The Cleansing Effect of Offshore Outsourcing in an Analysis of Employment

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Abstract

Despite the public concern regarding the destructive employment effect of offshore outsourcing, empirical studies of U.S. multinationals find that the effect is ambiguous. This paper presents theoretical and numerical analyses of labor market implications of offshore outsourcing. I construct a partial equilibrium model of outsourcing with heterogeneous firms. Heterogeneity in productivities generates different firm-level responses to outsourcing: the most productive firms outsource, the least productive firms are forced to exit (Cleansing Effect), and the firms with intermediate productivity level continue operating as home-producers.

The theory generates a strong prediction that offshore outsourcing unambiguously reduces aggregate employment at home. The numerical analysis, with calibration to U.S. manufacturing sector, shows that the strong negativity of the employment effect stems from the cleansing effect. It also shows that the net effect within outsourcing firms is ambiguous due to a sizeable job creation. By decomposing net employment loss into job destruction and creation, this paper finds that the net employment change can be less than half of the gross employment change, and that the layoffs by outsourcers account for the majority of total job destruction. These findings suggest that the previous empirical studies, of outsourcing firms alone, understate the negative impact of offshore outsourcing on employment.

JEL: F12, F14, F16

Key Words: cleansing effect, offshore outsourcing, employment effect, job destruction, job creation

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1 Introduction

In 2004, offshore outsourcing became so common in the public perception that it became a frequent topic of everybody's dinner-table talk. Especially since it was an election year, it was very much a political matter rather than just an economic phenomenon. Presidential candidates did not hesitate to blame outsourcing for large losses of manufacturing jobs. They went a step further to promise the nation that they would stop the outflow of American jobs. Mankiw and Swagel (2006) show the explosive rise in media references[1] to "outsourcing" in their Figure 1. In 2002 and 2003, the references were around 300 in each year, then it increased to more than 1000 in 2004.

There is yet no consensus on the definition of offshore outsourcing. Many studies use "offshoring" as carrying out some stages of production at owned affiliates in the foreign country; and "offshore outsourcing" as that using arm's-length contracts (Harrison and McMillan, 2006). However, I use "outsourcing" to refer to both foreign production at owned affiliates and through arm's-length contracts. "Offshore outsourcing" and "outsourcing" are used interchangeably.

Despite the public concern about the link between offshore outsourcing and job losses, empirical studies find that the employment effect of outsourcing is neither unanimously negative nor of significant magnitude. One branch of the empirical literature focuses its attention on the activities of foreign affiliate operations of multinational enterprises. They use firm-level data to investigate the within-firm labor substitution between domestic facilities and foreign affiliates. One of the most frequently used datasets is the firm-level surveys on U.S. Direct Investment Abroad collected by the U.S. Bureau of Economic Analysis (BEA). Brainard and Riker (1997) find small substitution between US facilities and foreign affiliates, and stronger substitution among foreign affiliates in low-wage countries. Stronger substitution between US employment and foreign affiliate employment is found by Hanson, Mataloni, and Slaughter (2003). On the other hand, Desai, Foley, and Hines (2005) find complementarity between US locations and foreign affiliates of US multinationals. They find that when foreign employment rises by 10%, US employment within the firm rises by 2.5%. In Contrast, Borga (2005) finds an insignificant effect. Harrison and McMillan (2007) separate horizontal and vertical affiliates, and also high-cost and low-cost locations. They find employment complementarity for vertical affiliates, but substitution for horizontal affiliates. There are also empirical studies on the outsourcing activities of other industrial nations. Muendler and Becker (2010) investigate German multinational enterprises (MNEs) and find strong substitution. Braconier and

[1] Reference by four major newspapers: The New York Times, Washington Post, Los Angeles Times, and USA Today

Ekholm (2000), in their study of Swedish multinationals, find substitution between Swedish facilities and affiliates in high-income countries, but neither substitution nor complementarity for affiliates in low-income countries.

Although these firm-level data are very rich in various operational information, foreign operations of multinationals should not be the definitive measure of outsourcing activities. In fact, a large portion of outsourcing takes place through arm's-length contracts (Crino, 2007). If outsourcing through own affiliates and through arm's-length contracts are driven by distinct incentives (Grossman and Helpman, 2003), their effect on employment at the headquarter location can also be different.

Another branch of the empirical literature utilizes the share of imported inputs at various level of aggregation as a measure of outsourcing. The employment effects from these studies are also weak. Amiti and Wei (2006) find that the impact is insignificant at the disaggregated level, but positive at a more aggregated level in the U.S. manufacturing sector between 1992 and 2000. In a similar study, Amiti and Wei (2005) find an insignificant employment effect in the U.K. manufacturing industry between 1995 and 2001. For the Canadian manufacturing sector, Morissette and Johnson (2007) find that the industries with intense outsourcing did not show significantly different employment growth rates compared to other industries. Keller and Stehrer (2008) use Austrian data and find that outsourcing has a negative effect during 1995-2000, but a positive effect during 2000-2003.

These ambiguous results suggest that outsourcers may create a number of jobs that is large enough to offset their layoffs. Outsourcing firms might be the source of job destruction, but they are also the ultimate beneficiaries of outsourcing, and the realized benefits may be translated into new jobs. However, these insignificant net effects could reflect a combination of small job destruction and small job creation, or alternatively large destruction and creation. Although both may result in net effects of the same magnitude, they imply very different adjustment costs for workers. In many cases, offshore outsourcing takes the form of relocating labor-intensive parts of the process. This implies that jobs that are destroyed and jobs that are newly created are likely to be different in their tasks and skill levels. In other words, the laid-off workers are not readily employable for the new jobs. In order to reduce the adjustment cost of workers, it is often necessary to provide them with occupational training and, in some cases, remedial education through a program such as Trade Adjustment Assistance (TAA).[2] In order to properly assist the

[2]The TAA program is specially designed for unemployed workers whose layoffs are caused by import competition and outsourcing, with the purpose of helping them get a new job sooner. The TAA services and benefits include occupational training, remedial education, income support during training, reemployment services, job search allowances,

displaced workers, a correct understanding and measurement of the size of outsourcing-related separations is necessary. None of currently available data on outsourcing activities is appropriate for this purpose. Data on multinationals' operations fail to capture outsourcing activities that utilize arm's length contracts. These data also do not report the amount of separation separately from new hires. Data on outsourcing activities measured by usage of imported inputs fail to capture outsourcing in the form of foreign assembly.

For this reason, we need more structural theoretical analysis to capture various labor market dynamics that drive the aggregate impact that we can observe in data. In this paper, I construct a partial equilibrium model of offshore outsourcing with firms that are heterogeneous in their productivity levels (Melitz, 2003). Initially there are two symmetric northern countries that are open for international trade. The manufacturing process consists of two segments, Assembly and Services. As outsourcing becomes feasible, outsourcing firms send their assembly segments to a Southern country that does not consume the final products. Using this structural model, I find that the most productive firms outsource - as found in Kurz (2006) - and that the least productive firms are forced to exit. I call the exit of the least productive firms *the Cleansing Effect of Offshore Outsourcing*[3]. With this structural model, I can quantify job creation separately from job destruction, and the employment response of different groups of firms - the cleansing effect, non-outsourcers, and outsourcers - separately.

I find that outsourcing unambiguously reduces aggregate employment as it becomes feasible. Whether this result is contrary to previous empirical findings requires further analysis, since this model includes the entire industry rather than only the outsourcers. For this, I perform numerical analysis by using benchmark parameter values that are calibrated to match the initial and outsourcing equilibrium to the U.S. manufacturing sector of 1992 and 2006, respectively. I find that the net employment loss may reach up to 36% of total initial employment. However, the majority (50-75%) of such net employment loss is due to the job destruction brought about by the cleansing effect of outsourcing rather than layoffs by outsourcers. As a sensitivity analysis, I show the cleansing effect as a share of net employment loss for six different sets of parameter values. All six cases confirm the dominance of the cleansing effect in driving the negative net employment effect. Although the cleansing effect is not directly related to outsourcing activities, such job destruction

and relocation allowances.

[3] The term 'Cleansing Effect' is first used by Caballero and Hammour (1994). They use the term to refer to firms' restructuring strategy that clean outdated techniques or less profitable products out of their plants during recession when adjustment cost is low.

is clearly an outcome of offshore outsourcing. This finding implies that the BEA dataset is only valid for the analysis of within-firm employment effects among outsourcers. In order to discuss the more aggregate employment effects that outsourcing brings about, non-outsourcers, and even the firms that disappear from the market as a result of outsourcing, should be included in the analysis as subjects.

The numerical analysis confirms the previous finding that employment effect of outsourcing within outsourcing firms is ambiguous. For the benchmark parameter values, the net effect ranges from 17% net loss to 3% net gain. The separate analysis of job destruction shows that the observable net employment change is less than half of the gross job flow. Total job destruction is up to 59% of initial employment. Despite the striking dominance of the cleansing effect in the net employment effect, the layoffs by outsourcers indeed account for a larger portion of total job destruction, implying that despite the ambiguous net employment effect, the layoffs by outsourcers are an important socio-economic phenomenon that deserves a significant amount of policy attention.

Besides the impacts on employment, I show theoretically that outsourcing promotes international trade by eliminating the price disadvantage that exporters face in their foreign market in the absence of outsourcing. I also find that outsourcing reduces the total number of varieties available to consumers. This is a surprising result since product variety gain has been regarded as one of the most important benefits of international trade. This result stems from the fact that outsourcing benefits a small number of large-scale firms with high productivities, and the cleansing effect drives a large number of small producers out of the market.

The structure of this model can be used for evaluation of various types of anti-outsourcing legislation. For instance, we can analyze the effect of complete prohibition of outsourcing in raising domestic employment by comparing the outsourcing equilibrium presented in the paper to the asymmetric outsourcing equilibrium where firms from one northern country (the home country) is prohibited from outsourcing while outsourcing of the other country's firms and international trade are allowed. The model can also be used to evaluate more specific policy proposals. For instance, in order to evaluate the efficacy of John Kerry's policy proposal that repeals the tax break for outsourcing firms[4], I can add one parameter for price distortion caused by changes in tax.[5] Although this is of great policy relevance, it is beyond the scope of this paper.

The rest of the paper is organized as follows. Section 2 introduces the model. Sections 3 and 4

[4] for more detail, see Mankiw and Swagel (2006)

[5] Or more easily, I can adjust the Southern wage rate which then affects the total price of outsourced products.

present, respectively, the analytical results and numerical analyses. Section 5 concludes.

2 Model

Initially, there are two symmetric Northern countries that produce and consume manufacturing products. Two countries trade with each other, so each market is served by its local products and imported products. There is a continuum of firms that are heterogeneous in their productivities. Each firm utilizes only labor as a factor to perform two processes - assembly and services - in order to manufacture its unique variety. As outsourcing becomes feasible, I introduce a Southern country with a lower wage as a host of outsourcing activities. The South does not have a market for the final products. A Northern firm has an option to outsource its assembly segment to the South to reduce its production cost.

