplied by 100. Heteroskedasticity-robust standard errors are between parentheses. Column 1 regresses the mean share of intermediate consumption (IC) in sales on the variance of  $\log(\text{sales})$ . Mean and variance are computed over the 1984-1999 period, for all firms present for at least 5 consecutive years in the panel. Model uses both means and variance computed over two sub periods: 1984-1991 and 1992-1999. It does the same For the sake of robustness, all regressions exclude top and bottom 5% values of dependent and independent variables.k

The next column seeks to include firm effects into the regression (and therefore to control for unobserved, though fixed, factor that increase the likelihood of vertical separation and the variance of sales). We do this by computing the average level of externalization and the  $\log(\text{sales})$  variance over two subperiods : 1984-1991 and 1992-1999. Correlation between the change in externalization and the change in variance, controlling for firm size, are given in column 2 of table 2. It remains significant and the 5% level, but looks much less robust. One possible reason is measurement error, since variances are computed using 7 points per firm.

Let us now turn to employment: equation (23) legitimates the estimation of the following empirical equation:

$$var \log L_{it} = \alpha_i + \beta_t + \gamma \left( \frac{pQ}{Y} \right)_{it} + \delta \left( \frac{wL}{Y - pQ} \right)_{it} + \varepsilon_{it}$$

If our assumptions are correct, employment fluctuations should be increasing in the shares of labor and intermediary inputs used for sales:  $\gamma, \delta > 0$ . Once again, the measurement of  $var \log L_{it}$  is the key empirical issue. Starting with the ACEMO survey, we will use three measures of firm level demand for labor flexibility: (1) the share of Fixed Term Contracts in total employment, (2) the share of interim workers in total employment, and (3) the difference between the highest and the lowest

be firm specific trend in sales - due for example to industry decline, or bad quality of the firm itself. In alternative specifications, that are not reported here, we tried other models of sales dynamics, including an industry level trend in  $\log(\text{sales})$ , a firm level trend in  $\log(\text{sales})$ , or an AR(2) model of  $\Delta \log(\text{sales})$ . Results of table 2 were robust to these alternative specifications.

level of employment in the current year, normalized by the average level of employment. While the last proxy is a clear empirical counterpart for labor demand variability, the first two require a few explanations. Indeed, their being good proxies depend on an underlying model of labor demand that may not be true at the firm level. We assume that "flexible" workers (such as those hired under fixed term contracts) are less productive (because they put less effort, as in Saint Paul [1995]), but their jobs are easier to terminate than LTC. In this case, the share of FTC in employment is a measure of the relative return of flexibility, and increases when the firm wishes to adjust employment more. Conditionally on that model being true, the share of "flexible" workers should be a good proxy for expected employment variance.

Table 3 - Flexible inputs and Employment Fluctuations

	Model 1		Model 2		Model 3	
$pQ/R$	1.4 (0.4)	3.2 (0.6)	4.8 (0.2)	10.0 (0.4)	6.2 (0.9)	3.9 (1.3)
$wl/(R - pQ)$	-	-1.2 (0.3)	-	-3.2 (0.2)	-	1.9 (0.7)
$\log L$	1.2 (0.1)	1.3 (0.1)	0.3 (0.1)	0.3 (0.1)	-2.2 (0.4)	-2.2 (0.4)
Firm effects	yes	yes	yes	yes	yes	yes
Year effects	yes	yes	yes	yes	yes	yes
Nb obs.	94,472	83,903	94,472	83,901	92,796	83,912

Reading: All estimates are multiplied by 100. Heteroskedastic standard errors are between parentheses.

Model 1 uses the share of FTCs in total employment as a proxy for the firm level variance of employment. Model 2 uses the share of interim workers. Model 3 relies on the difference between the current year highest and lowest level of employment, normalized by the average level of employment. All regressions exclude top and bottom 1% values of dependent and independent variables.

