Why do they just do it? A theory of outsourcing and working conditions

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Why do they JUST DO IT?

A theory of outsourcing and working conditions

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Abstract

Nike and other companies have long been criticized for outsourcing their production to contract factories with dismal working conditions. Despite the overwhelming amount of interest, there exists no theory for studying this topic. The current paper fills this gap. In the model, the most productive firms in the North make high profits and outsource their manufacturing production to contract factories in the South. Factories pay wages that can compensate for poor working conditions, but these wages might not meet workers' basic needs. The paper studies an extension under which factory workers are not appropriately compensated for inferior working conditions.

JEL: F16, J81, F23, F12, J31, F66, J83.

Keywords: Outsourcing, working conditions, compensating wage differentials, labor standards, subcontracting, Nike, sweatshop.

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1 Introduction

In 1997, an audit report revealed poor working conditions at one of Nike's contract factories. The factory, located in Vietnam, employed around 10,000 workers and produced 400,000 pair of shoes per month. According to the report, factory workers were exposed to excessive heat, noise, dust, and toxic fumes. Exposure to some carcinogens even exceeded by 171 times Vietnamese legal standards. An estimate suggested that more than 77% of the workers were suffering from respiratory diseases. Some of the contributing causes included inadequate ventilation systems, an understaffed medical room, insufficient protective equipment, and lack of training for workers on occupational health and safety. In addition, the report found that workers were required to work more hours than the legal limit and were only paid $10 a week.[1]

This was neither the first nor the last time that Nike had been accused of outsourcing production to contract factories operating under poor working conditions. But this report was different. It was not one of the many documents from human rights or labor groups that had been criticizing Nike's practices for several years. This was a report commissioned by Nike itself, and it was prepared by the prominent accounting firm Ernst & Young. The report was meant to be for Nike's internal use only, until it leaked to the media on November 1997, attracting significant press coverage and further damaging the company's image (see Greenhouse 1997).

Nike's business model consists of designing, developing, marketing, and selling the products, but the actual manufacturing process is outsourced to independent contract factories located in low-cost countries. In the fiscal year 2012-13, the company employed

[1] See Ernst & Young (1997). Despite the very serious findings, this report has been criticized for not being comprehensive enough (see O'Rourke 1997).

around 48,000 people directly and more than one million people indirectly at 789 contract factories. Despite the criticisms, the business model has been very successful and has transformed Nike from a small-scale importer of Japanese shoes to the world's leader in athletic footwear, apparel, and equipment. Nike's gross profits have increased steadily and surpassed the 12 billion mark in 2014.[2]

But Nike is by no means the only company that has been accused of benefiting from exploitative working conditions in developing countries. Other targeted companies include many brand names such as Reebok, Gap, Mattel, Levi Strauss, Adidas, H&M, Apple, etc.[3] The typical accusations are that workers in the contract factories are forced to work overtime, under poor working conditions, and for less than the living wage. These accusations raise several questions. In particular, why do profitable brand companies like Nike outsource their manufacturing production to contract factories operating under poor working conditions? Why are working conditions poor in those factories? And why are factory wages not high enough to meet workers' basic needs?

The main contribution of this paper is to provide a positive theory of outsourcing and working conditions that can be used to address these questions. The paper develops an analytically tractable framework that embeds a compensating-wage-differentials model à la Rosen (1974, 1987) into the global sourcing model of Antràs and Helpman (2004). The model consists of two countries, the technologically advanced North and the South. Only northern firms have the knowledge to design and develop differentiated manufacturing products. These firms, however, outsource the actual manufacturing stage to contract factories that can be located either in the North or in the South. Contract factories in the South can undertake the manufacturing stage at lower costs than contract factories

[2] See more details in Locke (2003) and Nike (2014a, 2014b).

[3] See, e.g., Moran (2002); Rosen (2002); Esbenshade (2004); Ross (2004); and Sluiter (2009).

in the North, but fixed and transportation costs associated with southern outsourcing are higher. Only the most productive northern firms find it profitable to invest in the higher fixed costs to benefit from the lower manufacturing costs at southern factories.

Manufacturing production is inherently dangerous. For this reason, good working conditions are more expensive to provide in factories than in other workplaces in the economy. In the model, workers' preferences depend not only on wages, but also (indirectly) on the working conditions prevailing at their workplace. Thus, to be able to attract workers, factories have to pay workers a wage premium that compensates them when working conditions are inferior. Factories, however, only need to pay workers their outside option plus the compensating wage premium. In the model, the factory workers' outside option is related to the country's labor productivity, and this productivity is assumed to be higher in the North. Thus, workers' outside option is higher in the North, and this explains why contract factories in the South can undertake the manufacturing stage at lower costs.

The benchmark model's main predictions are:

- P1: The most productive northern firms make high profits and outsource their actual manufacturing stage to contract factories in the South.
- P2: The level of working conditions at factories depends on the costs of providing these working conditions and on the country's labor productivity.
- P3: Workers in contract factories earn more than in alternative workplaces, but wages are only higher because they compensate workers for inferior working conditions.
- P4: Despite being higher, factory wages might not meet workers' basic needs, but the reason is that the country's labor productivity is too low.

P5: The only source of comparative advantage is the difference in labor productivities between the two countries. Thus, a low-productivity country can attract more outsourcing contracts since it can undertake the manufacturing stage at lower costs.

The benchmark model can easily be extended to study the consequences of other frequent accusations that have been made to brand companies. One topic that has attracted considerable attention is factory workers' lack of knowledge about occupational risks and about their labor rights. This is a problem of workers' misperception about the true level of working conditions at factories. This extension is important since it shows that workers' misperception can lead to poorer working conditions and lower factory wages. In particular, factory workers might not be appropriately compensated for the risks they are taking on the job. Also, under workers' misperception, factories can attract more outsourcing contracts because they can undertake the manufacturing stage at lower costs.

A second important extension is noncompliance. Contract factories, especially in low-cost countries, are often accused of noncompliance with local legal standards. As an example of noncompliance, this paper studies the consequences when factories do not comply with wage and safety standards that seek to alleviate the workers' misperception problem. The main result is that if compliance inspections are rare and penalties low, factories can undertake the manufacturing stage at lower costs and are thus able to attract more outsourcing.

Under workers' misperception and factories' noncompliance, the predictions of the benchmark model need to be replaced by:

P1': The most productive northern firms make high profits and outsource their actual manufacturing stage to contract factories in the South. **However, workers' mis-**

perception and factories' noncompliance in the South lead to even higher profits and more outsourcing.

P2': The level of working conditions at factories depends on the costs of providing these working conditions, on the country's labor productivity, **and on the degree of workers' misperception**.

P3': **Except for the (unlikely) perfect-misperception case**, workers in contract factories earn more than in alternative workplaces, but wages are only higher because they compensate workers for inferior working conditions.

P4': Despite being higher, factory wages might not meet workers' basic needs. The reasons are: a low country's labor productivity **and a high degree of workers' misperception**.

P5': There are three potential sources of comparative advantage: (i) differences in labor productivity; **(ii) differences in the degree of workers' misperception; (iii) differences in noncompliance**. Thus, a country with a low labor productivity, **or in which workers' misperception is high, or in which factories' noncompliance with legal standards is more prevalent** can attract more outsourcing contracts since it can undertake the manufacturing stage at lower costs.

The reminder of the paper is organized as follows. The next section relates this work to the existing literature. Section 3 introduces the benchmark model and applies this model to understand Nike's international labor practices. Section 4 extends the benchmark model to account for workers' misperception and factories' noncompliance. Section 5 concludes. A detailed Online Appendix contains all derivations reported in the paper.

2 Related literature

Despite the overwhelming amount of attention that working conditions at Nike contract factories have attracted from activists, college students, labor unions, NGOs, governments, international organizations, journalists, and the general public (see, e.g., Spar 2002), there exists to this date no integrated theory that can be used to study the topic. The current paper fills this gap. In doing so, the paper connects two strands of the literature.

The first strand is fairly recent and studies the global sourcing strategies of firms that differ in their productivities.[4] Following the seminal contribution of Antràs and Helpman (2004), this literature seeks to explain the organizational mode and location choice of firms that are able to fragment their production process into smaller segments. By incorporating contractual frictions between firms and their subsidiaries or suppliers, the organizational mode and location choice emerge endogenously as an outcome of these models. Firms with different productivity levels sort into different organizational forms. In contrast to Antràs and Helpman (2004), the current paper assumes away contractual frictions. The consequence of this simplification is that the organizational mode becomes irrelevant, and firms only have to focus on the location decision. On the other hand, the current paper extends this literature by incorporating the role of working conditions. This extension is crucial for studying the issues surrounding the accusations made to Nike and other brand companies.