2.1 Set-up

A representative consumer has CES preference over a continuum of goods indexed by ω. The utility function is as follows:

$$U = \left[\int_{\omega \in \Omega} q(\omega)^{\rho} d\omega \right]^{\frac{1}{\rho}} \tag{1}$$

Ω is the set of available varieties. The consumer spends a fixed amount of expenditure, R, on these differentiated varieties. the demand for variety ω is as follows.

$$q(\omega) = \frac{R}{P} \left[\frac{p(\omega)}{P} \right]^{-\varepsilon} \qquad \text{where} \qquad P = \left[\int_{\omega \in \Omega} p(\omega)^{1-\varepsilon} \right]^{\frac{1}{1-\varepsilon}} \tag{2}$$

ε is the elasticity of substitution and equal to $1/(1-\rho)$. P is the market price index.

Firms are heterogeneous in their productivity levels. The basic framework of firm-heterogeneity and the decision making process follows Melitz (2003). Upon entry into the market, a firm incurs the sunk entry cost f_e, and draws a productivity z from a cumulative distribution $G(z)$. Labor is the only factor of production, and the firm's unit labor requirement is determined as $1/z$. After observing z, the firm decides whether to stay and produce at the fixed cost of production, f, or to exit. In the absence of outsourcing, successful entrants again decide whether to export at an additional fixed export cost, f_x. Where outsourcing is feasible, successful entrants choose one of the following options: first, produce at home and only serve domestic market; second, produce at home and serve both domestic and foreign markets (incurring f_x); third, outsource and serve only domestic market (additional fixed cost of outsourcing, f_{os}); and lastly, outsource and serve both markets (both f_x and f_{os}).

Total labor requirement for a firm is sum of fixed and variable costs. For instance, total labor requirement for a firm that neither exports nor outsources is

$$l(z) = f + \frac{q(z)}{z} \tag{3}$$

The wage rate in both Northern countries is equal to one. Variable costs are composed of two segments, assembly and services. Each process utilizes a fixed share of workers with γ as the employment share of service segment. Therefore, labor requirement for one unit of final output is $(1-\gamma)/z$ for the assembly segment and γ/z for the service segment. After successful entry, every firm faces a probability of death, ξ every period. In a steady state equilibrium, as some of existing firms exit, new entrants fill their spots.

2.2 Open Economy without Offshore Outsourcing

The open economy equilibrium in the absence of outsourcing resembles that of Melitz (2003). There are two Northern countries who are identical and trade their final goods with each other. Every firm produces a different variety and charges a monopoly price. For domestic sales, the price is simply a constant markup over marginal cost; that is

$$p_{d,hp}(z) = \frac{1}{\rho z} \tag{4}$$

The subscript d and hp respectively indicate variables for domestic market and variables for home-producers (opposed to outsourcers). The profit from a firm's domestic sales is

$$\pi_{d,hp}(z) = \frac{r_{d,hp}(z)}{\varepsilon} - f \tag{5}$$

where the revenue, $r_{d,hp}(z)$, is, drawing from equations (2) and (4)

$$r_{d,hp}(z) = R\,(P\rho z)^{\varepsilon-1} \tag{6}$$

If this firm decides to export, it will charge the monopoly price inclusive of transport cost. Transport cost takes the form of the iceberg cost. The price of the same product in foreign market is, therefore, $p_{x,hp}(z) = \tau p_{d,hp}(z)$. The subscript x indicates the variables for export market. All exporters also serve their domestic markets and I can separately express the export profit from the domestic profit as follows:

$$\pi_{x,hp}(z) = \frac{r_{x,hp}(z)}{\varepsilon} - f_x \qquad \text{where} \qquad r_{x,hp}(z) = \tau^{1-\varepsilon} r_{d,hp}(z) \tag{7}$$

The total profit of an exporter is sum of equations (5) and (7).

2.2.1 Initial Open Economy Equilibrium

As seen in Melitz (2003), the equilibrium is characterized by two productivity cut-offs that summarize two decisions of firms - entry and exporting. I let z_{hp}^0 and z_x^0 denote the entry and export cut-off productivity, respectively. Superscript 0 indicates the variables for the initial open economy equilibrium.

First, I define two productivity cut-offs, $\check{z}_{d,hp}$ and $\check{z}_{x,hp}$. Their corresponding profits, $\pi_{d,hp}(\check{z}_{d,hp})$ and $\pi_{x,hp}(\check{z}_{x,hp})$, respectively, are zero. Since both $\pi_{d,hp}(z)$ and $\pi_{x,hp}(z)$, are monotonically increasing in z, the entry and export cut-off productivities, z_{hp}^0 and z_x^0, are simply the zero profit productivities, $\check{z}_{d,hp}$ and $\check{z}_{x,hp}$, respectively. Home producers' total profit function, $\pi_{hp}(z)$, and the pattern of operation are depicted in Figure 1. Using equations (5), (6), and (7), z_x^0 can be written as a function of z_{hp}^0 as the following:

$$z_x^0 = \tau \left(\frac{f_x}{f}\right)^{\frac{1}{\varepsilon-1}} z_{hp}^0 \tag{8}$$

As in Melitz(2003), I assume $f_x > \tau^{1-\varepsilon} f$ throughout this paper. This assumption ensures existence of both exporters and nonexporters in the market.

Let M_d^0 denote the number of domestic varieties in the initial open economy equilibrium, and M_x^0 the number of exporters. Due to symmetry, M_x^0 is also the number of imported varieties. The total number of varieties available to consumers is $M_t^0 = M_d^0 + M_x^0$. I define $\tilde{z}(\hat{z})$ as an average productivity for all firms with productivity higher than $\hat{z}$; that is,

$$\tilde{z}(\hat{z}) = \left[\frac{1}{1-G(\hat{z})} \int_{\hat{z}}^{\infty} z^{\varepsilon-1} g(z) dz\right]^{\frac{1}{\varepsilon-1}} \tag{9}$$

Then the average productivity of all varieties available in the initial equilibrium, $\tilde{z}_t^0$, is

$$\tilde{z}_t^0 = \left\{ \frac{1}{M_t^0} \left[M_d^0 \tilde{z}(z_{hp}^0)^{\varepsilon-1} + M_x^0 \left(\frac{\tilde{z}(z_x^0)}{\tau} \right)^{\varepsilon-1} \right] \right\}^{\frac{1}{\varepsilon-1}} \tag{10}$$

From equations (2), (4), and (10), I can derive two aggregate variables - price index, P_0, and the aggregate revenue, R - as functions of the average productivity, $\tilde{z}_t^0$.

$$P_0 = M_t^0 {}^{\frac{1}{1-\varepsilon}} \; p_{d,hp}(\tilde{z}_t^0) \tag{11}$$

$$R = M_t^0 \; r_{d,hp}(\tilde{z}_t^0) \tag{12}$$

2.2.2 Equilibrium Conditions

Let $\bar{\pi}^0$ denote the average profit of all operating firms in the initial open economy equilibrium. It can be written as

$$\bar{\pi}^0 = \pi_{d,hp}(\tilde{z}(z_{hp}^0)) + Pr_x^0 \pi_{x,hp}(\tilde{z}(z_x^0))$$

where Pr_x^0 is the probability of exporting upon successful entry, $Pr_x^0 = (1 - G(z_x^0))/(1 - G(z_{hp}^0))$. Using two zero cut-off productivities, z_{hp}^0 and z_x^0, together with equations (5), (6), and (7), we can rewrite the average profit function as the following.

$$\bar{\pi}^0 = fk(z_{hp}^0) + \left[\frac{1 - G(z_x^0)}{1 - G(z_{hp}^0)} \right] f_x k(z_x^0) \tag{13}$$

where

$$k(\hat{z}) = \left(\frac{\tilde{z}(\hat{z})}{\hat{z}} \right)^{\varepsilon-1} - 1 \tag{14}$$

There is free entry in the market. Therefore, the expected value of entry, measured as the stream of expected future profit with death hazard ξ, $\bar{\pi}^0/\xi$, must be zero. The probability of successful entry in the initial open economy equilibrium is $1 - G(z_{hp}^0)$, and there is an entry cost f_e. Therefore, the free entry condition for this equilibrium is, using equation (13) is

$$fk(z_{hp}^0) + \left[\frac{1 - G(z_x^0)}{1 - G(z_{hp}^0)} \right] f_x k(z_x^0) = \frac{\xi f_e}{1 - G(z_{hp}^0)} \tag{15}$$

where the cut-off productivity for exporting, z_x^0, is a function of z_{hp}^0, as in equation (8).

2.3 Open Economy with Offshore Outsourcing

Outsourcing takes the form of relocating assembly segment to another country. I introduce a Southern country that can perform assembly and does not demand the final product. The South has a lower wage rate, δ, which is smaller than one. δ is wage rate per efficiency unit of labor, controlling for any differential in labor productivity. The production technology is firm-specific, so the productivity, z, is preserved regardless of the location of assembly. The only advantage of outsourcing is labor cost reduction. If a firm with productivity z outsources, its marginal production cost becomes

$$mc_{os}(z) = \lambda \cdot \frac{1}{z} \qquad \text{where} \qquad \lambda = (1-\gamma)\delta + \gamma \tag{16}$$

I assume that the integration of assembly and service segments is virtual and that goods are completed in the South. That is as if the service portion is performed in the firm's home country and shipped to the South for completion, but there is no transport cost involved. Any extra cost involved in the integration process can be captured by fixed outsourcing cost, f_{os}. After completion, final goods are shipped to the market directly from the South. The iceberg transport cost, τ, applies to shipment of final goods. One anecdotal example is computer industry. More sophisticated tasks, such as R&D, are performed in the US while a lot of parts manufacturing and final assembly are done in low-wage countries, such as China. The world demand is met by direct shipments from those locations of production.