Regression results are produced in table 3. Since regressions embody fixed effects, estimates are identified on the correlation between changes in intermediate input reliance and changes in employment variability. As displayed in columns 1 and 3, firms that increase their reliance on intermediate inputs increase their demand for labor flexibility. The order of magnitude of estimated coefficients are moderate. In the sample, the average share of fixed term contracts in overall employment amounts to some 5% (2.9% are interim workers). An increase by 6 percentage points in the share of intermediate inputs (which corresponds to one sample standard deviation of the change) is therefore accompanied by an increase of 0.1% in the share of FTC, and 0.2% in the share of interim workers. Results given in column 5 confirm this diagnosis using the more direct measure of labor demand variability. In the sample, the average within year change in employment is 11% of the total. A one standard deviation increase in the reliance on intermediate inputs increase employment variability by 0.4 percentage

points.

In opposite to our prediction, column 2 and 4 show that labor’s share has a negative impact on the demand for flexibility. However, our more direct measure of employment fluctuations displays a positive correlation between increased reliance on intermediate inputs.

These encouraging results should however not be taken too seriously. At this stage, our estimates are plagued with endogeneity and simultaneity biases. For example, they could reflect that labor flexibility and intermediate input purchase are organizational complements, such that firms choosing to switch a new organizational form do both simultaneously. A crude way to account for this would be to instrument dependant variables by their lags: we tried to used 2 years lagged levels of  $Q/Y$  and  $wl.(Y - Q)$ . Results, not displayed here but available from the authors upon request, confirm the positive relations discussed above. They are still vulnerable to many kind of simultaneity bias, since firms organization change may take more than two year. Another, more serious critic, is that the positive relation found above could reflect firm reactions to unexpected, temporary, positive demand shocks. In this case, firms temporarily hire flexible workers, and outsource a larger part of their production.

In addition to this limitation, the methodology used so far does not allow to disentangle the effect of uncertainty on outsourcing from the reverse. While it is difficult to show that firms respond to uncertainty by outsourcing more (our "flexibility effect"), the most interesting prediction of our model is indeed that outsourcing amplifies uncertainty. Fortunately, it is possible to design a method that (1) does not require the actual measurement of variance, (2) accounts for some degree of unobserved firm heterogeneity and (3) pinpoints the causality from outsourcing to uncertainty. This is what we do in the following section.

### 4.2.3 Outsourcing Amplifies Uncertainty : Evidence From Industry Shocks

Firms that tend to rely more on external production should adapt more easily to exogenous demand shocks. As a result, their labor demand should also adapt more. The trick here is to use industry sales shocks to identify exogenous demand - or technology - shocks.<sup>20</sup> To see how they can help, let us take the model outlined in (22), and derive the ex post production level:

$$\log R = \frac{1}{(1-s)(1-\alpha)} \left( \log A - \log \left( \frac{w^{(1-s)(1-\alpha)} p^s}{s^s ((1-\alpha)s)^{(1-\alpha)s}} \right) \right)$$

---

<sup>20</sup>This approach is borrowed from the corporate finance literature, which often lacks proper instruments for its explanatory variable (see e.g. Bertrand and Mulhainathan [2001]).

Assume now that  $s$  does not change from one period to another. Output growth is then given by, after a first order Taylor expansion:

$$\Delta \log R \sim (1 + s - \alpha)\Delta \log A - \Delta \log w - s\Delta \log p$$

Posit now that  $A$ ,  $p$  and  $w$  are fixed at the industry level. In this case, if we denote industry averages by "hats", we get:

$$\Delta \widehat{\log R} \sim (1 + \widehat{s} - \alpha)\Delta \log A - \Delta \log w - \widehat{s}\Delta \log p$$

where  $\widehat{s}$  is the average reliance to intermediate inputs. Combining both equations help us to remove the unobserved productivity shock:

$$\Delta \log R \sim (1 + s - \widehat{s})\Delta \widehat{\log R} - (1 + s - \widehat{s})\Delta \log w - (\widehat{s} - s).\Delta \log p$$