The second strand of the literature that this paper connects is a series of applications of the compensating-wage-differentials theory.[5] This theory goes back to Adam Smith's

[4]See, e.g., Antràs and Helpman (2004); Grossman and Helpman (2004); Grossman, Helpman, and Szeidl (2005); and Antràs and Helpman (2008).

[5]See Rosen (1987) for a summary.

Wealth of Nations from 1776 but was first formalized by Rosen (1974). The basic idea is that jobs have nonpecuniary attributes that can be unpleasant for workers. In order to attract workers, firms have to pay them a premium (or a "compensating wage differential") for accepting those unpleasant attributes. The current paper incorporates this framework into the model to explain why factory workers in low-cost countries tend to earn more than in alternative employment. The explanation is that their wages are higher because workers are compensated for the poorer working conditions at factories.

Finally, this paper also contributes to the literature on labor standards and globalization.[6] One important concern in this literature is over the universality of labor standards. In particular, should all countries in the world adhere to a set of minimum universal standards? One argument in favor is that countries with low labor standards can unfairly attract more investments and that minimum standards are necessary to avoid unfair competition. In contrast to this, some scholars have claimed that prematurely imposing labor standards might be counterproductive for developing countries. After all, rich countries introduced most labor standards after having attained a relatively high development level (see, e.g., Hall and Leeson 2007). The framework presented in this paper proposes a way to rationalize both views. On the one hand, the benchmark model predicts that the level of working conditions depends naturally on the development level of a country. On the other hand, the extended version of the model shows that workers' misperception about working conditions and factories' noncompliance with minimum standards can indeed be sources of comparative advantage that might serve the South in attracting more outsourcing contracts at the expense of the North.[7]

[6] This literature is summarized in Brown (2000) and Basu et al. (2003). See also Elliott and Freeman (2003) and Donado and Wälde (2015).

[7] Although outside the scope of this paper, a few empirical studies have also investigated the impact

3 The benchmark model

This section introduces the benchmark model. The model features a world economy with two countries (the technologically-advanced North and the South), one factor of production (labor), and two sectors. In sector one, firms in either country produce a homogeneous good. In sector two, northern firms design, develop, and assemble different varieties of a manufacturing good. Only the North has the knowledge to undertake these activities, but northern firms outsource the actual manufacturing stage to contract factories that can be located either in the North or in the South.

3.1 Individuals

Individuals in the two countries consume the goods produced in both sectors. In particular, an individual in country i working in occupation j consumes the quantity y_j^i of the homogeneous good and a continuum of varieties of the differentiated manufacturing good.[8] The index of the manufacturing varieties is given by

$$X_j^i = \left(\int_{\in\Omega} x_j^i (\omega)^{(\sigma-1)/\sigma} \, d\omega \right)^{\sigma/(\sigma-1)}, \tag{1}$$

where Ω represents the endogenous mass of available varieties, and $\sigma > 1$ is the constant elasticity of substitution between any two varieties. The individual preferences are given

of anti-sweatshop activism (Harrison and Scorse 2010) and monitoring for compliance with corporate codes of conduct (Locke, Qin, and Brause 2007 and Locke et al. 2007) on wages and working conditions at Nike contract factories.

[8] As it will be clear along the paper, individuals in the North ($i = N$) can work in one of five different types of occupations. They can either provide headquarter services ($j = h$), manufacturing services ($j = m$), fixed costs services ($j = f$), entry costs services ($j = e$), or produce the homogeneous good ($j = y$). In the South ($i = S$), individuals can only work in one of two occupations. They can either provide manufacturing services ($j = m$) or produce the homogeneous good ($j = y$).

by

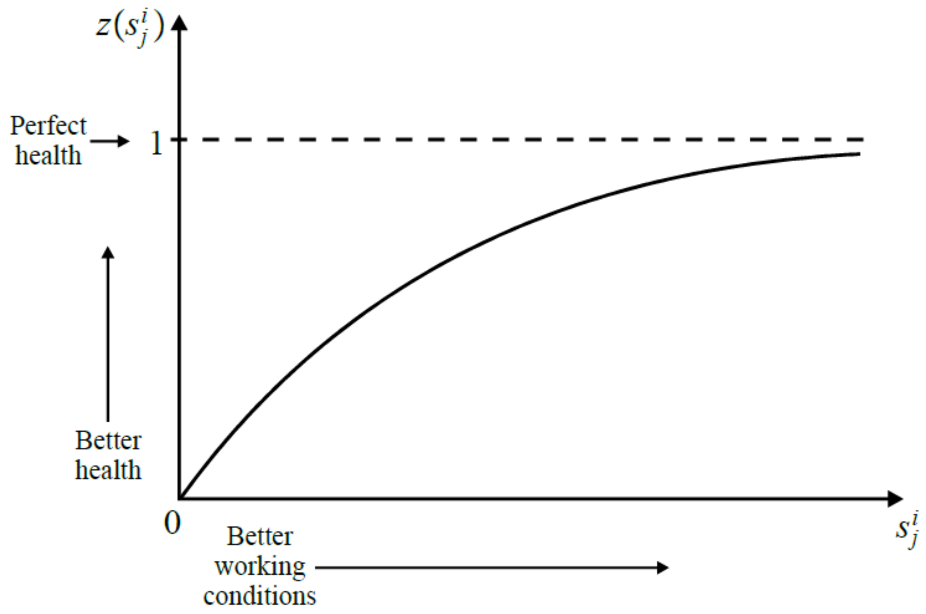
$$u_j^i = z\left(s_j^i\right)\left(X_j^i\right)^\alpha\left(y_j^i\right)^{1-\alpha} - u_{\min}, \tag{2}$$

where $0 < \alpha < 1$. The Cobb-Douglas structure of consumption $\left(X_j^i\right)^\alpha\left(y_j^i\right)^{1-\alpha}$ in (2) is standard in the literature, but $z\left(s_j^i\right)$ and $u_{\min}$ require more explanation.

First, $z\left(s_j^i\right)$ represents a subutility which is a function of the working conditions $s_j^i \geq 0$ prevailing in the occupation j and country i where the individual works. The function $z\left(s_j^i\right)$ is assumed to increase in s_j^i but with a diminishing slope, that is, $z_s > 0$ and $z_{ss} < 0$. For concreteness, it is convenient to suppose, as in Donado and Wälde (2012, 2015), that $z\left(s_j^i\right)$ represents the individual's health. The implicit assumption is that poor working conditions deteriorate workers' health.[9] To capture this idea in the most convenient way, the model restricts z to be bounded between zero and one, $z \in [0, 1]$. The interpretation is that individuals who are completely healthy ($z = 1$) enjoy their consumption $\left(X_j^i\right)^\alpha\left(y_j^i\right)^{1-\alpha}$ fully, while less healthy individuals ($z < 1$) enjoy only a fraction of that consumption. Figure 1 illustrates this health function. An increase in the level of worker conditions improves the individuals' health. In the limit, where working conditions tend to infinity, the health of workers is "perfect." In this framework, working conditions s_j^i are characterized in a very general way. Low levels of s_j^i can thus represent a hazardous working environment, excessive working hours, discrimination, harassment, abuse, corporal punishment, lack of fringe benefits, etc.

[9] Empirical support for this assumption can be found in Fletcher, Sindelar, and Yamaguchi (2010); Cottini and Lucifora (2013); and Barnay (2014).