The transportation structure is summarized in Figure 2. Figure 2 is depicted for two representative goods that are produced by two firms originating in two Northern countries. These goods are produced with the same productivity. The circles represent the national borders; and two prices in each circle represent the prices of local and imported goods, respectively. Panel (a) describes traditional international trade where goods are shipped directly from the origin countries. This applies to all firms in the initial open economy equilibrium and non-outsourcers in the outsourcing equilibrium. One can see that goods face price disadvantage in their foreign markets in the case of traditional international trade due to transport cost. Panel (b) describes the case for outsourcers. Where goods are outsourced, the markup over the marginal cost upon completion at the Southern facilities is λP. These goods are shipped to both markets where they are sold for $\tau\lambda P$. Therefore, outsourcing lowers domestic prices from P to $\tau\lambda P$, while it lowers export prices from τP to $\tau\lambda P$. For this reason, exporters benefit more from outsourcing than non-exporters do. For instance, where $\tau\lambda \geq 1$, non-exporters do not have an incentive to outsource while exporters still might depending on the relative size of domestic and foreign sales.[6]

As described in Figure 2, the price of a good produced by an outsoucer with productivity z is as follows.

$$P_{d,os}(z) = P_{x,os}(z) = \frac{\tau\lambda}{\rho z} \tag{17}$$

Since prices in the home and foreign markets are the same, revenues from the two markets are the same as well.

$$r_{d,os}(z) = r_{x,os}(z) = R\left(\frac{P\rho z}{\tau\lambda}\right)^{\varepsilon-1} \tag{18}$$

There is a fixed cost of outsourcing, f_{os}. Outsourcing firms incur f_{os} in addition to fixed production cost f, and fixed export cost f_x in case they export. All exporting outsourcers also serve their domestic markets; so I can write two separate expressions for domestic and export profits of an outsourcer as the following.

$$\pi_{d,os}(z) = \frac{r_{d,os}(z)}{\varepsilon} - f - f_{os} \qquad\qquad \pi_{x,os}(z) = \frac{r_{x,os}(z)}{\varepsilon} - f_x \tag{19}$$

If $f_x > f + f_{os}$, the total profit function for an outsourcer, $\pi_{os}(z)$, looks like panel (a) of Figure 3. $\check{z}_{d,os}$ and $\check{z}_{x,os}$ represent two zero-profit productivities such that $\pi_{d,os}(\check{z}_{d,os}) = 0$ and $\pi_{x,os}(\check{z}_{x,os}) = 0$. In this case, exporting and non-exporting outsourcers co-exist and more productive outsourcers export. $\check{z}_{d,os}$ and $\check{z}_{x,os}$ serve as the cut-off productivities for outsourers' entry and exporting decisions, respectively.

Where $f_x \leq f + f_{os}$, depicted in panel (b), all outsourcers export. The total profit function for an outsourcer is $\pi_{d,os}(z) + \pi_{x,os}(z)$ if $z \geq \check{z}_{os}$ and zero otherwise. $\check{z}_{os}$ is the productivity level where $\pi_{d,os}(\check{z}_{os}) + \pi_{x,os}(\check{z}_{os}) = 0$. Not to participate in outsourcing is still an option for firms. I call the firms that choose not to outsource home-producers. In this equilibrium, variables for home-producers are indicated by subscript hp. Their total profit function is depicted in Figure 1.

2.3.1 Equilibria

Firms make three decisions in the outsourcing equilibrium: first, whether to stay in the market or exit; second, whether to produce at home or outsource; finally, whether to export. Such decisions are based on two profit functions, the total profit functions for home-producers ($\pi_{hp}(z)$) and outsourcers ($\pi_{os}(z)$). These decisions depend crucially on the shapes and positions of two profit functions,

[6] I do not allow firms to outsource assembly only for export sales for mathematical tractability.

which are determined by parameter values (λ, τ, and ε) and fixed costs (f, f_x, and f_{os}). Each set of parameter values and fixed costs can potentially represent a specific industry.

Under the assumption, $f_x > \tau^{1-\varepsilon} f$, there are total of twelve equilibria.[7] Figure 4 shows four of them as examples. One can clearly see how $\pi_{hp}(z)$ and $\pi_{os}(z)$ determine the patterns of operation. Since the goal of this paper is to study the response of labor market to outsourcing, I will narrow the focus by making an additional assumption, $\tau\lambda < 1$. Recall that where $\tau\lambda \geq 1$, non-exporters do not have an incentive to outsource because it raises their prices for domestic sales. The assumption $\tau\lambda < 1$ limits our analysis to cases with sizeable outsourcing activities in the market. Seven out of twelve equilibria satisfy the condition. The four equilibria shown in Figure 4 also satisfy the condition $f_x > f + f_{os}$ which ensures the existence of non-exporting outsourcers.

The seven equilibria together display five distinctive operational patterns shown in Figure 5. Figure 6 then shows the size of fixed costs that corresponds to each pattern given other parameter values. α is the size of fixed export cost relative to that of fixed production cost ($\alpha = f_x/f$), and β denotes the size of fixed outsourcing cost relative to f ($\beta = f_{os}/f$). Where outsourcing cost is very small as in patterns D and E, there is no home-producer in the market. Where there are home-producers as well as outsourcers, the extent of outsourcing still depends on the size of fixed outsourcing cost. According to Figure 6, pattern A shows the highest degree of outsourcing and pattern C the lowest. Accordingly, the impacts of outsourcing on the industry - such as employment effect - is the largest under pattern A.

Analyses of the impacts of outsourcing on the various aspects of the industry require comparison between the initial open economy equilibrium and the outsourcing equilibrium. This comparison should be carried out separately for each outsourcing equilibrium pattern - A through E - because the firms' operational responses differ across patterns. In the next section, I present a detailed model under pattern A. The detailed model for other patterns is not presented in this paper, but will be included in the numerical analyses.

2.3.2 Equilibrium Pattern A.

Under the pattern A, there are three groups of firms - home producers that only serve the domestic market, outsourcers that only serve the domestic market, and outsourcers that serve both domestic and foreign markets. The entry cut-off productivity, z^A_{hp}, is the home-producers' zero-profit productivity, $\check{z}_{d,hp}$. The outsourcing cut-off productivity, z^A_{os}, is where a firm is indifferent between

[7] These twelve equilibria are drived and presented in the Technical appendix available upon request.

outsourcing and home-production, $\pi_{d,hp}(z_{os}^A) = \pi_{d,os}(z_{os}^A)$. All exporters are outsourcers, so the export cut-off productivity, z_x^A is the productivity level with which an outsourcer's export profit is zero, $\tilde{z}_{x,os}$. The superscript A indicates the variables under the outsourcing equilibrium pattern A. Using equations (5), (6), and (18)-(19), z_{os}^A and z_x^A can be written as functions of z_{hp}^A as the following:

$$z_{os}^A = \left[\frac{1}{(\tau\lambda)^{1-\varepsilon} - 1}\left(\frac{f_{os}}{f}\right)\right]^{\frac{1}{\varepsilon-1}} z_{hp}^A \qquad \text{and} \qquad z_x^A = \tau\lambda\left(\frac{f_x}{f}\right)^{\frac{1}{\varepsilon-1}} z_{hp}^A \tag{20}$$

The average productivity of all varieties that are availale in the market is as follows.

$$\tilde{z}_t^A = \left\{\frac{1}{M_t^A}\left[M_{hp}^A \tilde{z}_{hp}^{A\,\varepsilon-1} + M_{os}^A\left(\frac{\tilde{z}(z_{os}^A)}{\tau\lambda}\right)^{\varepsilon-1} + M_x^A\left(\frac{\tilde{z}(z_x^A)}{\tau\lambda}\right)^{\varepsilon-1}\right]\right\}^{\frac{1}{\varepsilon-1}} \tag{21}$$

M_{hp}^A, M_{os}^A, and M_x^A, respectively, denote the numbers of varieties of home producers, outsourcers, and imported varieties. M_t^A is the total number of varieties in the market; that is $M_t^A = M_{hp}^A + M_{os}^A + M_x^A$. $\tilde{z}_{hp}^A$ is the average productivity of home-producers whose productivities lie between z_{hp}^A and z_{os}^A which can be written as the following.

$$\tilde{z}_{hp}^A = \left[\frac{M_d^A}{M_{hp}^A}\tilde{z}(z_{hp}^A)^{\varepsilon-1} - \frac{M_{os}^A}{M_{hp}^A}\tilde{z}(z_{os}^A)^{\varepsilon-1}\right]^{\frac{1}{\varepsilon-1}} \tag{22}$$

M_d^A is the number of domestic varieties, hence, sum of M_{hp}^A and M_{os}^A. The aggregate revenue and the price index are, from equations (4), (11), and (12),

$$R = M_t^A\ r_{d,hp}(\tilde{z}_t^A) \qquad \text{and} \qquad P_A = M_t^{A\,\frac{1}{1-\varepsilon}}\left(\frac{1}{\rho\tilde{z}_t^A}\right)$$

Free entry condition requires that the expected value of entry, $(1 - G(z_{hp}^A))\bar{\pi}^A/\xi$, is equal to the sunk entry cost, f_e. $\bar{\pi}^A$ is the average profit of all varieties under the outsourcing equilibrium pattern A which is the weighted average of average profits of non-exporting home-producers, non-exporting outsourcers, and exporting outsourcers, It is very similar to equation (15). Then the equilibrium condition for the outsourcing equilibrium pattern A is as the following:

$$k(z_{hp}^A)f + \left[\frac{1-G(z_{os}^A)}{1-G(z_{hp}^A)}\right]k(z_{os}^A)f_{os} + \left[\frac{1-G(z_x^A)}{1-G(z_{hp}^A)}\right]k(z_x^A)f_x = \frac{\xi f_e}{1-G(z_{hp}^A)} \tag{23}$$

3 Theoretical Results

The rich structure of the model allows us to derive many valuable economic implications. In this section, I expand the scope to patterns A through C. More specifically, I analyze the subset of the equilibrium space that allow some non-outsourcers to be profitable enough to survive in the market.

First, I look at the changes in entry and export cut-off productivities and where outsourcing cut-off productivity is located. The location of cut-off productivities is of great importance because it determines the operational responses of firms. For instance, a change in the entry cut-off productivity could force some firms to exit. A change in export cut-off productivity could either generate or eliminate export opportunities for firms. The location of outsourcing cut-off productivity determines how many firms lay off workers to relocate their assembly segments. These different responses by different firms, then, determine the impacts of outsourcing on various aspects of the economy such as aggregate productivity, trade flow, number of varieties, and employment. Proposition 1 and 2 summarize the relative size of cut-off productivities.

Proposition 1 Cleansing Effect of Outsourcing *The entry cut-off productivity is higher in outsourcing equilibrium than in the initial open economy equilibrium. Also, the rise of the entry cut-off productivity is the largest where fixed outsourcing cost (f_{os}) is the smallest (pattern A), and the smallest where f_{os} is the largest (pattern C). That is,*

$$z_{hp}^0 < z_{hp}^C < z_{hp}^B < z_{hp}^A$$

Lemma 1 *The outsourcing cut-off productivity relative to the entry cut-off productivity is the lowest under the pattern A and the highest under the pattern C of the outsourcing equilibrium. That is,* $\frac{z_{os}^A}{z_{hp}^A} < \frac{z_{os}^B}{z_{hp}^B} < \frac{z_{os}^C}{z_{hp}^C}$

Lemma 2 *The export cut-off productivity relative to the entry cut-off productivity is the lowest under the pattern A and the highest under the pattern C. The value for the pattern C is equal to that for the initial open economy equilibrium. That is,* $\frac{z_x^A}{z_{hp}^A} < \frac{z_x^B}{z_{hp}^B} < \frac{z_x^C}{z_{hp}^C} = \frac{z_x^0}{z_{hp}^0}$

Proof : See Appendix A.1

The first implication of Proposition 1 is that the entry cut-off productivity rises with outsourcing in all outsourcing equilibrium patterns. This implies that the least productive firms in the initial open economy equilibrium exit as outsourcing becomes feasible. As prices of outsourcers decrease, non-outsourcers face a rise in their relative prices and a fall in the demand for their products. To firms who made small profits in the initial open economy equilibrium, such a sales loss is enough to turn their positive profits into negative ones, driving them out of the market. I call this *the Cleansing Effect of Offshore Outsourcing.*[8] The cleansing effect is directly related to the employment level of the industry. As firms exit, all workers employed by the exiting firms lose their jobs. This implies that non-outsourcers can be a source of significant amount of outsourcing-related job losses. Where outsourcing is relatively easy (pattern A), more firms take advantage of outsourcing, driving the price index further down. This enlarges the cleansing effect and the size of resulting job destruction. This is the case in industries with a high-degree of outsourcing - industries with easily transferrable technology, less issue of intellectual property right, and smaller potential variations in quality; most likely low-skilled manufacturing sectors such as textile, apparel, and footwear.[9] In section 4, I quantify the size of job losses due to the cleansing effect by calibrating parameter values. Whether the majority of job destruction is generated by outsourcers or the cleansing effect will also be analyzed.