Hence, this equation relates own output fluctuations to industry sales shocks, and their interaction with the relative level of outsourcing. Since home production and intermediate inputs are complements in this model, a greater reliance on outside production (ex post adjustable) improves the level of adaptation to industry sales shocks. Our assumptions can thus be tested using the following empirical equation, for a firm  $i$ , operating in industry  $s$ , at date  $t$ :

$$\Delta \log R_{ist} = \alpha + \delta_s + \beta \left( \frac{Q}{R} \right)_{ist-k} + \gamma_0 \Delta \log R_{st} + \gamma_1 \left( \frac{Q}{R} \right)_{ist-k} \cdot \Delta \log R_{st} + \gamma_2 \left( \frac{Q}{R} \right)_{st-k} \cdot \Delta \log R_{st} \quad (25)$$

where  $R_{ist}$  stand for total sales,  $\Delta \log R_{st}$  for the industry average growth in sales (excluding firm  $i$ ) and  $Q$  is the total cost of intermediary inputs.  $\delta_s$  is an industry effect.  $\gamma_0$  captures the basic reaction of individual firms to industry (exogenous) shocks. If our assumptions are correct,  $\gamma_1 > 0$  and  $\gamma_2 < 0$ , i.e. the larger the reliance on intermediate inputs, the more sensitive a firm is to demand shocks. In the basic model  $k = 2$ , which means that the reliance on intermediate inputs is lagged in order to remove the potential spurious correlation that would arise if  $k = 1$ .<sup>21</sup>

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<sup>21</sup>Indeed, an increase in  $R_{it-1}$  would simultaneously reduce  $Q/R_{it-1}$  and decrease  $\Delta \log R_{it}$ , inducing an upward bias on the estimate of  $\gamma_1$ . Taking  $Q/R_{it-2}$  partially alleviates this problem.

Table 4 - Use of Inputs and Sales Employment Fluctuations

	$\Delta \log(\text{Sales})$		$\Delta \log(\text{Empl.})$	
$\Delta \log R_{st}$	20.9	18.7	10.2	1.2
	(2.2)	(2.7)	(1.7)	(1.9)
$\left(\frac{Q}{R}\right)_{ist-k}$	-2.7	-1.7	-0.4	0.8
	(0.2)	(0.3)	(0.1)	(0.2)
$\left(\frac{Q}{R}\right)_{ist-k} \cdot \Delta \log R_{st}$	56.3	43.0	23.7	6.7
	(4.3)	(4.9)	(3.0)	(3.3)
$\left(\frac{Q}{R}\right)_{st-k} \cdot \Delta \log R_{st}$	-49.8	-32.0	-41.5	-5.2
	(5.2)	(6.6)	(3.7)	(4.6)
Industry effect	no	yes	no	yes
Year effects	yes	yes	yes	yes
Nb obs.	183,918	183,918	183,918	183,918

Reading: All estimates are multiplied by 100. Heteroskedastic standard errors are between parentheses. All regressions exclude top and bottom 5% values of dependent variables, as well as observation with negative value added.

Equation (25)'s estimates are summarized in table 4. The accounting and employment dataset is the fiscal source described above. It covers all firms whose total sales exceed 75,000 \$ a year, and goes from 1984 to 1999. It is an unbalanced panel, and we restrict our estimations to firms that do not leave and reenter the panel. Since our fiscal database allows to draw a distinction between general inputs and firm specific, we restrict, in a first step, our measurement of externalization to the former type.. We used two different dependent variables : total sales and employment.<sup>22</sup>. We also present two sets of estimations, the first one without industry dummy, and the other including industry effects. These two sets are motivated by the fact that industry variability in sales shocks is at the core of our identifying strategy, so that adding industry dummies is likely to deteriorate our estimates. We do it however in order to check whether our results are purely driven by industry effects, or whether our interaction term  $\gamma_1 \left(\frac{Q}{R}\right)_{ist-k} \cdot \Delta \log R_{st}$  really has identifying power on its own.