Figure 1: Health as a function of working conditions



The second novel element in (2) is $u_{\min}$. This parameter represents a utility threshold below which individuals are considered to be "suffering." It is the utility level that individuals would reach if they were able to exactly meet their basic needs in terms of health and consumption. It is similar in spirit to the poverty threshold of a multidimensional poverty index. Following the influential work of Amartya Sen (see, e.g., Sen 1985), the literature has proposed several such indices.[10] The motivation is that poverty should not be assessed based only on consumption deprivation, but it should also incorporate other dimensions such as the individual's health. There are several ways to define a multidimensional poverty threshold. However, the definition that is closest to $u_{\min}$ is one that allows for some substitutability between consumption and health; that is, one in which for instance a very good health status can partially compensate for a consumption level below a predefined consumption threshold. Thus, according to (2), an individual will only have a positive utility ($u_j^i > 0$) if the mix of actual consumption and health yields a utility level that is higher than $u_{\min}$. A negative utility level in this context ($u_j^i < 0$)

[10] See, e.g., Permanyer (2014) and the references therein.

means that the individuals are "suffering" because they are not able to satisfy their basic needs.[11]

Individuals choose the consumption level that maximizes their utility (2) subject to their budget constraint. The solution to the problem is given by the demand functions (see the Online Appendix)

$$y_j^i = (1-\alpha)\frac{w_j^i}{p_y} \qquad \text{and} \qquad x_j^i(\omega) = \frac{p^i(\omega)^{-\sigma}}{P^{1-\sigma}}\alpha w_j^i, \tag{3}$$

where w_j^i is the individual's wage, p_y denotes the price of the homogeneous good, $p^i(\omega)$ is the price of the final good variety whose manufacturing process has been outsourced to country i, and

$$P = \left(\int_{\in\Omega} p^i(\omega)^{1-\sigma} d\omega\right)^{1/(1-\sigma)} \tag{4}$$

is the price index dual to (1). As it will be clearer below, both countries have the same price index because the model assumes no transportation costs to export the final manufacturing variety.

Inserting these demand functions in the utility function (2) gives the *indirect* utility function (see the Online Appendix)

$$u_j^i = z\left(s_j^i\right)\frac{w_j^i}{\Lambda}\Phi - u_{\min}, \tag{5}$$

where

$$\Lambda \equiv P^\alpha p_y^{1-\alpha} \qquad \text{and} \qquad \Phi \equiv \alpha^\alpha (1-\alpha)^{1-\alpha}.$$

Since Λ denotes the cost-of-living index, the fraction w_j^i/Λ in (5) gives the individual's real wage. When we think of individuals as being "consumers," it is better to represent

[11] Note that setting $u_{\min} = 0$ does not change the results of this paper in any significant way. The only point of introducing $u_{\min} > 0$ in (2) is to capture the recurrent idea from the nonacademic literature that factory workers might not be able to meet their basic needs. Allowing for $u_{\min} > 0$ also simplifies the presentation and discussion of the model's main predictions below.

their preferences with (2), while when we think of them as being "workers," it is more convenient to use (5). Both utility functions are closely related. However, the indirect utility function in (5) shows clearer how wages and worker conditions affect the individual's utility. In fact, (5) with $u_{\min} = 0$ is the analogue of the canonical utility function in compensating wage differential models in which the utility function depends on wages and working conditions (see, e.g., Rosen 1987).

3.2 Homogeneous good sector

The homogeneous good sector is perfectly competitive. Goods are produced in both countries using a constant-returns-to-scale technology. Total output in country i is equal to $Y^i = a^i L_y^i$, where L_y^i is the labor allocated for the production of the homogeneous good, and a^i denotes the labor productivity in this sector. Homogeneous goods are costlessly traded between the two countries at the international price p_y. One of the main differences between the North and the South is that the labor productivity is assumed to be higher in the North, $a^N > a^S$. This is one of the reasons why the North is technologically more advanced than the South.[12] Moreover, due to perfect competition, the price is equal to the marginal costs of production, $p_y = w_y^i / a^i$. This condition, together with $a^N > a^S$, implies that wages in this sector are higher in the North, $w_y^N = a^N p_y > w_y^S = a^S p_y$.

International trade models typically introduce a homogeneous good sector to pin down wages in a general equilibrium framework. This sector is sometimes called the "outside" sector, the "agricultural" sector, or the "rest of the economy." In the current model, this sector serves as a reference not only for wages but also for productivity and working conditions in country i. In particular, a country can be made more technologically

[12] The other reason is that only the North has the knowledge to produce final manufacturing goods (see below).

advanced by increasing its labor productivity a^i in an exercise of comparative statics. Also, the current model assumes that working conditions are "perfect" in this sector. Using the notation from the previous section, "perfect" working conditions mean that $s_y^i \longrightarrow \infty$, which in turn implies that individuals working in this sector enjoy their consumption fully since $z\left(s_y^i\right) = 1$. These working conditions are taken as a point of reference by individuals working in the other sector. Moreover, since working conditions are "perfect" in the homogeneous sector, workers do not demand compensating wage premia to accept a job. The wage

$$w_y^i = a^i p_y \tag{6}$$

can therefore be thought of as the "risk-free" wage in country i.

3.3 Manufacturing sector

The manufacturing sector features increasing returns to scale and monopolistic competition in the production of final goods. Only northern firms have the knowledge to produce those final goods, but they can outsource the actual manufacturing stage to contract factories located either in the North or in the South. The structure of this sector is a complete-contract version of Antràs and Helpman (2004). The timing of events is as follows:

1. In order to enter the market, northern firms have to pay a sunk entry cost of f_e units of northern labor.

2. These firms then draw their productivity φ from a common distribution $g(\varphi)$.

3. Depending on the productivity draw, firms decide whether to immediately exit the market or to stay and produce the final good. The production of the final

good takes place in the North and combines two stages, headquarter services h and manufacturing services m, under a Cobb-Douglas production function of the form

$$q^i\left(h^i, m^i\right) = \varphi \left(\frac{h^i}{\eta}\right)^{\eta} \left(\frac{m^i}{1-\eta}\right)^{1-\eta}, \tag{7}$$

where $0 < \eta < 1$ is a measure of headquarter intensity in the production process. "Headquarter services" are a shortcut for several activities that might include management, R&D, brand development, marketing, design, accounting, finance operations, etc. Their production can only take place in the North, and it requires one unit of northern labor per unit of h. "Manufacturing services" represent the actual manufacturing process. In some industries, however, m better fits the interpretation of an intermediate input. Final-good producers can outsource the production of m to a contract factory located either in the North or in the South. Production of one unit of m requires one unit of local labor from the supplier country. Note that the superscript i on h does not mean that h can be produced in the South. This superscript only identifies the country where the production of the other input, m, has been outsourced to.[13]

Given the individual demand function in (3), final-good producers face an aggregate *inverse* demand function

$$p^i(\omega) = \left(\frac{\alpha E}{q^i(\omega) P^{1-\sigma}}\right)^{1/\sigma}, \tag{8}$$

where E denotes total expenditure. Using (7) and (8), the revenue of a firm that outsources production to country i is given by

$$r^i\left(h^i, m^i\right) = p^i q^i.$$

[13]Since all manufacturing firms are always located in the North, the superscript i on the variables directly associated with those manufacturing firms (h^i, p^i, q^i, r^i, π^i, f^i) only denotes the country in which they outsource their manufacturing stage m.

4. The decision on where to outsource the production of m depends on the costs associated with each location. On the one hand, southern factories might be able to produce m at lower costs than northern factories. These costs are denoted by p_m^i (see below). On the other hand, firms have to pay an additional fixed cost f^i in units of northern labor to produce the final good, and these fixed costs are assumed to be higher in the case of southern outsourcing, $f^S > f^N$. The difference in fixed costs captures, for instance, differences in communication or search costs between northern and southern outsourcing. Moreover, if m is produced in the South, firms have to pay "iceberg" transportation costs $\tau > 1$ to import m back to the North for final assembly. Thus, when outsourcing in the South, final-good producers compare the potentially lower variable costs against the higher fixed costs of this strategy. For simplicity, the current version of the Antràs and Helpman (2004) model assumes that final-good producers outsource the production of m to an external supplier and do not find it profitable to produce m in a wholly owned factory. This assumption represents a very accurate approximation of the low-skill and labor-intensive industries (in particular, the apparel and footwear industry) which are the main focus of the current paper. This also corresponds to the "low headquarter intensity" case in the original Antràs and Helpman (2004) model.

5. After the location decision has been made, the northern firm and the factory sign a contract stipulating a quantity m^i to be provided by the factory in exchange of a fee F^i. The maximization problem of the northern firm is

$$\max_{h^i, m^i, F^i} \pi^i = r^i\left(h^i, m^i\right) - w_y^N h^i - F^i - w_y^N f^i \tag{9}$$

subject to

$$F^N - p_m^N m^N \geq 0 \tag{10}$$

if the factory is located in the North and subject to

$$F^S - \tau p_m^S m^S \geq 0 \tag{11}$$

if the factory is located in the South, where p_m^i denotes the price of producing one unit of m in country i. As might be expected, the northern firm will set F^i in the contract to make the factory's participation constraint (10) or (11) exactly bind.