Proposition 2 *The cut-off productivity for outsourcing is the lowest under the outsourcing equilibrium pattern A and the highest under the pattern C; that is,*

$$z_{os}^A < z_{os}^B < z_{os}^C$$

Proposition 2 implies that outsourcing is profitable for firms with lower productivities under pattern A than under pattern B or C. In other words, more firms will take advantage of outsourcing opportunities. This is not surprising since pattern A is where the fixed outsourcing cost is the lowest.

[8] This paper is not the first to find such an effect. Melitz (2003) and Helpman et al (2004) theoretically show that the least productive firms exit as a country opens up for free trade or FDI. Bernard et al (2006) closely investigates the response of U.S. manufacturing plants to the imports from low-wage countries and find that this specific import competition raises probability of plant death significantly. They also find that the rise of the death probability is larger for more labor-intensive plants. More labor-intensive firms in their study are equivalent to the least productive firms in this paper since labor is the only factor of production.

[9] It is also worth noting that there has been an increase in the availability of outsourcing advisory services which potentially reduces the fixed cost of outsourcing further down. These services are provided by consulting firms such as Deloitte, EquaTerra, neoIT, PA consulting group, Pace Harmon, PricewaterhouseCoopers, RampRate, and TPI. (source: Forrester Research, Inc. http://www.forrester.com/Research/Document/Excerpt/0,7211,40655,00.html)

Unlike the entry cut-off productivity, export cut-off productivity does not uniformly rise or decrease with outsourcing. Whether it increases depends on the parameter values. Generally export cut-off productivity is low where fixed outsourcing cost is small. This is because outsourcing benefits exporters more than non-exporters by bringing about a large reduction in exporters' prices in their foreign markets. Outsourcing expands export opportunities; so, the export cut-off productivity is lower where outsourcing is easy. Under pattern A, all exporters outsource and their export operations are based on the reduced prices. The exporter with productivity z_x^A generates revenue that is just enough to break-even in the foreign market by outosurcing. In the absense of outsorucing, exporting is not profitable for this firm. For this reason, the export cut-off productivity of pattern A is lower than that of the initial equilibrium. Under pattern C, the exporter with productivity (z_x^C) is a home-producer, and its relative price is higher in the outsourcing equilibrium. In the initial equilibrium, this firm makes positive profit. z_x^0 must be lower than z_x^C. Pattern B is the intermediate case, and the sign of the change in the export cut-off productivity is ambiguous.

3.1 Firm-level Operational Responses to Outsourcing under Pattern A

In this section, I briefly discuss how different firms respond to outsourcing in more detail by presenting the case under the outsourcing equilibrium pattern A. Figure 7 depicts the cut-off productivities of both the initial open economy equilibrium and the outsourcing equilibrium. These cut-off productivities divide firms into five groups - (A.b) through (A.f). As feasibility of outsourcing results in different operational responses for different groups of firms, the employment implications also differ across groups.

The firms that fall in the range of (A.a) exit in both equilibria; therefore, they are not relevant for the analysis. The firms in the group (A.b) are forced to exit due to the *Cleansing Effect.* As these firms shut down, the workers previously employed by these firms will be laid off generating pure job destruction. The firms in the group (A.c) survive as *Home-Producers.* Although they do not change their operational strategy, their relative prices rise; thus, they suffer from a decrease in sales which, in turn, results in layoffs.

The firms in the group (A.d) are the firms that switch from being non-exporting home-producers to non-exporting outsourcers. I call these firms *New Outsourcers.* The change in the assembly location involves job destruction; however, the price reduction generates a rise in demand. In order to meet the higher demand, they hire more workers in their service segments creating new jobs. Thus, in this group, there will be both job destruction and job creation. The firms in the group (A.e) are *New Exporters* switching from being non-exporting home-producers to exporting outsourcers. The initiation of export operation brings these firms a whole new market, and this market expansion generates a large pure job creation. In their domestic operations, there is job destruction as well as job creation, as for new outsourcers. The firms in the group (A.f) are *Existing Exporters*, switching from being exporting home-producers to exporting outsourcers. They generate both job destruction and creation, but the larger benefits in export operation is likely to bring about a larger job creation compare to *New Outsourcers*.

When one looks empirically at the aggregate employment figures over the course of time where outsourcing activities increase in the market, one only observes the net change, which is a mixture of job destruction and creation in different types of firms. The structural model introduced in sections 2 enables us to separate job destruction from creation, and the relative size of employment changes in different groups of firms.

3.2 Distributional Assumption

Under a certain functional assumption for the productivity distribution, G(z), we can derive more practical implications. For the rest of the theoretical analysis and the numerical analysis, I assume that the productivity draws follow a Pareto Distribution.[10] The Cumulative Distribution Function $G(z)$ is

$$G(z) = 1 - \left(\frac{z_{min}}{z}\right)^{\eta} \qquad \text{where} \qquad \eta > \varepsilon - 1 \;\; \text{and} \quad z \geq z_{min} \tag{24}$$

z_{min} is the minimum value of z, and η is the shape parameter that determines the dispersion of productivity draws. Large η implies a low dispersion; that is, large mass is concentrated at the low productivity. With small η, productivity draws are more evenly distributed, so drawing a high productivity is more likely. For this reason, the shape parameter is crucial in determining the overall productivity level of an industry and the cut-off productivities in equilibria. The inequality, $\eta > \varepsilon - 1$ is required for the average productivity to be finite.

Under the Pareto distribution, the probabilities of outsourcing and exporting can be written in a very simple form. For example, the probability of exporting in the initial open economy equilibrium can be written as $Pr_x^0 = \left(z_{hp}^0/z_x^0\right)^{\eta}$. Then, lemma 1 and 2 have direct implications on the composition of the market. They show that both the fractions of outsourcers and exporters

[10]used by Helpman, Melitz, and Yeaple (2004), Ghironi and Melitz (2005), Bernard, Redding, and Schott(2007), and many others.

among domestic firms are the largest under pattern A and the smallest under pattern C. This confirms that outsourcing promotes exporting.

Under this distributional assumption, $k(\hat{z})$ is a constant that is independent of $\hat{z}$. I define k as the constant value of $k(\hat{z})$ as the following:

$$k = k(\hat{z}) = \frac{\varepsilon - 1}{\eta - \varepsilon + 1} \tag{25}$$

Since $\eta > \varepsilon - 1$, k is positive. Using equations (24) and (25), I can rewrite equilibrium conditions for the initial open economy equilibrium and the outsourcing equilibrium A.

$$\text{Initial equilibrium:} \quad kf + \left(\frac{z_{hp}^0}{z_x^0}\right)^\eta kf_x = \frac{\xi f_e}{1 - G(z_{hp}^0)} \tag{26}$$

$$\text{Outsourcing equilibrium A:} \quad kf + \left(\frac{z_{hp}^A}{z_{os}^A}\right)^\eta kf_{os} + \left(\frac{z_{hp}^A}{z_x^A}\right)^\eta kf_x = \frac{\xi f_e}{1 - G(z_{hp}^A)} \tag{27}$$

Equilibrium conditions for patterns B and C can be obtained in a similar manner.

The rank of the entry cut-off productivities shown by Proposition 1 together with the change in the export cut-off productivities discussed in the previous section has a direct implication on the number of varieties in each equilibrium. The following propositions summarize the impact of outsourcing on product varieties.

Proposition 3 *The number of domestic varieties decreases as outsourcing becomes feasible. Also, the decrease in variety is the largest where fixed outsourcing cost (f_{os}) is the smallest (pattern A), and the smallest where f_{os} is the largest (pattern C). That is,*

$$M_d^A < M_d^B < M_d^C < M_d^0$$

Proposition 4 Outsourcing Reduces Variety: *The total number number of varieties available to consumers decreases as outsourcing becomes feasible.*

$$max\{\ M_t^A, M_t^B, M_t^C\ \} < M_t^0$$

Proposition 3 implies, first, that the number of domestic varieties decreases with outsourcing, and second, that the decrease in domestic varieties gets larger as outsourcing intensifies. This is due to the cleansing effect. As shown in Proposition 1, the magnitude of the cleansing effect is large where outsourcing is relatively easy to undertake; therefore, more domestic firms are driven out of the market under pattern A. Unlike domestic varieties, the number of imported varieties (same as the number of exporters) does not uniformly increase or decrease. The pattern of increase and decrease resembles that of the export cut-off productivities. Since outsourcing benefits exporters more than non-exporters, the relative easiness of outsourcing under pattern A promotes exporting, increasing the number of exporters ($M_x^A > M_x^0$).

Proposition 4 states that the total number of varieties that are available to consumers unambiguously falls as outsourcing becomes feasible. This is rather surprising since the increase in product variety is often regarded as one of the most important gains from international trade. This reduction in total variety is also a result of the cleansing effect. Especially under pattern A, the number of imported varieties rises; but the decrease in domestic product variety due to the cleansing effect dominates, resulting a net decrease in total product variety. Since death of firms causes massive job destruction, the changes in product varieties summarized by Propositions 3 and 4 have important implications on the employment effect of outsourcing. The next section presents the employment effect of outsourcing.

3.3 Employment

Total employment of an industry consists of production employment by active firms and the investment made by new entrants. The production employment, then, consists of assembly, services and fixed cost employment of home-producers, outsourcers, exporters and non-exporters. Since each equilibrium - the initial open economy equilibrium and three outsourcing equilibrium patterns - is composed of different groups of firms, the total employment should be calculated separately. In this section, I presents the initial open economy equilibrium and the outsourcing equilibrium pattern A. Employment analyses under the patterns B and C resemble that of the pattern A.