When estimated without industry effects, estimates suggest that reaction of both own sales and own employment to sales shock increases with the extent of externalization. Estimates from columns 1 and 3, i.e. without industry effects show sizeable effects. Considering a 1% shock of industry sales, own sales go up on average by 0.2%. If own externalization is 15 percentage points greater than the

<sup>22</sup>Recall that under our Cobb Douglas assumption:

$$L = \frac{s(1-\alpha)}{w} R$$

so that a simple equivalent to equation (25) can be found relating employment to industry shocks.

industry average (about one sample standard deviation), then own sales react by an increase of 0.3% instead of 0.2%. These results are to some extent robust to industry effects. The impact on own sales of an industry sales shock remains sensitive to the extent of externalization, though a little smaller. The reaction of labor demand is less robust to the introduction of industry effects, since the t-statistic goes down from 7.8 to 2.4, but remains significant at the 5% level. Here lie the limits of our identifying strategy. Another interpretation of this lack of significant could be that adjustment costs of labor - remember that we are working on French data - compel firms to have a smoother labor demand than required. In our model however, this would create unemployment.

Last, a critical reader may raise some concerns about the simultaneity of the choice of  $s$  (the share of intermediate inputs in total sales), and a temporary demand shock, that would have little to do with the causal impact of reliance on intermediate inputs on reaction to shocks. Taking  $\left(\frac{Q}{R}\right)_{ist-2}$  partially accounts for this. Another way to look into this issue is to instrument  $\left(\frac{Q}{R}\right)_{ist-1}$  through its lagged values (we have no better firm level instrument). We thus performed regression (25) using as instruments, contemporaneous industry shocks interacted with 3 year lagged share of intermediate inputs. Results were not very different than those displayed in table 4.

### 4.3 Leads for Further Research

Although the argument we develop in this paper is fairly simple, we believe it yields interesting insights on the relation between the product market and job market instability. Because of its very simplicity though, we believe that this intuition pursued in this paper delivers several promising leads for further research. First, we have not really modelled imperfections that may arise from frictions on the labor market. Assuming we add frictions in the labor market, outsourcing would be increasing mismatch of workers to vacancies, decreasing employment, and increasing unemployment. Another vein of research would be to look at the interplay between unionization and outsourcing : in a Grossman and Hart-like framework, outsourcing can be modelled as a tool for shareholders to increase their outside option when they bargain with unions. In such a context, outsourcing and fragmentation would be an endogenous response to the rise in unions' toughness. We believe that such a theory would go a long way explaining recent organisational trends in continental europe, particularly in France.

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## A Idiosyncratic Uncertainty

### A.1 Microeconomic Behavior and Determinants of Outsourcing

The model is to be solved backwards. Joint operating profits - gross of effort costs - are given by:

$$\begin{aligned}\Pi^*(\tilde{\tau}; s) &= \max_{l^A, l^B} \left\{ \frac{\tilde{T}^{\frac{1}{\sigma}} [(l^A)^{(1-\alpha)(1-s)} (e^A)^{\alpha(1-s)} (l^B)^{(1-\alpha)s} (e^B)^{\alpha s}]^{1-1/\sigma}}{-w(1-s)l^A - w^*sl^B} \right\} \\ &= \frac{1}{\sigma\varepsilon} \left( \frac{\sigma-1}{\sigma} \frac{1-\alpha}{w^{1-s}w^*s} \right)^{\sigma\varepsilon-1} \tilde{T}^\varepsilon (e_A^{1-s}e_B^s)^{1-\varepsilon}\end{aligned}$$

where  $\varepsilon = 1/(1 + \alpha(\sigma - 1))$ . Supervisor B is however owner of his production, which allows him to claim  $\varphi\Pi^*$  in the bargaining stage. He will therefore take effort *ex post*. The share of surplus allocated to the subcontractor will determine its *ex post* effort level:

$$\Pi_{ST}(k_1, \tilde{T}; s) = \max_{E^B} \left\{ \varphi\Pi^*(\tilde{T}; s) - cse^B \right\}$$