Two points are worth emphasizing about the maximization problem in (9) - (11). First, to focus exclusively on the novel aspects related to outsourcing and working conditions, the model assumes that contracts are complete. Incomplete contracting has already been studied extensively in the literature (see, e.g., Antràs and Helpman 2004, 2008 and Antràs 2016). Second, the model assumes that firms pay workers producing h^i and those required for f^i the northern risk-free wage w_y^N. In the following section, it will become clearer how this contrasts to the wages paid to factory workers. For the time being, it suffices to emphasize that the implicit assumption in (9) is that workers producing h^i and f^i enjoy "perfect" working conditions, and northern firms do not need to pay them any compensating wage premium to attract those workers.

Now, plugging the first-order conditions that result from the maximization problem in the profit function in (9) allows us to express the profit flow of the firms outsourcing in the North as

$$\pi^N(\varphi) = \varphi^{\sigma-1} B \left(\left(w_y^N\right)^\eta \left(p_m^N\right)^{1-\eta} \right)^{1-\sigma} - w_y^N f^N \tag{12}$$

and of the firms outsourcing in the South as

$$\pi^S(\varphi) = \varphi^{\sigma-1} B \left(\left(w_y^N\right)^\eta \left(\tau p_m^S\right)^{1-\eta} \right)^{1-\sigma} - w_y^N f^S, \tag{13}$$

where

$$B \equiv \frac{1}{\sigma}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1}\frac{\alpha E}{P^{1-\sigma}} \tag{14}$$

measures the demand level (see the Online Appendix for details).

6. After the inputs h and m have been produced, northern firms assemble the final good q and then sell it to consumers in both countries. As in the original model from Antràs and Helpman (2004), the current model assumes for simplicity that there are no costs associated with exporting the final good q to the South.[14]

3.4 Contract factories

As already mentioned, northern firms subcontract factories to undertake the actual manufacturing process, m. Factories, for their part, produce m under perfect competition and with a technology that features constant returns to scale. In the model, good working conditions are more expensive to provide in factories than in other workplaces in the economy. Building on the Nike example from the introduction, a safe shoe factory requires ventilation systems, protective equipment for workers, training on occupational health and safety, a medical room, etc. Some of these measures have a public good character because they benefit all factory workers equally. For simplicity, however, the model assumes that the costs of these measures increase linearly with the number of workers.

Since factories produce m under constant returns to scale (i.e., m can be produced one-to-one with labor), the maximization problem can be solved for each worker separately.

[14]See also Antràs (2016, ch. 4) and Antràs and Yeaple (2014, sect. 5.3). This assumption is typically made to abstract from the horizontal (FDI) dimension in which firms might replicate the same production process in another country to save on transportation costs or tariffs.

The profits *per worker* of a factory located in country i are given by

$$\pi_m^i = p_m^i - w_m^i - \gamma s_m^i, \tag{15}$$

where w_m^i and s_m^i respectively denote the wage and the level of working conditions, and γ represents the cost per worker of a unit of working conditions. To attract workers, factories have to make them indifferent between working in a factory and in a "risk-free" workplace. Thus, using the indirect utility function in (5), the workers' participation constraint is given by

$$\begin{aligned} z\left(s_m^i\right) \frac{w_m^i}{\Lambda}\Phi - u_{\min} &= \frac{w_y^i}{\Lambda}\Phi - u_{\min} \\ \Longleftrightarrow \quad z\left(s_m^i\right) w_m^i &= w_y^i. \end{aligned} \tag{16}$$

Factories choose w_m^i and s_m^i to maximize (15) subject to (16). A very convenient functional form for the health function $z\left(s_m^i\right)$ that allows to obtain closed-form solutions is

$$z\left(s_m^i\right) = \frac{s_m^i}{1 + s_m^i}. \tag{17}$$

Under the assumption of (17), the first-order conditions resulting from the factory's maximization problem are (see the Online Appendix)

$$s_m^i = \left(\frac{w_y^i}{\gamma}\right)^{1/2} \tag{18}$$

and

$$w_m^i = \left(w_y^i \gamma\right)^{1/2} + w_y^i. \tag{19}$$

Equations (18) and (19) are very intuitive. First, the level of working conditions in (18) is increasing in the workers' outside option w_y^i and decreasing in the cost of working conditions γ. It is clear from (18) that working conditions in the factories are less than "perfect" (since $s_m^i < \infty$). Second, factory wages in (19) represent a premium $\left(w_y^i \gamma\right)^{1/2}$

over the country's risk-free wage w_y^i. The premium $\left(w_y^i\gamma\right)^{1/2}$ is what the literature calls the "compensating wage differential," and it is a premium that workers receive for the poorer working conditions in the factories. Note that this premium increases in γ. The reason is that factories provide a lower level of working conditions in (18) when γ is high. To compensate for this lower level, factories have to increase the wage premium in (19) to be able to attract workers.

Perfect competition among factories drives profits down to zero, and the manufacturing production price can be determined from (15) with $\pi_m^i = 0$, which after inserting (18) and (19) and rearranging is given by

$$p_m^i = 2\left(w_y^i\gamma\right)^{1/2} + w_y^i. \tag{20}$$

This manufacturing production price is a very important variable in the model. Together with the fixed costs f^i and the transportation costs τ, it is the price that the northern firms take into consideration when choosing the location for the manufacturing stage. In the model, southern factories can produce m at a lower price $\left(p_m^S < p_m^N\right)$ since the risk-free wages are lower in the South $\left(w_y^S < w_y^N\right)$. Looking at how these risk-free wages are determined in (6) makes it clear that the ultimate source of the North-South difference in manufacturing production prices is the difference in labor productivities $\left(a^S < a^N\right)$.

Interestingly, not only p_m^i but also s_m^i and w_m^i depend indirectly on a^i, and all three variables increase with this labor productivity. In other words, the development level of a country (as measured by a^i) determines the level of wages and working conditions in the factories and the manufacturing production price. Thus, in more developed countries, factories pay higher wages and provide better working conditions, but the prices they demand for undertaking the manufacturing stage are also higher.

It is worth emphasizing that if the cost of working conditions was equal to zero ($\gamma = 0$), working conditions in the factories would be perfect ($s_m^i \to \infty$), and factory wages and manufacturing production prices would converge to the risk-free wage $\left(w_m^i = p_m^i = w_y^i\right)$. Perfect working conditions and risk-free wages are the standard assumptions in outsourcing models. In fact, a perfect-contract version of Antràs and Helpman (2004)[15] is a special case of the current model when $\gamma = 0$ and $u_{\min} = 0$.

To close this section, note that wages and working conditions in the two sectors can be represented in a standard compensating-wage-differentials diagram,[16] such as the one in Figure 2. The worker's indifference curve v^i comes from (16) using (17),

$$\frac{s_m^i}{1+s_m^i} w_m^i = w_y^i \iff w_m^i = w_y^i + \frac{w_y^i}{s_m^i}, \tag{21}$$

while the factory's zero-profit isoprofit line π_{m0}^i can be obtained using (15),

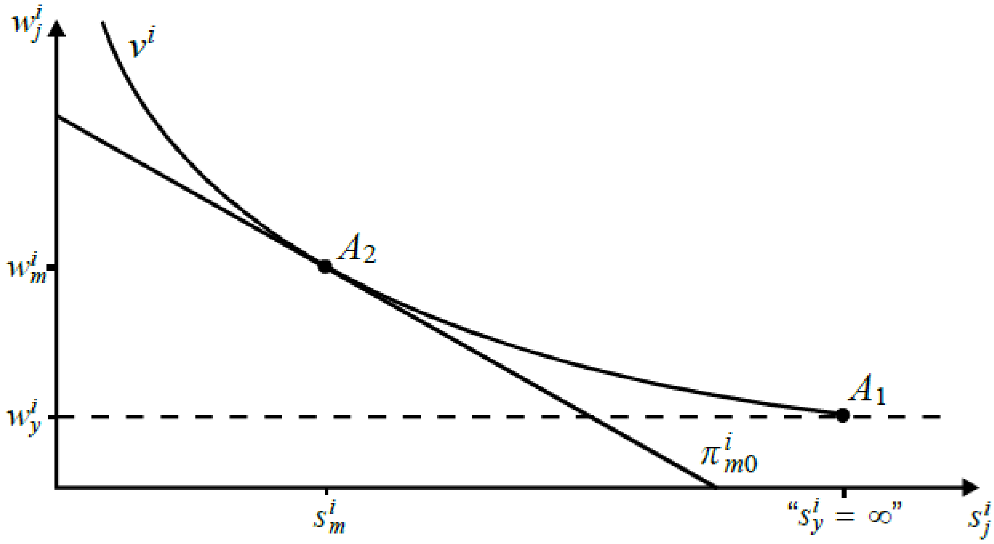
$$p_m^i - w_m^i - \gamma s_m^i = 0 \iff w_m^i = p_m^i - \gamma s_m^i.$$