3.3.1 Initial Open Economy Equilibrium

M_d^0 firms serve domestic markets and each firm's labor requirement for domestic operation is the same as equation (3). M_x^0 firms export in addition to their domestic operation. The average employment in their domestic and foreign operations can be written as follows:

$$l_{d,hp}(\tilde{z}(z_{hp}^0)) = f + \frac{q_{d,hp}(\tilde{z}(z_{hp}^0))}{\tilde{z}(z_{hp}^0)} \qquad l_{x,hp}(\tilde{z}(z_x^0)) = f_x + \frac{\tau q_{x,hp}(\tilde{z}(z_x^0))}{\tilde{z}(z_x^0)} \tag{28}$$

$q_{d,hp}(.)$ and $q_{x,hp}(.)$ represent the sales in domestic and foreign markets. Using equations (2), (4), (10), (11), and (28), the total number of production workers can be written as follows:

$$\rho R + M_d^0 f \left[1 + \left(\frac{z_{hp}^0}{z_x^0}\right)^\eta \frac{f_x}{f}\right] \tag{29}$$

The entry investment employment is $M_e^0 f_e$ where M_e^0 is the number of new entrants each period in the equilibrium. In the steady state, number of successful entry each period must be equal to the number of firm deaths; that is $\left[1 - G(z_{hp}^0)\right] M_e^0 = \xi M_d^0$. Therefore, the entry investment employment is, using equation (26),

$$M_e^0 f_e \;=\; M_d^0 \; kf \left[1 + \left(\frac{z_{hp}^0}{z_x^0}\right)^\eta \frac{f_x}{f}\right] \tag{30}$$

Now, the total employment in the initial open economy equilibrium, denoted as Emp^0, is sum of equations (29) and (30). In order to simplify further, I assume that the total labor compensation is equal to the total expenditure in this industry. Since the wage rate is 1, Emp^0 must equal R. Then, the total employment in the initial open economy equilibrium can be written as the following:

$$Emp^0 \;=\; \varepsilon M_d^0 \; (k+1) f \left[1 + \left(\frac{z_{hp}^0}{z_x^0}\right)^\eta \frac{f_x}{f}\right] \tag{31}$$

3.3.2 Outsourcing Equilibrium Pattern A

There are three types of firms in this equilibrium: non-exporting home-producers, non-exporting outsourcers, and exporting outsourcers. Their operations can be divided into three categories; home-producers' domestic operation, outsourcers' domestic operation, and outsourcers' export operation. There are M_{hp}^A home-producers and their average employment is $l_{d,hp}(\tilde{z}_{hp}^A)$ where $l_{d,hp}(.)$ is shown in equation (28) and their average productivity, $\tilde{z}_{hp}^A$, is described by equation (22). M_{os}^A firms outsource and serve the domestic market. Among these firms, M_x^A also serve the foreign market. Since their assembly segment is performed in the South, their home employment only includes service workers and fixed-cost workers. Their employments for domestic and foreign sales are, on average, as follows:

$$l_{d,os}(\tilde{z}(z_{os}^A)) = f + f_{os} + \frac{\tau\gamma q_{d,os}(\tilde{z}(z_{os}^A))}{\tilde{z}(z_{os}^A)} \qquad l_{x,os}(\tilde{z}(z_x^A)) = f_x + \frac{\tau\gamma q_{d,os}(\tilde{z}(z_x^A))}{\tilde{z}(z_x^A)} \tag{32}$$

The total number of production workers in this industry is $M_{hp}^A \; l_{d,hp}(\tilde{z}_{hp}^A) + M_{os}^A \; l_{d,os}(\tilde{z}(z_{os}^A)) +$

$M_x^A l_{x,os}(\tilde{z}(z_x^A))$. The entry investment employment, $M_e^A f_e$, under the steady state equilibrium condition discussed above is as follows:

$$M_e^A f_e \ = \ kf\left[1+\left(\frac{z_{hp}^A}{z_{os}^A}\right)^{\eta}\frac{f_{os}}{f}+\left(\frac{z_{hp}^A}{z_x^A}\right)^{\eta}\frac{f_x}{f}\right] \tag{33}$$

Then, the total employment in this industry, denoted as Emp^A, is, using equations (2), (10), (11), (17), (22), (32), and (33), as the following:

$$\begin{aligned} Emp^A = R\left(\frac{\varepsilon-1}{\varepsilon}\right)\frac{M_d^A}{M_d^0}&\left\{\frac{1+\left[\frac{\gamma}{\lambda}(\tau\lambda)^{1-\varepsilon}-1\right]\left(\frac{z_{os}^A}{z_{hp}^A}\right)^{\varepsilon-1-\eta}+\frac{\gamma}{\lambda}(\tau\lambda)^{1-\varepsilon}\left(\frac{z_x^A}{z_{hp}^A}\right)^{\varepsilon-1-\eta}}{1+\tau^{1-\varepsilon}\left(\frac{z_x^0}{z_{hp}^0}\right)^{\varepsilon-1-\eta}}\right\} \\ &+(k+1)M_d^A f\left[1+\left(\frac{z_{hp}^A}{z_{os}^A}\right)^{\eta}\frac{f_{os}}{f}+\left(\frac{z_{hp}^A}{z_x^A}\right)^{\eta}\frac{f_x}{f}\right] \end{aligned} \tag{34}$$

We can obtain toal employment in the equilibrium patterns B and C in a similar manner.

3.3.3 Employment Effect of Outsourcing

The analysis of the impact of outsourcing on employment requires comparison between total initial employment and total employment in the outsourcing equliibrium. The ratio between two total employment can be obtained using equations (31) and (34) as the following:

$$\frac{Emp^A}{Emp^0}=\left(\frac{\varepsilon-1}{\varepsilon}\right)\left(\frac{z_{hp}^0}{z_{hp}^A}\right)^{\eta}\left\{\frac{1+\left[\frac{\gamma}{\lambda}(\tau\lambda)^{1-\varepsilon}-1\right]\left(\frac{z_{os}^A}{z_{hp}^A}\right)^{\varepsilon-1-\eta}+\frac{\gamma}{\lambda}(\tau\lambda)^{1-\varepsilon}\left(\frac{z_x^A}{z_{hp}^A}\right)^{\varepsilon-1-\eta}}{1+\tau^{1-\varepsilon}\left(\frac{z_x^0}{z_{hp}^0}\right)^{\varepsilon-1-\eta}}\right\}+\frac{1}{\varepsilon} \tag{35}$$

The last term, $\frac{1}{\varepsilon}$, represents the employment for fixed costs and the entry investment. This implies that the number of workers hired for these costs is constant at $\frac{R}{\varepsilon}$ which is the markup portion of the total revenue in this industry. This is due to the assumption that the total expenditure in one industry is equal to the total labor compensation.

The first part of the first term $\left(\frac{\varepsilon-1}{\varepsilon}\right)$ indicates the variable cost portion of employment. If the first term excluding $\left(\frac{\varepsilon-1}{\varepsilon}\right)$ is equal to one, outsourcing has no impact on total employment. The second part of the first term - the ratio between two entry cut-off productivities - represents the cleansing effect, the employment adjustment at the extensive margin. As z_{hp}^A is larger than z_{hp}^0, employment in the outsourcing equilibrium decreases. The terms in the curly bracket is the comparison of average firm-level employment, the employment adjustment at the intensive margin.

Using equation (35) and the equivalent expressions for patterns B and C, I summarize the effect of outsourcing on total employment of the subject industry in Proposition 5.

Proposition 5 Outsourcing Results in Net Job Loss: *Outsourcing unambiguously reduces the aggregate employment.*

$$Emp^A \ < \ Emp^B \ < \ Emp^C \ < \ Emp^0$$

Emp^B and Emp^C denote total employment under the outsourcing equilibrium patterns B and C. Proposition 5 strongly suggest that outsourcing hurts employment at the aggregate level regardless of the degree of outsourcing. Different groups of firms (as seen in Figure 7) destroy and create different amount of jobs under different patterns; but the sum of these employment responses is always negative.

4 Numerical Analyses

Proposition 5 may serve as a supporting argument for the public concern that outsourcing destroys U.S. manufacturing jobs. However, the blame by the public is very concentrated on the outsourcing firms rather than the whole economy. As shown by Proposition 1 and Figure 7, the cleansing effect - exits of uncompetitive non-outsourcers - generates pure job destruction which could be the main source of the negative employment effect of outsourcing. Outsourcing firms, on the other hand, create new jobs as well as destroy some. Whether the net impact for outsourcers alone is negative require further investigation. In this section, I perform various numerical analyses to quantify the employment implications of different groups of firms - outsourcers, non-outsourcers, and the cleansing effect. I also measure the size of job destruction of different groups of firms.

4.1 Calibration

There are five parameters: transport cost (τ), Southern efficiency wage (δ), employment share of the service segment (γ), elasticity of substitution (ε), and the shape parameter of Pareto distribution (η). λ is simply a combination of δ and γ as defined in equation (16).

First, τ=1.3 is chosen from Anderson and van Wincoop (2004). Their estimate of international transport cost is equivalent of a 70% *ad valorem* tariff rate (τ=1.7). Out of this 70%, 30% is variable cost (physical and time cost of transit, tariffs) and 40% is border-related cost (language, currency, information and security). Since I have a fixed cost of exporting in addition to transport cost, I take 30% of the tariff-equivalent transport cost. Second, δ=0.5 is chosen from the data on manufacturing wage and productivity of the US (BEA) and Mexico (Instituto Nacional de Estadistica y Geografia, INEGI) for 2000. Third, the 2002 Census of Manufactures reports that the share of non-production workers in US manufacturing employment is 29.6%. I use γ=0.3. From these vaues of δ and γ implies λ=0.65. Fourth, Broda and Weinstein (2006) estimate various elasticities for different aggregation levels (3-, 4-, 5-digit) of SITC manufacturing industry classifications (Rev.2 for 1972-1988, Rev.3 for 1990-2001). For the period 1990-2001, 4-digit SITC industries have a median of 2.53 and mean of 5.88. I choose ε=3. Lastly, η=4 is chosen for the shape parameter of Pareto distribution. For this, I match the model's prediction on the market share of imports in the initial open economy equilibrium to the 1992 US manufacturing industry. According to BEA's report, imports accounted for 18.08% of the US manufacturing market in 1992. The model's prediction gives us a range of imports' market share for different size of fixed export cost rather than a single value. The range that fits to 18.08% is generated by η=4.

4.2 Net Employment Effect

Figure 8 shows the net employment change as a share of total initial employment. Panel (a) presents the entire $\alpha - \beta$ space. Recall that α and β refer to f_x/f and f_{os}/f, respectively. Panel (b) presents net employment effect for selected values of alpha. As can be seen by equation (35), fixed and sunk costs portion of employment is a fixed share of total initial employment ($1/\varepsilon$) regardless of equilibrium; so the employment response shown in Figure 8 comes solely from the changes in the numbers of assembly and service workers.

Where fixed outsourcing cost is very small, the economy loses up to 36% of its initial employment. The employment response is very sensitive to the size of outsourcing cost (β). As β increases, the net employment loss decreases dramatically. In this model, the feasibility of outsourcing is the only shock to the economy. Where outsourcing is very costly, the feasibility alone is not enough to induce many firms to outsource. As a small number of firms outsource, the overall effect of outsourcing on the economy is also small, resulting in a smaller net job loss. Net employment effect approaches to zero where β is very large, but never becomes positive. Overall, the net job loss is quite sizeable for reasonable value of β.