The subcontractor's expected profit is then :

$$\Pi_{ST}(e^A, e^B; s) = \frac{\varphi(1-s(1-\varepsilon))}{\sigma\varepsilon} \left( \frac{\sigma-1}{\sigma} \right)^{\sigma\varepsilon(s)-1} \left( \left( \frac{\alpha\varphi}{c} \right)^{\alpha s} \left( \frac{1-\alpha}{w^{1-s}w^*s} \right)^{1-\alpha} \right)^{(\sigma-1)\varepsilon(s)} E(\tilde{T}^{\sigma\varepsilon(s)}) \cdot (e^A)^{1-\varepsilon(s)}$$

where  $\varepsilon(s) = 1/(1 + \alpha(\sigma - 1)(1 - s))$ . At date 2, the final producer's expected payoff totals the subcontractor's (obtain through auctions) and its own. It is given by:

$$\Pi(e^A; s) = \frac{(1-\varphi s(1-\varepsilon))}{\sigma\varepsilon} \left( \frac{\sigma-1}{\sigma} \right)^{\sigma\varepsilon(s)-1} \left( \left( \frac{\alpha\varphi}{c} \right)^{\alpha s} \left( \frac{1-\alpha}{w^{1-s}w^*s} \right)^{1-\alpha} \right)^{(\sigma-1)\varepsilon(s)} E(\tilde{T}^{\sigma\varepsilon(s)}) \cdot (e^A)^{1-\varepsilon(s)}$$

and the in-house contractible level of effort is given by :

$$V(s) = \max \left\{ \Pi(e^A; s) - c(1-s)e^A \right\}$$

which yields:

$$V(s) = \frac{(\sigma-1)^{\sigma-1}}{\sigma^\sigma} \left( \left( \frac{\alpha}{c} \right)^\alpha \left( \frac{1-\alpha}{w^{1-s}w^*s} \right)^{1-\alpha} \right)^{(\sigma-1)} \underbrace{\cdot \varphi^{1/\varepsilon} \cdot \left( 1 + \frac{1-\varphi}{\varphi} \cdot \frac{\varepsilon(s)}{\varepsilon} \right)^{1/\varepsilon(s)}}_{\text{Hold up}} \cdot \underbrace{\left( E(\tilde{T}^{\sigma\varepsilon(s)}) \right)^{1/\varepsilon(s)}}_{\text{Flexibility}}$$

The entrepreneur maximizes  $\pi(s)$  with respect to  $s$ . We make the same Arrow Pratt approximation as in the main text, based on the fact that the variance of  $\tilde{\tau}$  around its mean is small when compared

to 1. Under this assumption, the first order condition of this problem yields:

$$\begin{aligned}
& \underbrace{\alpha(\sigma-1)\sigma^2\frac{\varepsilon(s)^2}{2}\sigma_{\tilde{\tau}}}_{\text{flexibility gain}} + \underbrace{(1-\alpha)(\sigma-1)\log\frac{w}{w^*}}_{\text{Cost gain}} \\
= & \underbrace{\alpha(\sigma-1)\left(\log\left(1+\frac{1-\varphi}{\varphi}\cdot\frac{\varepsilon(s)}{\varepsilon}\right)+\frac{1}{1+(1-\varphi)\varepsilon(s)/\varphi\varepsilon}-1\right)}_{\text{Strategic cost}}
\end{aligned}$$

which yields the implicit definition of  $s$  as a function of  $\alpha$ ,  $\sigma_{\tau}$ ,  $\sigma-1$ , and  $\varphi$ . It can be shown that the second order condition at the maximum is satisfied if and only if, at the maximand:

$$\alpha(\sigma-1)\sigma^2\sigma_{\tau} < \left(\frac{1-\varphi}{\varphi\varepsilon+(1-\varphi)\varepsilon(s)}\right)^2$$

which we assume to hold; in particular, it always do if :

$$\alpha(\sigma-1)\sigma^2\sigma_{\tau} < \left(\frac{1-\varphi}{\varphi\varepsilon+(1-\varphi)}\right)^2$$