It is clear from (21) that the factory wage w_m^i converges to the risk-free wage w_y^i as factory working conditions s_m^i tend to infinity. In Figure 2, this means that the indifference curve v^i converges to the dashed line without ever reaching it. For illustrative purposes, however, Figure 2 pretends that there exists a point at which the indifference curve touches the dashed line, and at this point, working conditions are perfect ("$s_y = \infty$"). This allows us to represent point A_1, which gives the package of wages and working conditions in the homogeneous sector. Moreover, point A_2 represents the package of wages and working conditions at factories. Since the indifference curve passes through A_1 and A_2, workers are indifferent between working in the homogeneous sector (for perfect working conditions and risk-free wages) and in a factory (for poor working conditions but relatively high wages).

[15] See also Antràs 2016, ch. 4.

[16] See, e.g., Ehrenberg and Smith 2014, ch. 8.

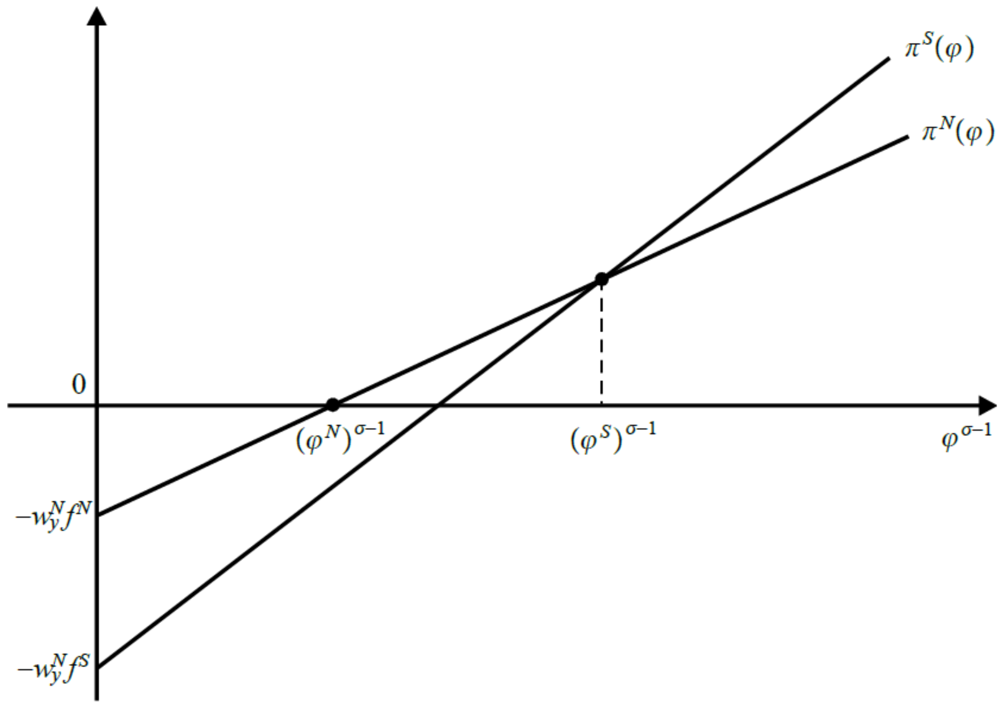
Figure 2: Wages and working conditions



3.5 Equilibrium

Now that we understand how the manufacturing production prices p_m^i are determined in the economy, we can turn to the characterization of the equilibrium. Remember that the profit flows of northern manufacturing firms for each outsourcing location are given by (12) and (13). Figure 3 plots these profits as a function of $\varphi^{\sigma-1}$ under the assumption that $p_m^N > \tau p_m^S$. As the figure illustrates, northern firms with productivity levels below φ^N would make negative profits if they produced. Thus, these firms exit the market immediately after learning their productivity. From the firms that remain active, those with productivity levels between φ^N and φ^S will outsource their manufacturing stage to northern factories, while those with productivity levels above φ^S will find it more profitable to outsource their manufacturing stage to southern factories.

Figure 3: Profit flows and firm productivity



As is evident from the figure, φ^N can be computed from (12) with $\pi^N\left(\varphi^N\right) = 0$, and φ^S can be computed using (12) and (13) for $\pi^N\left(\varphi^S\right) = \pi^S\left(\varphi^S\right)$. The resulting productivity cutoffs are

$$\varphi^N = \left(\frac{w_y^N f^N}{B}\right)^{\frac{1}{\sigma-1}} \left(w_y^N\right)^{\eta} \left(p_m^N\right)^{1-\eta} \tag{22}$$

and

$$\varphi^S = \left(\frac{\left(w_y^N\right)^{1-\eta(1-\sigma)}\left(f^S - f^N\right)}{B\left(\left(\tau p_m^S\right)^{(1-\eta)(1-\sigma)} - \left(p_m^N\right)^{(1-\eta)(1-\sigma)}\right)}\right)^{\frac{1}{\sigma-1}}. \tag{23}$$

In the model, the only reason why manufacturing firms pay the sunk entry cost is because they expect their profits to be positive after entering the market. In equilibrium, the expected operating profits of a potential entrant have to be equal to the total entry costs. The total entry costs are the amount of northern labor employed in the entry stage (f_e) multiplied by the northern risk-free wage paid to that labor w_y^N. The free entry condition is

$$\int_{\varphi^N}^{\varphi^S} \pi^N(\varphi)\, g(\varphi)\, d\varphi + \int_{\varphi^S}^{\infty} \pi^S(\varphi)\, g(\varphi)\, d\varphi = w_y^N f_e. \tag{24}$$

Equations (22), (23), and (24) form a system of three equations in three unknowns. These equations provide solutions for the cutoffs φ^N and φ^S and for the demand level B. Having obtained φ^N, φ^S, and B, we can then determine all other variables in the model (see the Online Appendix for more details).

3.6 Model predictions

After having laid out the model, this section enumerates its main predictions and applies the framework to understand the debate surrounding Nike and its international labor practices. In particular, this section seeks to understand: why do profitable brand companies like Nike outsource their manufacturing production to contract factories operating under poor working conditions? Why are working conditions poor in those factories? And why are factory wages not high enough to meet workers' basic needs? In short: "why do they JUST DO IT?" The model's first prediction is:

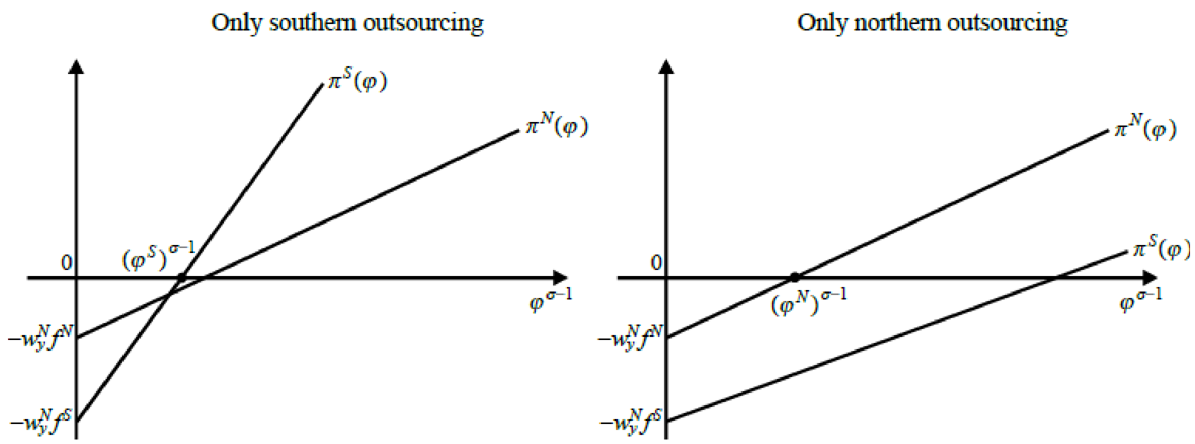
P1: The most productive northern firms make high profits and outsource their actual manufacturing stage to contract factories in the South.