4.2.1 Employment Responses by Different Group of Firms

In order to understand the net employment effect of outsourcing better, we need to look at it at more disaggregate level. Figure 9 presents the net employment effect of five different groups of firms under Pattern A discussed in Figure 7. Panel (a) is the net employment effect for all firms and is identical to Figure 8. Overall, the employment effects of different groups differ drastically in signs, sizes, and shapes. These diagrams show that analysis of only the aggregate employment change unintentionally discards a lot of valuable information.

The most noticeable features are the negative impact of the cleansing effect. The magnitude is overwhelmingly large compared to other groups' responses. Home-producers suffer from employment reduction due to the rise in their relative prices. The negative impact is small compared to that of the cleansing effect, but not negligible. Panel (d) and (f) show that new outsourcers and existing exporters fail to generate a net job gain. New exporters, on the other hand, create more jobs than they destroy as shown in panel (e). Although the magnitude is small, it shows that one of the major benefits of outsourcing is that it generates export opportunities to some outsourcers. Overall, the negative employment effect of outsourcing is driven by the cleansing effect.

In all equilibria (patterns A through C), firms can be categorized into three major groups. First, *Cleansing Effect* - uncompetitive non-outsourcers that exit; second, *Home-Producers* - non-outsourcers that survive in the outsourcing equilibrium; and finally, *Outsourcers* - the firms that decide to send their assembly segment to the South. The export status of home-producers and outsourcers change across patterns. Figure 10 presents the net employment effect of these three groups. The cleansing effect again proves dominance in negative net effect. The effect of home-producers is generally small. The impact of outsourcers is very negative for very small β, but the magnitude decreases rapidly as β rises. Except where β is very small, the negative net employment effect of outsourcers is negligible and in fact becomes positive for a certain range of α and β.

Figure 9 and 10 strongly suggest the dominance of the cleansing effect in employment responses to offshore outsourcing. In an attempt to summarize, Figure 11 shows the net employment loss due to the cleansing effect as a share of total net employment effect for selected values of α. It takes up to 70-75% of total net employment loss for small value of β, and more than 50% for the most range of α and β. The lower bound for the value of β for the values of α shown is around 45% for $\beta > 20$.

4.2.2 Sensitivity Analyses

Figure 12 presents the cleansing-effect-induced job destruction as a fraction of total net employment effect for various deviations from the benchmark parameter values. There are two main messages that we can learn from Figure 12. First, the dominance of the cleansing effect is preserved for various sets of parameter values. The cleansing effect takes up significant portion of total employment loss in all six cases. The smallest cleansing effect is shown in panel (e) with a large demand elasticity. It still accounts for more than 18% of the total net job loss. Second, outsourcers generate net employment gain for some parameter values. Panel (b) and (d) show such cases. Where outsourcers generate net job gain, the employment reduction from the cleansing effect exeeds the total net job loss.

Besides these two major points, Figures 12 conveys a lot of information about outsourcing. Comparing panels (a) and (b) shows that, a larger shape parameter of Pareto distribution (η) makes the cleansing effect larger and more sensitive to β. A large η implies that productivity draws are higly concentrated at the low end of productivity spectrum. A rise in the entry cut-off productivity due to outsourcing churns out a larger number of firms. Consequently, cleansing effect is larger, and so is cleansing-effect-induced job destruction. The high sensitivity of the cleansing effect around β also stems from the high concentration of firms at low productivity under large η. A small variation in the entry cut-off productivity for different values of β influences many low-productivity firms, causing a large change in the magnitude of the cleansing effect. Panels (c) and (d) present the variations in Southern wage rate, δ. Under the benchmark value ($\delta = 0.5$), the price reduction from outsourcing is 15% and 35% for domestic and foreign sales, respectively. Given τ =1.3, $\delta = 0.6$ in panel (c) implies 6% and 28% price reduction while $\delta = 0.3$ implies 34% and 49%. The benefit from a large price reduction to outsourcers is translated to more new jobs at home. With a significantly low value of δ, outsourcers generate a net job gain. Where consumers are more price-sensitive as in panel (e), high productivity firms serve a large market share with large employment in the initial equilibrium. This implies fewer workers are employed by firms in the cleansing effect group, hence, a smaller job destruction. Panel (f) shows the effect of a smaller transport cost (τ). A smaller transport cost enlarges the price reduction from outsourcing, generating a larger cleansing effect.

To sum up, the cleansing effect plays a dominant role in generating net employment loss from outsourcing. This should not be interpreted as that outsourcers are not responsible for the displacement that workers experience in the wake of offshore outsourcing. It should rather be interpreted as that when we measure the employment responses to outsourcing, we should not only focus on the employment changes within outsourcing firms and that the workers employed by non-outsourcers and, more importantly, the firms who disappear due to lack of competitiveness are very much affected and should be the subject of analyses.

4.3 Job Destruction

Firms tend to outsource the most low-skilled and labor-intensive parts of their businesses while the newly created jobs tend to be more high-skilled and service-related. For this reason, the displaced workers are not readily employable in the newly created jobs. In order to reduce the adjustment costs of these workers, the U.S. government provide them various assistance programs such as the Trade Adjustment Assistance program. In order to properly assess the funding and serivce needs for these programs, it is particularly important to measure the size of job destruction rather than the net impact.

Figure 13 presents decomposition of the job destruction as a share of the initial employment and Figure 14 shows it as a share of job destruction from the cleansing effect and outsourcers as a share of total job destruction. Panel (a) shows that the total job destruction reaches up to 59% of initial employment. This means that job creation amounts up to 23% of initial employment. Panel (b) is job destruction due to the cleansing effect. Panel (a) of Figure 14 shows that the cleansing effect accounts for 30-40 % of the total job destruction.

Panel (d) shows job destruction caused by outsourcers. One should notice that outsourcers' job destruction is larger than the cleansing effect. Although the cleansing effect is dominant in the net employment effect, layoffs by outsourcers account for larger portion of the total displacement. According to panel (b) of Figure 14, outsourcers' layoffs account for more than half of total job destruction cause by outsourcing where outsourcing is easy (small β). For larger values of β, it accounts for 40-50% of total job destruction. The fact that outsourcers create new jobs does not make their layoffs any less important than job destruction due to the cleansing effect. Rather, the cleansing effect includes both assembly and service workers while outsourcers' layoffs only affect assembly workers. Where labor is not perfectly mobile between segments, displaced service workers will be more easily reemployed while the displacement of the assembly workers is more permanent.

5 Conclusion

As outsourcing becomes feasible, some firms relocate their assembly segment to low-wage country. The overall price level decreases, and competition gets fiercer. As a result, the minimum productivity required to survive in the market rises, forcing a large number of less productive firms out of the market. This is called *the Cleansing Effect of Offshore Outsourcing.* Outsourcers lay off assembly workers, then create new service jobs as their demand rises due to price reduction. Outsourcing allows some firms to expand their operations to a foreign market which results in a larger job creation. In the mean time, non-outsourcers experience a fall in demand due to a rise in their relative prices, so they layoff some workers. At the aggregate level, various employment responses to outsourcing together generate a net loss of employment. Outsourcing also reduces the number of product varieties available for consumption.

The numerical analyses confirm the theoretical finding that outsourcing unambiguously reduces the aggregate employment. The net employment loss under the benchmark parameter values, which is calibrated to match various moments of the data, reaches up to 36% of total employment in the initial traditional trade equilibrium where outsourcing is not introduced yet. This negativity of employment effect stems mostly from the cleansing effect. As a large number of small firms exit, they let go of all of their workers. Such job destruction accounts for 50-75% of the aggregate net employment loss. The sensitivity analysis shows robustness of this result. The numerical analyses also support the findings in the literature that the net employment effect within outsourcing firms is ambiguous. Under the benchmark parameter values, their net effect ranges from 17% net loss to 3% net gain in employment. The separate analysis of job destruction shows that analysis of the net employment effect alone throws away a lot of valuable information. The net employment change of up to 36% of total initial employment is sum of job destruction of up to 59% and creation of up to 23%. Investigation of job destruction shows the significance of outsourcers' layoffs. Layoffs by outsourcers account for 45-55% of total job destruction under the benchmark parameters while the cleansing effect accounts for 29-42%.

Economists acknowledge that there are winners and losers of international trade, and it is also the case for offshore outsourcing. The winners in this context are the outsourcing firms who enjoy a rise in their profits, and the service workers, who enjoy more employment opportunity. The low-skilled assembly workers who goes through displacemen or who face the fear of displacement are certainly the losers of this game. In order to reduce the adjustment costs of the displaced assembly workers, proper unemployment policy tools should be prepared. For correct assessment of funding and service needs for such displaced worker programs, careful measurement of the size of job destruction as well as the net employment adjustment is very crucial.

The results of the numerical analyses emphasize the inadequacy of currently available datasets in evaluating the aggregate labor market dynamics - gross rather than net - that outsourcing brings about. It also calls for a more detailed and thorough dataset on the outsourcing activities of U.S. manufacturing firms. The dataset should include the entire manufacturing sector rather than multinational firms alone. It should also convey the number of layoffs and new hires of production and non-production workers separately. Detailed operational information of outsourcers will help us establish a meaningful measure of industry-level outsourcing activities which then can be used to measure the levels of competitive pressure that non-outsourcers face.