## A.2 General Equilibrium Analysis

All results obtained above must in fact be divided through the price index  $P^{1-\sigma}$ . After some computations, we obtain:

$$\begin{aligned}
P^{1-\sigma} &= \left(\frac{\sigma}{\sigma-1}\right)^{(1-\sigma)} \cdot \left[\left(\frac{c^s C^{1-s}}{\alpha}\right)^{\alpha} \left(\frac{w^{1-s} w^{*s}}{1-\alpha}\right)^{1-\alpha}\right]^{(1-\sigma)} \\
&\times \varphi^{1/\varepsilon-1} \left(1+\frac{1-\varphi}{\varphi}\cdot\frac{\varepsilon(s)}{\varepsilon}\right)^{1/\varepsilon(s)-1} \cdot \left(E(\tilde{\tau}^{\sigma\varepsilon(s)})\right)^{1/\varepsilon(s)}
\end{aligned}$$

Plugging in the price index back into the labor demand function, we get at the firm - and subcontractor - level is given by :

$$\begin{aligned}
l &= \frac{(1-\alpha)\cdot(1-s)}{w} \cdot \frac{\sigma-1}{\sigma} \cdot \frac{1}{n} \cdot \frac{\tilde{\tau}^{\sigma\varepsilon(s)}}{E\tilde{\tau}^{\sigma\varepsilon(s)}} \\
l^* &= \frac{(1-\alpha)\cdot s}{w^*} \cdot \frac{\sigma-1}{\sigma} \cdot \frac{1}{n} \cdot \frac{\tilde{\tau}^{\sigma\varepsilon(s)}}{E\tilde{\tau}^{\sigma\varepsilon(s)}}
\end{aligned}$$

while firm level price and production are given by:

$$\begin{aligned}
\tilde{y} &= \frac{1}{P} \cdot \left(\frac{\tilde{\tau}^{\sigma\varepsilon(s)-1}}{E\tilde{\tau}^{\sigma\varepsilon(s)}}\right)^{\frac{\sigma}{\sigma-1}} \\
\tilde{p} &= P \cdot \left(E\tilde{\tau}^{\sigma\varepsilon(s)}\right)^{\frac{1}{\sigma-1}} \cdot \tilde{\tau}^{\frac{\sigma}{\sigma-1}(1-\varepsilon(s))}
\end{aligned}$$

Ex post joint operating profits - raw of effort costs - are given by :

$$\tilde{\Pi} = \frac{1}{\sigma \varepsilon} \cdot D \cdot \frac{\tilde{\tau}^{\sigma \varepsilon(s)}}{E \tilde{\tau}^{\sigma \varepsilon(s)}}$$

Joint profits - net of effort costs - equal:

$$\tilde{\Pi} = \frac{D}{\sigma} \left( \varphi + (1 - \varphi) \frac{\varepsilon(s)}{\varepsilon} \right) \cdot \left( 1 + \frac{1}{\varepsilon(s)} \left( \frac{\tilde{\tau}^{\sigma \varepsilon(s)}}{E \tilde{\tau}^{\sigma \varepsilon(s)}} - 1 \right) \right)$$

And expected overall profit - relevant for final producer entry - equals :

$$E \tilde{\Pi} = \frac{D}{\sigma} \left( \varphi + (1 - \varphi) \frac{\varepsilon(s)}{\varepsilon} \right)$$