It is not unusual for a brand company like Nike to make high profits. Since its foundation in 1964, Nike has constantly reported positive gross profits. The model's explanation is very simple: Nike makes high profits because it is a very productive company. As illustrated in Figure 3, the model predicts a positive linear relationship between profits and the productivity measure $\varphi^{\sigma-1}$. In the model, the most productive firms make the highest profits.

But why does Nike outsource its manufacturing production to foreign countries? During its initial years, Nike shoes were produced in the U.S. and Japan. Over time, however, the company started to look for lower cost alternatives. With the constant reduction in transportation costs, Nike outsourced more an more production to contract factories located in South Korea and Taiwan. However, as these countries developed and their production costs increased, Nike relocated production to independent factories in Indonesia, Vietnam, and China (Locke 2003).

As with profits, the model predicts that Nike outsources its manufacturing production in the South because it is a very productive company. In the model, only the most productive firms find it profitable to invest in the fixed costs associated with southern outsourcing (f^S) to benefit from the lower production costs at southern factories. As it is clear from the profit flows in (12) and (13), differences in fixed costs (f^N vs. f^S) and in the effective prices (p_m^N vs. τp_m^S) are the key location determinants. A decline in southern fixed costs f^S, in transportation costs τ, or in the southern manufacturing production prices p_m^S increases the prevalence of southern outsourcing. Moreover, if τp_m^S is very low relative to p_m^N, the model predicts an equilibrium in which all firms in the sector will outsource their manufacturing stage in the South. In contrast, if τp_m^S is very high compared to p_m^N, then the resulting equilibrium is one in which all firms outsource the manufacturing stage in the North. These two extreme equilibria are illustrated in Figure 4.

Figure 4: Extreme equilibria



P2: The level of working conditions at factories depends on the costs of providing these working conditions and on the country's labor productivity.

Working conditions at Nike contract factories have often been criticized for being very poor. As shown in equation (18), the benchmark model provides two explanations for poor working conditions. The first one is that the production process taking place at those factories is inherently dangerous and providing good working conditions requires investment in costly safety measures. For instance, the manufacturing process of a Nike pair of shoes involves several health and safety risks for workers.[17] Adhesives for gluing together the different shoe components might not only be highly flammable, but they can also contain toxic solvents (such as benzene, toluene, or xylene) that can cause vertigo, headaches, nausea, loss of consciousness, or even cancer and reproductive disorders. Machines can injure workers directly or produce excessive vibrations, noise, heat, or dust that can affect workers health. Appropriate ventilation systems, protective equipment, training on occupational health and safety, and regular medical examination can reduce the harmful effects of production, but these preventive measures are costly to provide.

[17]See Chen and Chan (1999); Markkanen (2009: 23-28); and Conradi and Portich (2011).

Without any investments in these measures, shoe production can be very dangerous for workers.

The second explanation from the model for poor factory working conditions is related to the country's labor productivity (a^i).[18] In the model, the labor productivity is a measure of the country's development level. The model thus predicts that the quality of working conditions improves with the development level of a country. Compared to rich countries, factory working conditions in the Third World can appear dreadful. But factory working conditions have not always been good in the developed world either. For instance, during the Industrial Revolution in Great Britain, factory workers labored for as many as sixteen hours a day, six days per week. They performed activities that were monotonous, dangerous, and unhealthy. Factories were not only noisy, but they were also poorly lit and lacked appropriate ventilation (Powell 2014: 112-120). Some of these working conditions resemble those of developing countries today. Thus, according to the model, working conditions in southern factories will improve naturally as the country develops.

P3: Workers in contract factories earn more than in alternative workplaces, but wages are only higher because they compensate workers for inferior working conditions.

Are wages at Nike contract factories too low? In the example from the introduction, workers at the Vietnamese factory were only paid \$10 a week. Compared to the U.S. minimum wage of \$5.15 an hour (also for the year 1997), Vietnamese factory wages look indeed very low. An American factory worker would have earned more after two hours of work than a Vietnamese factory worker after 48 hours. But this is not the relevant comparison. For a Vietnamese worker, what counts are the job alternatives in

[18] This can be seen after plugging (6) in (18).

Vietnam, not in the U.S., and the relevant question is "how do Vietnamese factory wages compare to the workers' next best alternative in their own country?" The number of studies addressing this type of question is still very limited, but they suggest that factory workers in low-cost countries tend to earn more than the local national average. For instance, Powell and Skarbek (2006) and Powell (2014: 48-62) find that apparel workers' average income exceeds the average income in Vietnam and in other countries to which brand companies typically outsource their manufacturing production.[19]

The model is able to capture the two main features from this discussion: First, that factory wages are higher in the North than in the South; and second, that wages at factories are higher than in other workplaces in the economy. The first result can be clearly seen by plugging equation (6) into (19). The simple prediction from the model is that wages are higher at northern factories because the North is technologically more advanced than the South ($a^N > a^S$). The explanation for the second result is that factory wages are higher than in alternative employment in the same country because they compensate for the poorer working conditions.

In reality, working conditions at factories do not necessarily have to be worse than in alternative workplaces. If workers' alternatives are scavenging in a trash dump or prostitution, then working conditions at shoe factories are comparably better. For simplicity, however, the model assumes that the homogenous sector is characterized by "perfect" working conditions. Thus, relative to that point of comparison, factories have to offer wage premia to be able to attract workers. However, the real testable prediction from the benchmark model is not necessarily that factory wages are higher, but that they

[19] Other studies have found that foreign owned businesses tend to pay higher wages (see Brown, Deardorff, and Stern 2004 for a literature overview). However, in the industries that are the focus of the current paper, factories are typically not owned by the subcontracting companies.

are only higher if working conditions at factories are relatively worse than in alternative employment.

P4: Despite being higher, factory wages might not meet workers' basic needs, but the reason is that the country's labor productivity is too low.

Why do factory wages might not be high enough to meet workers' basic needs? According to the model, Nike contract factories only need to offer workers a package of wages and working conditions that makes them indifferent between factory employment and alternative employment (see equation (16) and Figure 2). If the package of wages and working conditions in alternative employment is bad in the first place, then Nike factories can attract workers by also offering a bad package. The composition of that package is different at factories because of the inferior working conditions, but workers' utility from both alternatives is equally low. In other words, what workers can get at Nike factories is only as good (or as bad) as their available alternatives.

But why are these alternatives bad? In the model, factory workers' alternatives are jobs in the homogeneous sector. Wages in the homogeneous sector in (6) are determined by the country's labor productivity. If this productivity is low, wages might not be high enough to meet workers' basic needs $u_{\min}$ in the indirect utility function (5). Thus, in the benchmark model, the only reason for why workers might not be able to meet their basic needs is that the country's labor productivity is too low.

P5: The only source of comparative advantage is the difference in labor productivities between the two countries. Thus, a low-productivity country can attract more outsourcing contracts since it can undertake the manufacturing stage at lower costs.

Over time, Nike has changed the location of its manufacturing production. This relocation has taken place because Nike has searched for the cheapest countries to manufacture its goods. In the model, the cheapest country is the one that can offer the lowest manufacturing production prices p_m^i. As explained below equation (20), the only reason why these prices differ across countries is because countries differ in their labor productivities a^i. Factories in a low-productivity country can undertake the manufacturing stage at lower prices. Thus, low-productivity countries are able to attract more manufacturing contracts.

4 Extensions

The benchmark model, although stylized in some dimensions, is tractable enough to accommodate several extensions. This section studies two extensions that have been at the heart of the Nike debate. The first one is workers' misperception about their working conditions, and the second one is factories' noncompliance with minimum labor standards.

4.1 Workers' misperception

One finding of Nike's audit report from the introduction was that workers at the Vietnamese factory were not fully aware of the harmful effects of the chemicals they had to deal with. This was not an isolated case. According to another report on Nike and Reebok contract factories in China,[20]

> "[m]any workers did not consider the chemicals in their factories to be hazardous, but this is often a reflection of their lack of understanding about health

[20] AMRC and HKCIC (1997). See also Chen and Chan (1999).