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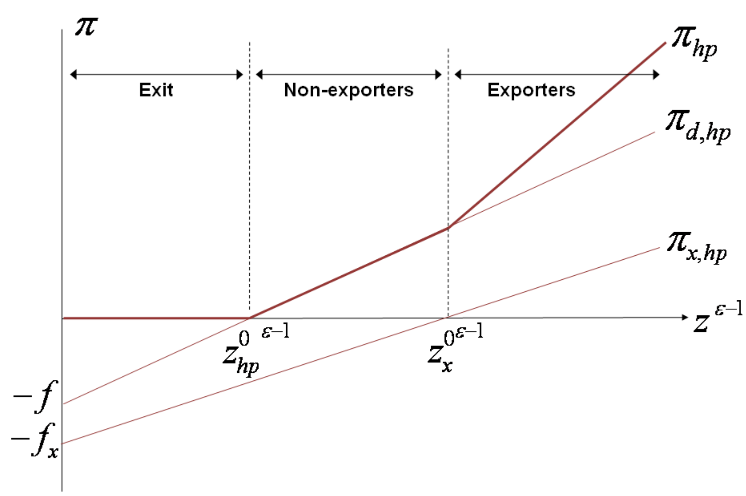


Figure 1: Open Economy Equilibrium

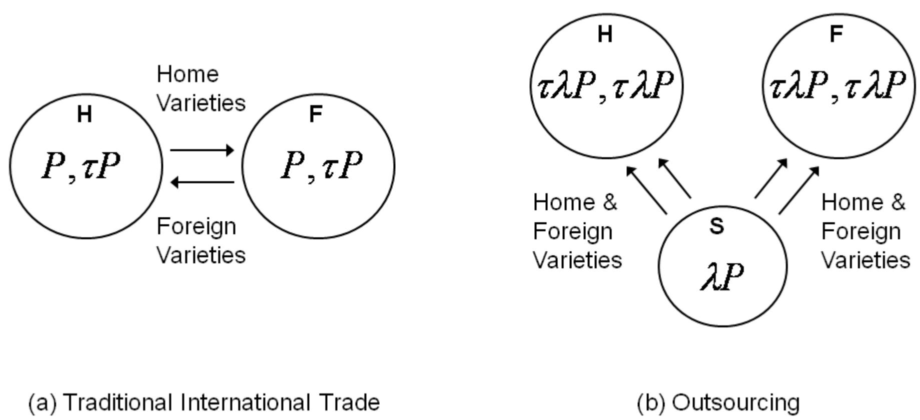
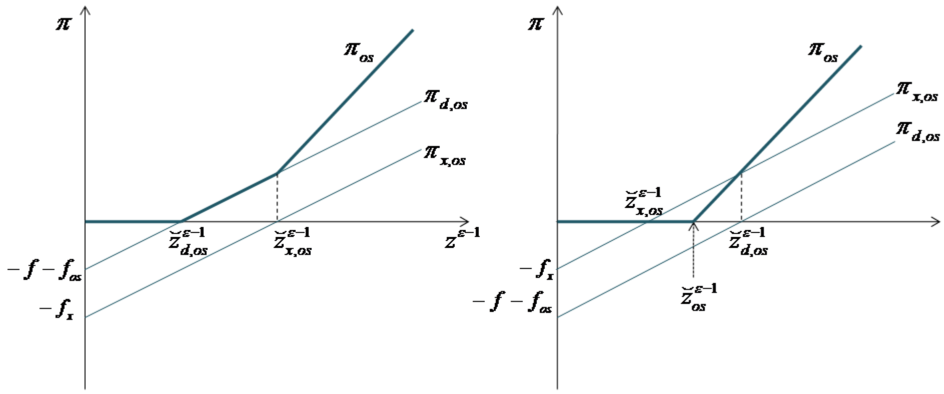
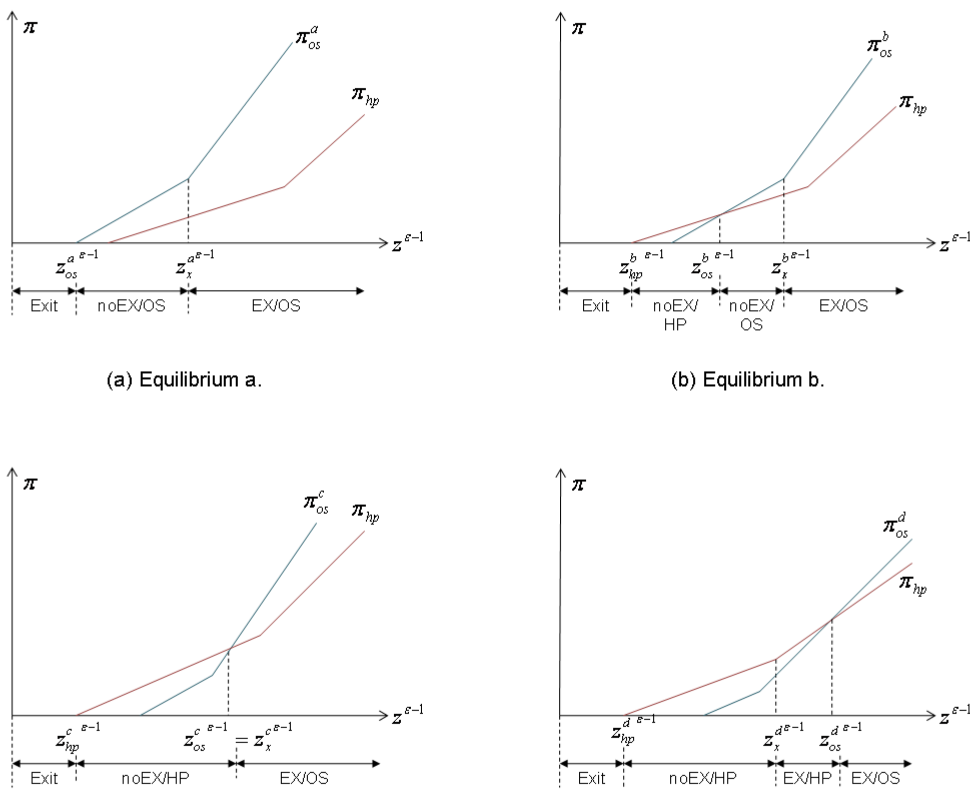


Figure 2: Transportation Structure



$f_x > f + f_{os}$ $\qquad\qquad$ $f_x \leq f + f_{os}$

Figure 3: Total Profit Functions of Outsourcers



(a) Equilibrium a. $\qquad$ (b) Equilibrium b.

(c) Equilibrium c. $\qquad$ (d) Equilibrium d.

Figure 4: Four Equilibria under Outsourcing

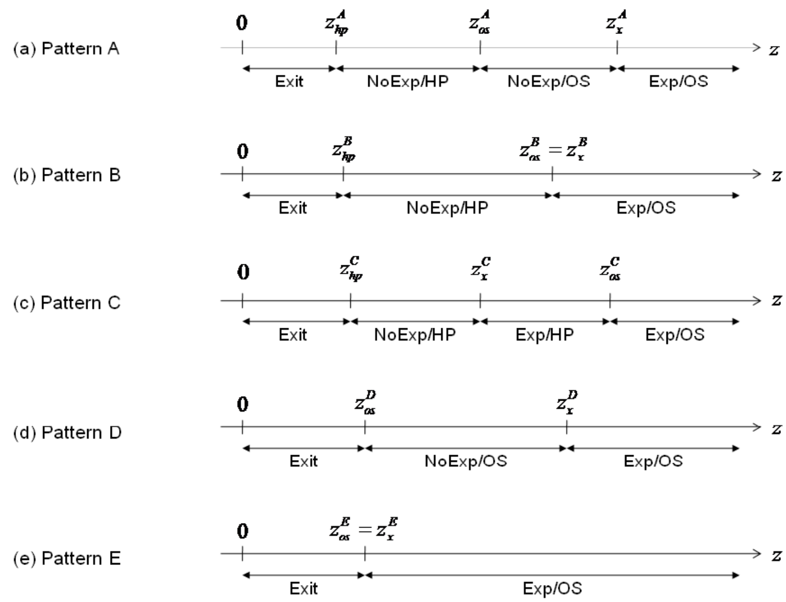


Figure 5: Various Patterns of Outsourcing in Outsourcing Equilibria

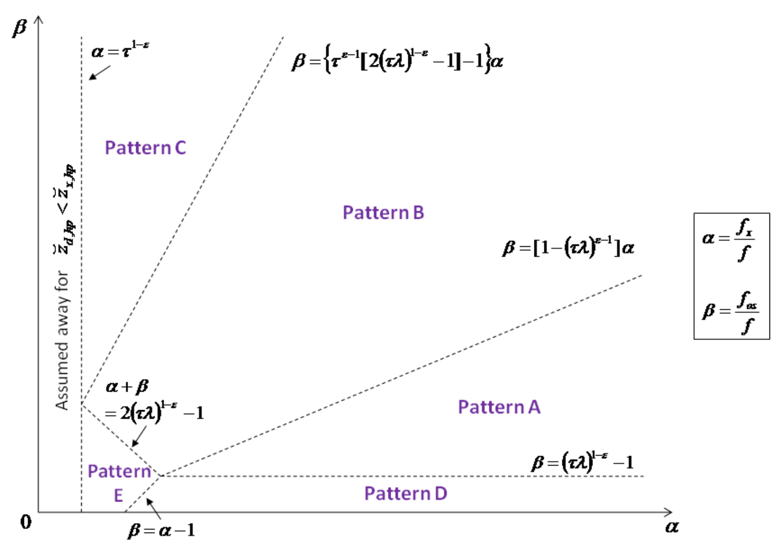


Figure 6: Equilibrium Space

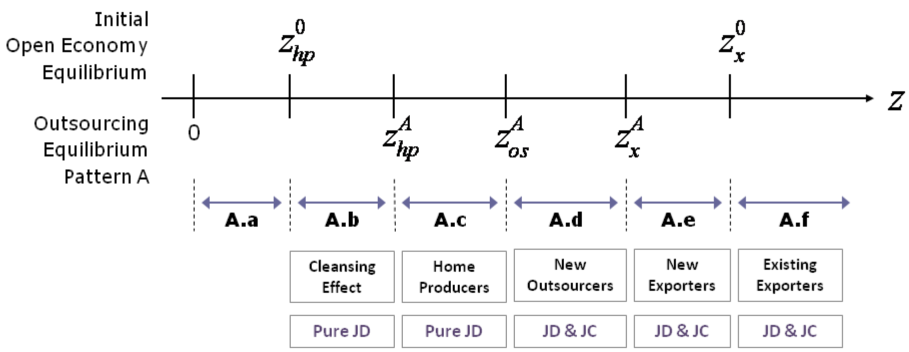


Figure 7: Different Operational Responses by Different Group of Firms under Pattern A