There is an externality of outsourcing onto firms profits. Outsourcing pushes unit costs up and therefore increases the aggregate price level. This raises demand for any single firm. This is a positive externality on firms profits, but a negative one on aggregate production. To see this, we compute aggregate consumption :

$$Y = \left[ \left( \frac{\sigma - 1}{\sigma} \right) \left( \frac{c}{\alpha} \right)^\alpha \left( \frac{\sigma - 1}{\sigma L} \right)^{1 - \alpha} \right]^{-1} \\ \times \left( \varphi^{1/\varepsilon - 1} \left( 1 + \frac{1 - \varphi}{\varphi} \cdot \frac{\varepsilon(s)}{\varepsilon} \right)^{1/\varepsilon(s) - 1} \right)^{1/(\sigma - 1)} \cdot \left( E \tilde{\tau}^{\sigma \varepsilon(s)} \right)^{1/(\sigma - 1)\varepsilon(s)}$$

which, thanks god, does not depend on normalisation. Aggregate consumption is maximised for  $s$  optimizing :

$$\underbrace{\frac{\varepsilon(s) - 1}{2} \sigma_{\tilde{\tau}} + (\sigma - 1)s(1 - \alpha) \log \frac{w}{w^*} + \frac{1}{\varepsilon(s)} \log \left( 1 + \frac{1 - \varphi}{\varphi} \cdot \frac{\varepsilon(s)}{\varepsilon} \right)}_{\text{Individual firm's program}} \\ - \underbrace{\log \left( 1 + \frac{1 - \varphi}{\varphi} \cdot \frac{\varepsilon(s)}{\varepsilon} \right)}_{\text{Externality}}$$

The last term of this expression highlights the negative externality discussed above. Outsourcing increases unit costs, and therefore prices : this externality is non zero as long as  $\varphi < 1$ .

## B Aggregate Uncertainty

### B.1 Computing the New First Order Condition

The new assumptions are described in the main text. The model now has to be solved backward, taking into account the fact that macroeconomic variables - like  $P$ ,  $w$  - may now be stochastic. After

uncertainty is resolved, joint operating profits (sales minus labor costs, gross of effort costs) are now given by :

$$\begin{aligned} \tilde{\Pi} = & \frac{1}{\sigma\varepsilon} \cdot \left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1} \cdot \underbrace{\varphi^{\frac{1}{\varepsilon}-1} \left(1 + \frac{1-\varphi}{\varphi} \cdot \frac{\varepsilon(s)}{\varepsilon}\right)^{\frac{1}{\varepsilon(s)}-1}}_{=H \text{ Hold Up Costs}} \cdot \underbrace{\left[\left(\frac{\alpha}{c}\right)^\alpha\right]^{\sigma-1}}_{=1/C_1 \text{ Effort Unit Cost}} \times \\ & \underbrace{\left[\left(\frac{1-\alpha}{w^*s\tilde{w}^{1-s}}\right)^{(1-\alpha)}\right]^{(\sigma-1)\varepsilon(s)}}_{=1/\tilde{C}_2 \text{ Labor Unit Cost}} \cdot \tilde{T}^{\sigma\varepsilon(s)} \cdot E \left\{ \left[\left(\frac{1-\alpha}{w^*s\tilde{w}^{1-s}}\right)^{(1-\alpha)}\right]^{(\sigma-1)\varepsilon(s)} \cdot \tilde{T}^{\varepsilon(s)} \right\}^{\frac{1}{\varepsilon(s)}-1} \end{aligned}$$

Before uncertainty is resolved, expected profits for final producer, net of effort costs and including license to subcontract intermediate goods is given by :

$$E\tilde{\pi} = \frac{(\sigma-1)^{\sigma-1}}{\sigma^\sigma} \cdot \varphi^{\frac{1}{\varepsilon}} \left(1 + \frac{1-\varphi}{\varphi} \cdot \frac{\varepsilon(s)}{\varepsilon}\right)^{\frac{1}{\varepsilon(s)}} \cdot C_1^{-(\sigma-1)} \cdot E \left\{ \tilde{C}_2^{-(\sigma-1)\varepsilon(s)} \cdot \tilde{T}^{\varepsilon(s)} \right\}^{\frac{1}{\varepsilon(s)}}$$