> and safety issues. One chemical, benzene, which is used in China as a glue in making sports shoes, can cause anemia and leukemia and is so toxic that it has been banned in the United States and many European countries. But the factories do not inform the workers of the contents of poisonous substances, so workers have no way of knowing the degree of harm done to their bodies."

Lack of sufficient knowledge on occupational risks is a common problem. Another problem is that factory workers are not aware of their legal rights either. For instance, the same report claimed that

> "workers often had a difficult time answering questions about overtime because it is hard for them to distinguish between a 'normal work day' and overtime. When hired, the workers were told they had to work 12 hours a day. According to the Chinese Labour Law, the work day should only be eight hours long, and the four extra hours of work should be counted as overtime. However, the factories set the 'normal' work day as 12 hours, and then add additional overtime work. Therefore, if a worker works a 15-hour day, she will usually say she worked three hours of overtime, when she really worked seven overtime hours."

Lack of knowledge on occupational risks and on labor rights are both examples of workers' misperception about the true level of working conditions. As this section will show, workers' misperception has consequences for wages, working conditions, and the manufacturing production price.

The current paper models workers' misperception in the simplest possible way. It builds on the approach introduced by Diamond (1977) and Viscusi (1980). Specifically, factories still choose w_m^i and s_m^i to maximize the same profit function in (15), but the workers' participation constraint is now given by

$$z\left(\mu^i s_m^i\right) \frac{w_m^i}{\Lambda}\Phi - u_{\min} = \frac{w_y^i}{\Lambda}\Phi - u_{\min}$$

$$\iff z\left(\mu^i s_m^i\right) w_m^i = w_y^i, \tag{25}$$

where $\mu^i \geq 1$. Except for the parameter μ^i, this participation constraint is identical to the one from the benchmark model in (16). The parameter μ^i is called the "misperception" parameter. Note that μ^i is present in (25) but not in the factory's profit function in (15). This is how the model captures the idea that factory owners are assumed to know the exact level of working conditions, while workers perceive these working conditions to be better than they actually are.[21] For instance, $\mu^i = 2$ would mean that workers perceive their working conditions to be twice as good as they actually are.

The factory's problem consists in maximizing its profits in (15) subject to the new workers' participation constraint in (25). To obtain closed-form solutions, it is again convenient to assume the following functional form for the health function (see eq. (17))

$$z\left(\mu^i s_m^i\right) = \frac{\mu^i s_m^i}{1 + \mu^i s_m^i}.$$

Under this assumption, the first order-conditions are given by

$$\widetilde{s}_m^i = \left(\frac{w_y^i}{\gamma \mu^i}\right)^{1/2} \tag{26}$$

[21] In reality, factory owners might not have perfect knowledge on some working conditions either. For example, some occupational diseases might take several years to manifest, and even employers might not be aware of the causal link between a particular disease and factory production. However, what is important for the argument is that factory owners have *more* knowledge than workers. To simplify the model, the paper assumes that factory owners perceive working conditions as they truly are, while workers underperceive them.

and

$$\widetilde{w}_m^i = \left(\frac{w_y^i \gamma}{\mu^i}\right)^{1/2} + w_y^i, \tag{27}$$

where the tilde ($\widetilde{}$) is used to denote the variables for the workers' misperception case.

Compared to the benchmark model, the first-order conditions in (26) and (27) now feature the misperception parameter μ^i. Importantly, an increase in misperception leads to poorer working conditions in (26) and to lower wages in (27). These results echo those of Diamond (1977) and Viscusi (1980) who find that workers' wages are lower and job risks are higher under workers' misperception. In the current model, wages are lower because the compensating premium $\left(w_y^i \gamma / \mu^i\right)^{1/2}$ decreases in μ^i. The implication is that workers are not appropriately compensated for the poorer working conditions at factories.

Following the same steps as in the benchmark model, the manufacturing production price can be derived as

$$\widetilde{p}_m^i = 2\left(\frac{w_y^i \gamma}{\mu^i}\right)^{1/2} + w_y^i. \tag{28}$$

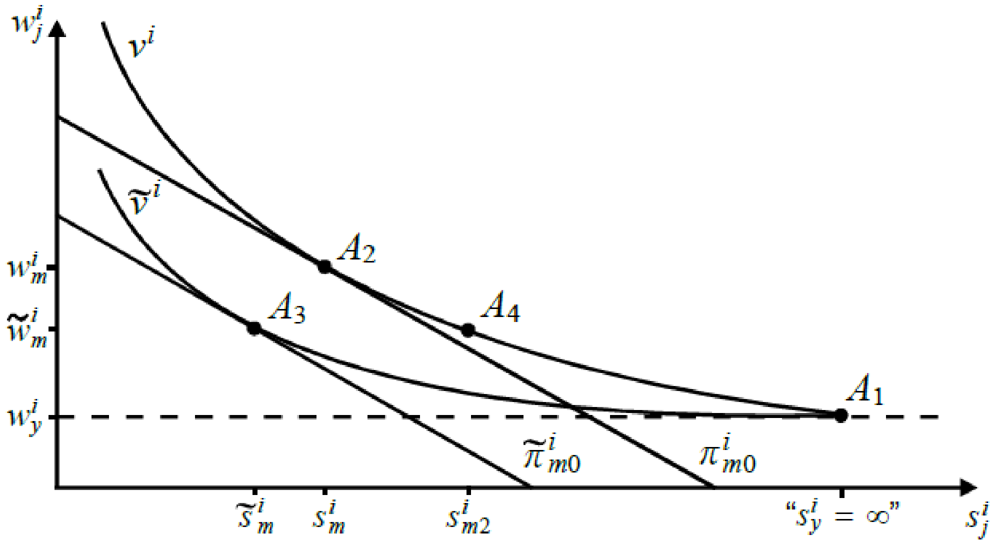
As with the first-order conditions, this price also decreases in the misperception parameter. Thus, under workers' misperception, factories are able to attract more outsourcing contracts because they can undertake the manufacturing stage at lower costs.

Figure 5 illustrates wages and working conditions in a compensating-wage-differentials diagram.[22] For workers, the main consequence of their misperception is that, instead of receiving the "perfect-perception" package (w_m^i, s_m^i) represented by point A_2, they now

[22] In the current model, "perfect" working conditions correspond to the case in which $s_j^i \longrightarrow \infty$. This level of working conditions cannot be represented in a standard compensating-wage-differentials diagram. For illustration purposes, however, Figures 2 and 5 pretend that such a point exists on the horizontal axis. This point is labeled as "$s_y^i = \infty$". In reality, in Figure 5, the two indifference curves v^i and $\widetilde{v}^i$ will never meet at point A_1. Both indifference curves will converge to the dashed line (without ever touching it), but $\widetilde{v}^i$ will always be closer to that line than v^i.

obtain the inferior package $(\widetilde{w}^i_m, \widetilde{s}^i_m)$ represented by A_3. Workers clearly see their wage $\widetilde{w}^i_m$, but they misperceive their actual level of working conditions. In particular, they believe that their working conditions are equal to s^i_{m2}, instead of equal to $\widetilde{s}^i_m$. In other words, workers believe that they are at point A_4, while they are in fact at point A_3. If workers were informed about their actual working conditions, they would immediately experience the lower utility level $\widetilde{v}^i$.

Figure 5: Consequences of workers' misperception



4.2 Noncompliance

Nike's audit report from the introduction identified several violations of local laws at the Vietnamese contract factory (see Table 1). In some sections of the factory, workers' exposure to heat, noise, dust, and to the toxic solvents toluene and acetone clearly exceeded legal standards. The most alarming transgression was workers' exposure to toluene, which was found to be 171 times higher than the maximum permitted. Moreover, a follow-up report (see O'Rourke 1997) claimed violations of maximum overtime hours that substantially surpassed the limit of 200 hours per year. These accusations parallel those of the Nike and Reebok report on contract factories in China that denounced factories' noncompliance with Chinese labor laws on minimum wages, maximum overtime hours, treatment of workers, safety standards, medical insurance, bereavement leave, maternity leave, etc.[23] Connor (2002) makes similar claims of Nike and Adidas contract factories in Indonesia.