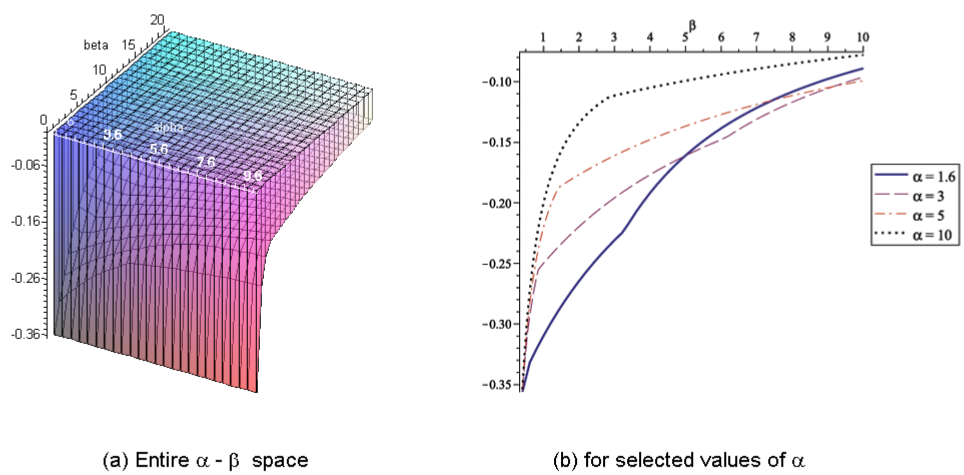
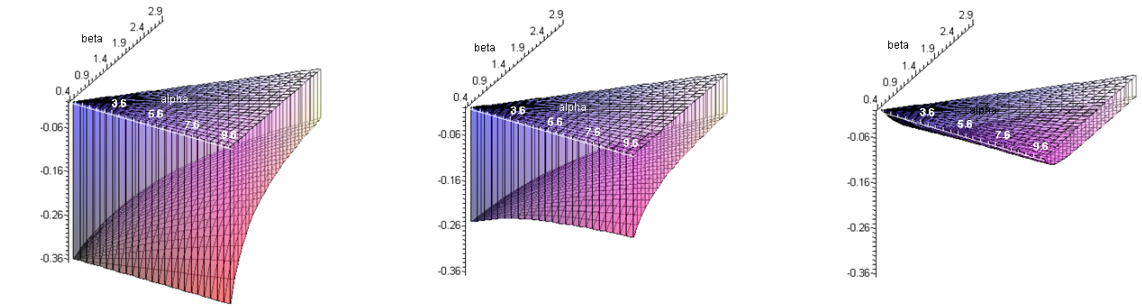
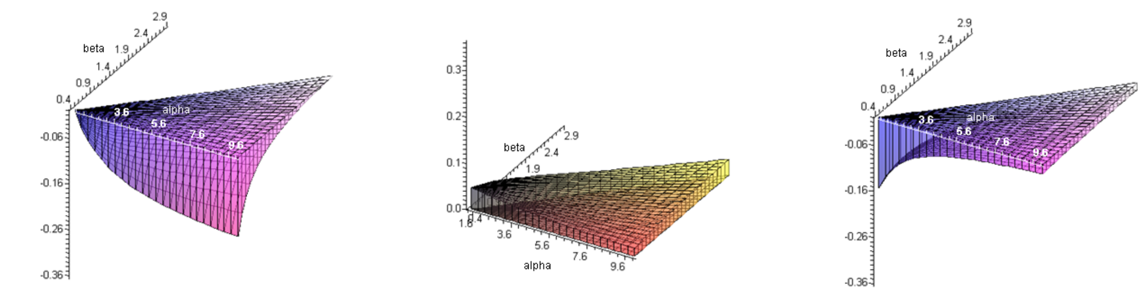


Figure 8: Total Net Employment Effect

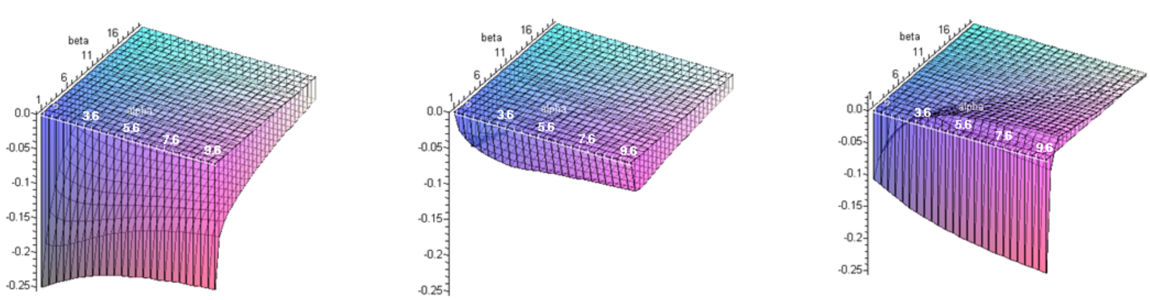


(a) Total Net Employment Effect (b) Cleansing Effect (A.b) (c) Home Producers (A.c)



(d) New Outsourcers (A.d) (e) New Exporters (A.e) (f) Existing Exporters (A.f)

Figure 9: Net Employment Effect by various firm groups under the Pattern A



(a) Cleansing Effect (b) Home Producers (c) Outsourcers

Figure 10: Net Employment Effect: Cleansing Effect, Home-Producers, and Outsourcers

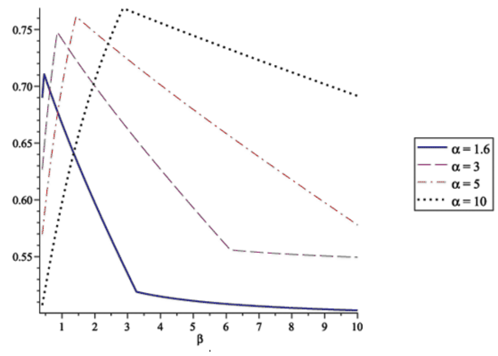


Figure 11: Cleansing Effect as a Share of Total Net Employment Effect

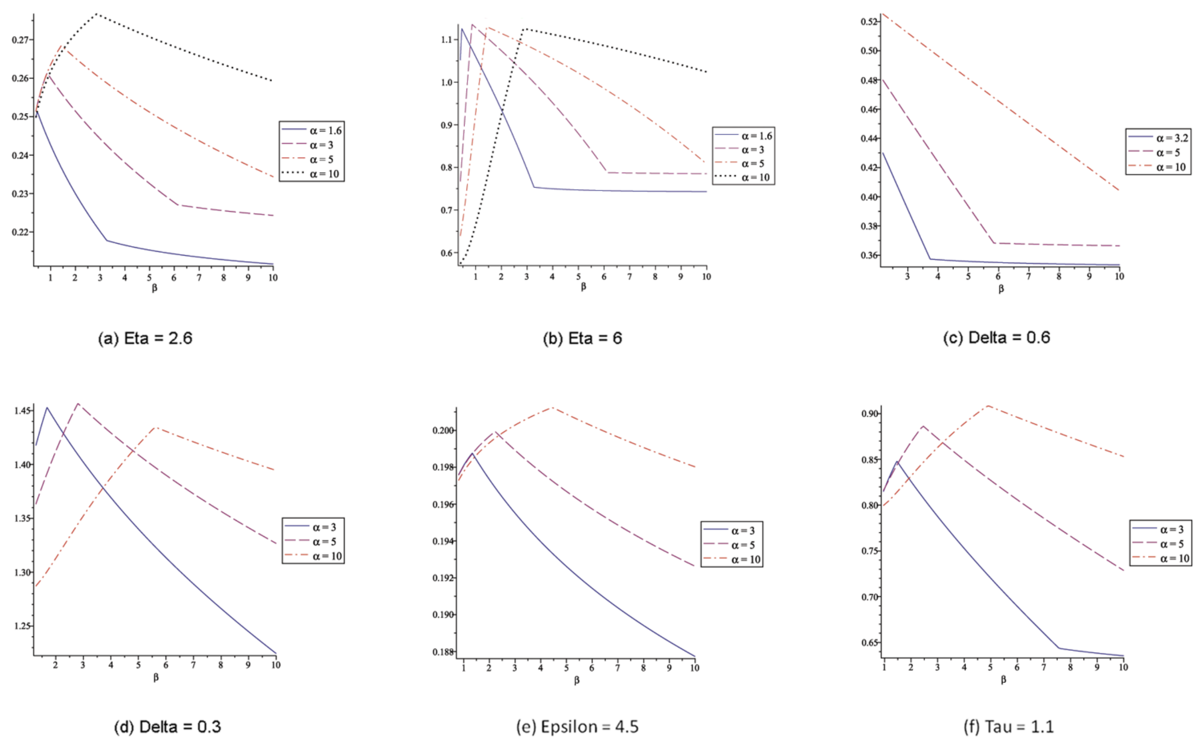
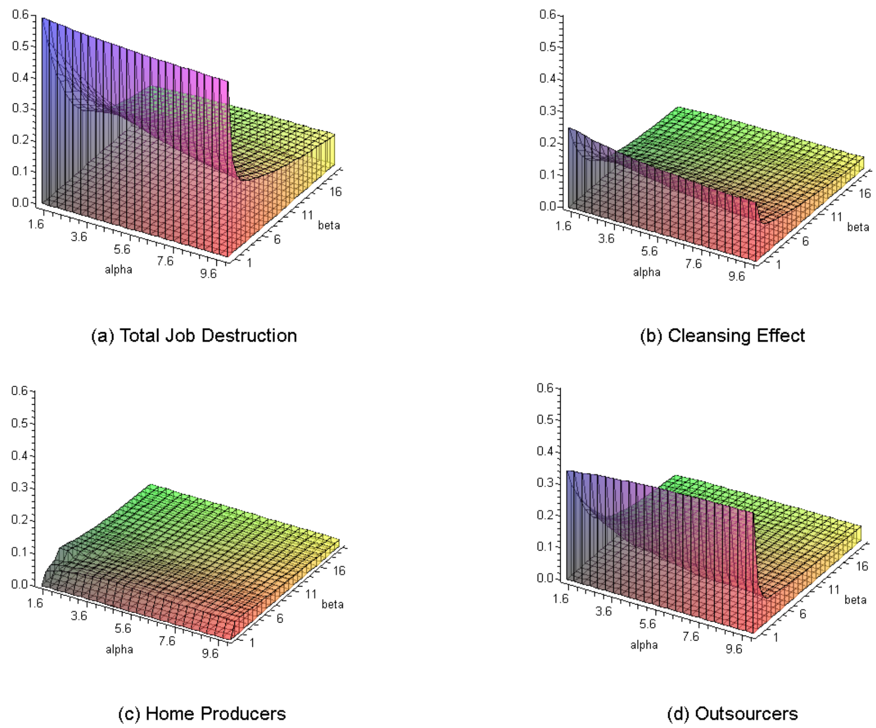


Figure 12: Cleansing Effect as a Share of Total Net Employment Loss
Various Deviations from Benchmark Parameters



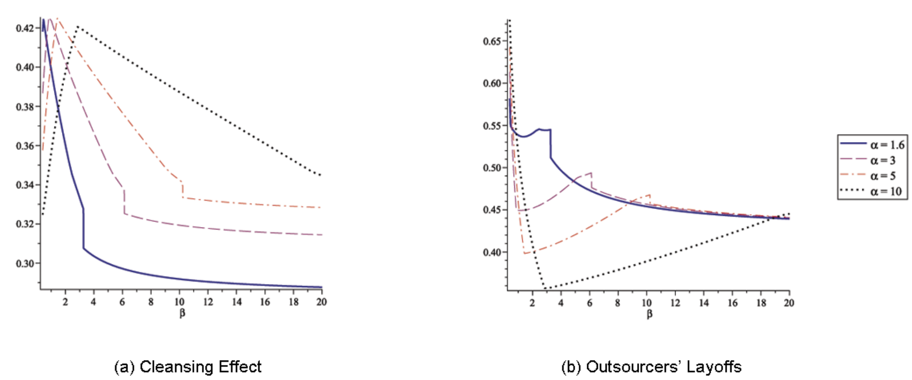
(a) Total Job Destruction

(b) Cleansing Effect

(c) Home Producers

(d) Outsourcers

Figure 13: Decomposition of Total Job Destruction



(a) Cleansing Effect

(b) Outsourcers' Layoffs

Figure 14: Cleansing Effect and Outsourcers' Layoffs as a share of Total Job Destruction