whose maximum with respect to  $s$  yields the desired choice of subcontracting. To do this however, we need to compute the ex post distribution  $\tilde{T}$ , which includes fluctuations in prices  $P$ . In a rational expectation equilibrium, each firm takes the other's  $s^*$  as given, and computes the distribution of  $\tilde{T}$  (which includes aggregate demand  $\tilde{D}$  and the price level  $\tilde{P}$ ) by correctly expecting the distribution of possible market equilibria.

We look for symmetric equilibria in  $s$ . Assume all firms chose  $s^*$ , then, the ex post price level is given by :

$$\tilde{P}^{(\sigma-1)\varepsilon(s^*)} = \left(\frac{\sigma}{\sigma-1} C_1(s^*) \tilde{C}_2(s^*)\right)^{(\sigma-1)\varepsilon^*} \cdot H(s^*)^{\varepsilon(s^*)} \cdot \left(\frac{1}{\int_0^n \tilde{\tau}_i^{\sigma\varepsilon(s^*)} di}\right) \cdot E \left\{ \frac{\tilde{\tau}_i^{\sigma\varepsilon(s^*)}}{\int_0^n \tilde{\tau}_i^{\sigma\varepsilon(s^*)} di} \right\}^{\varepsilon(s^*)-1}$$

Plugging in this expression of the price level into firm level labor demand yields :

$$\begin{aligned} l &= \frac{(1-\alpha) \cdot (1-s^*)}{\tilde{w}} \cdot \frac{\sigma-1}{\sigma} \cdot \frac{\tilde{\tau}_i^{\sigma\varepsilon(s^*)}}{\int_0^n \tilde{\tau}_i^{\sigma\varepsilon(s^*)} di} \\ l^* &= \frac{(1-\alpha) \cdot s^*}{\tilde{w}^*} \cdot \frac{\sigma-1}{\sigma} \cdot \frac{\tilde{\tau}_i^{\sigma\varepsilon(s^*)}}{\int_0^n \tilde{\tau}_i^{\sigma\varepsilon(s^*)} di} \end{aligned}$$

Domestic labor market equilibrium is therefore :

$$\tilde{w} = \frac{(1-\alpha) \cdot (1-s^*)}{L} \cdot \frac{\sigma-1}{\sigma}$$

Hence, the wage - in terms of aggregate spending - does not fluctuate. We now know the distributions of  $\tilde{w}$  and  $\tilde{P}$ . Since  $\tilde{T}_i = D \cdot \tilde{\tau}_i \cdot P^{\sigma-1}$ , we recalculate the expected joint profit  $E\tilde{\pi}$  and maximise it to

derive the new first order condition of the model. It now takes the form :

$$(\sigma - 1)\alpha\varepsilon^2(s)\sigma_I^2 + (1 - \alpha).(\sigma - 1).\log\left(\left[\frac{\sigma - 1}{\sigma\gamma Lw^*}.(1 - \alpha).(1 - s)\right]\right) = -\frac{H'}{H}(s)$$

which is equation (20).

## B.2 New Aggregate Production

To know whether aggregate uncertainty is amplified by  $s$ , we compute aggregate production function, which is equal to  $1/P$  and is given by :

$$\tilde{Y} = \left(\frac{\sigma - 1}{\sigma}C_1\tilde{C}_2\right)^{-1} .H^{\frac{1}{\sigma-1}} . \left(\int_0^n \tilde{\tau}_i^{\sigma\varepsilon(s^*)} di\right)^{\frac{1}{(\sigma-1)\varepsilon(s^*)}} .E \left\{ \frac{\tilde{\tau}_i^{\sigma\varepsilon(s^*)}}{\int_0^n \tilde{\tau}_i^{\sigma\varepsilon(s^*)} di} \right\}^{\alpha(1-s)-1}$$