Table 1: Noncompliance at the Vietnamese factory

Working conditions	Vietnamese maximum legal standard	Maximum value measured in factory
Heat exposure	28 °C	33 °C
Noise exposure	85-90 dB(A)	101 dB(A)
Dust exposure	Not available from the report	Exceeded standard by 11 times
Toluene exposure	Not available from the report	Exceeded standard by 171 times
Acetone exposure	Not available from the report	Exceeded standard by 18 times
Overtime work	200 hours per year	700 hours or more per year

Sources: Ernst & Young (1997) and O'Rourke (1997).

This section adapts the approach by Ashenfelter and Smith (1979) to study the consequences on working conditions and outsourcing of factories' noncompliance with legal standards. As an example of noncompliance, the section focuses on the consequences when factories do not comply with wage and safety standards that intend to solve the workers' misperception problem. The previous section made clear that workers' misperception can lead to lower wages, poorer working conditions, and lower utility for workers. A perfectly informed government could increase workers' utility by mandating minimum wage and labor standards that match those of the perfect-perception case.

More precisely, suppose that the government of country i mandated the perfect-perception standards (see equations (18) and (19))

$$s_m^i = \left(\frac{w_y^i}{\gamma}\right)^{1/2}, \qquad w_m^i = \left(w_y^i \gamma\right)^{1/2} + w_y^i.$$

[23] AMRC and HKCIC (1997). See also Chen and Chan (1999).

However, since workers are uninformed about their true working conditions, factories can still attract workers by offering them the inferior package (see equations (26) and (27))

$$\widetilde{s}^i_m = \left(\frac{w^i_y}{\gamma\mu^i}\right)^{1/2}, \qquad \widetilde{w}^i_m = \left(\frac{w^i_y\gamma}{\mu^i}\right)^{1/2} + w^i_y. \tag{29}$$

For factories, the decision to comply or not to comply with the government standards depends on the resulting *ex-ante* profits from each strategy. In particular, complying factories expect to generate the *ex-ante* profit (see eq. (15))

$$\pi^i_m = p^i_m - w^i_m - \gamma s^i_m, \tag{30}$$

while noncomplying factories expect

$$\widetilde{\pi}^i_m = \widetilde{p}^i_m - \widetilde{w}^i_m - \gamma\widetilde{s}^i_m - \rho^i D^i, \tag{31}$$

where ρ^i denotes the probability of being caught, and D^i is the per-worker penalty. Factories will not comply if $\widetilde{\pi}^i_m > \pi^i_m$. It turns out that the prevalence of noncompliance increases with the misperception parameter μ^i and decreases with ρ^i or D^i. The consequences for working conditions and wages are clear. If μ^i is high or if ρ^i or D^i are low, factories are more likely to offer workers the inferior package in (29).

Also note that, as in the benchmark model, perfect competition drives factories' *ex-post* profits to zero. The compliance and noncompliance manufacturing production prices can therefore be obtained from (30) and (31) with $\pi^i_m = 0$ and $\widetilde{\pi}^i_m = 0$, respectively. The resulting compliance price is identical to the one of the benchmark model in (20). In contrast, the noncompliance price is now given by

$$\widetilde{p}^i_m = 2\left(\frac{w^i_y\gamma}{\mu^i}\right)^{1/2} + w^i_y + \rho^i D^i.$$

This price increases in ρ^i and D^i. As a consequence, factories in a country in which compliance inspections are rare or in which penalties are low can undertake the manufacturing stage at lower prices and will therefore be able to attract more outsourcing contracts.

4.3 Predictions of the extended model

This section explains how the 5 predictions of the benchmark model are affected by workers' misperception and by factories' noncompliance. The first new prediction is:

P1': The most productive northern firms make high profits and outsource their actual manufacturing stage to contract factories in the South. **However, workers' misperception and factories' noncompliance in the South lead to even higher profits and more outsourcing**.

To best understand this prediction, consider the following exercise of comparative statics: Starting from a situation in which workers in both countries are perfectly informed ($\mu^N = \mu^S = 1$), increase the southern misperception parameter ($\mu^S \nearrow$), while keeping the northern misperception parameter at the perfect-perception level ($\mu^N = 1$). In other words, introduce workers' misperception in the South, but maintain perfect perception in the North. What are the consequences of this exercise on profits and outsourcing?

The first impact is a decline in the manufacturing production price in the South p_m^S (see eq. (28)). In Figure 3, this price reduction would increase the slope of the profit function associated with southern outsourcing π^S, moving the cutoff point $\left(\varphi^S\right)^{\sigma-1}$ to the left. The consequences are twofold: First, more northern firms would find it profitable to outsource their manufacturing stage in the South. Second, those northern firms that were already engaged in southern outsourcing would be able to generate even higher profits. The consequences of a reduction of p_m^S via a decrease in the southern probability of being caught ρ^S or in the southern noncompliance penalty D^S are identical. Thus, in the extended model, northern manufacturing firms benefit from a misinformed labor force and from low levels of compliance. Policies that reduce the degree of workers' misperception or that increase factories' compliance in the South would lead to higher utility for southern workers (see Figure 5) but to lower profits for northern manufacturing firms.

P2': The level of working conditions at factories depends on the costs of providing these working conditions, on the country's labor productivity, **and on the degree of workers' misperception**.

Under workers' misperception, working conditions at the factory are worse than under perfect perception. Factories are able to provide this lower level of working conditions only because workers do not notice the difference.

P3': **Except for the (unlikely) perfect-misperception case**, workers in contract factories earn more than in alternative workplaces, but wages are only higher because they compensate workers for inferior working conditions.

In the extended model, the wage premium paid to factory workers for accepting inferior working conditions decreases with the misperception parameter μ^i (see eq. (27)). The reason is that if workers are misinformed about their working conditions, they are willing to take factory jobs without demanding an appropriate compensation for the poorer working conditions. In general, even under misperception, factory workers will earn more than in alternative workplaces. The factory premium might be lower when workers are misinformed, but there will still be a premium. There is, however, one exception to this rule: "perfect misperception." When workers are perfectly misinformed (that is, when $\mu^i \longrightarrow \infty$), factory wages in (27) converge to the risk-free wage w_y^i. Only in that extreme (and unlikely) case, the factory premium disappears completely, and factory workers are paid the same wage as other workers in the economy.

P4': Despite being higher, factory wages might not meet workers' basic needs. The reasons are: a low country's labor productivity **and a high degree of workers' misperception**.

Workers' misperception can also explain why workers might not be able to meet their basic needs. The mechanism is very simple. As it is clear from the misperception first-order conditions in (26) and (27), wages and the level of working conditions decrease in the misperception parameter μ^i. Plugging these first-order conditions in the indirect utility function in (5) implies that workers' utility also decreases in μ^i. Consequently, if μ^i is high enough, workers might not be able to satisfy their basic needs $u_{\min}$. Moreover, in the extreme case of perfect misperception ($\mu^i \longrightarrow \infty$), the indirect utility converges to $-u_{\min}$, the lowest possible utility level in the model.

P5': There are three potential sources of comparative advantage: (i) differences in labor productivity; **(ii) differences in the degree of workers' misperception; (iii) differences in noncompliance**. Thus, a country with a low labor productivity, **or in which workers' misperception is high, or in which factories' noncompliance with legal standards is more prevalent** can attract more outsourcing contracts since it can undertake the manufacturing stage at lower costs.

As it is clear from this prediction, the extended model is able to rationalize the idea that poor working conditions can be a source of comparative advantage. If workers' knowledge on labor rights and on occupational risks is insufficient, or if compliance inspections are rare and penalties are low in a developing country, then that country will probably be able to manufacture products at lower costs than other countries. First World companies will find it profitable to source their products from that country.

5 Conclusion

For several years, Nike and other brand companies have been the target of widespread criticism for outsourcing their manufacturing production to contract factories with dismal working conditions. The main allegations are that factory workers are paid extremely low wages, are required to work excessive overtime, and are often exposed to unsafe, unhealthy, and abusive working conditions. According to critics, these working conditions stand in stark contrast to the large profits usually reported by brand companies. The current paper has introduced a theory of outsourcing and working conditions that is able to rationalize these observations.

In the framework, the most productive northern firms make large profits and outsource their manufacturing production to independent contract factories located in the South. Compared to the North, wages and the level of working conditions in southern factories can be relatively low. Southern workers, despite earning more at factories than in alternative employment, might not be able to meet their basic needs. The benchmark model predicts that only an improvement in the southern labor productivity can lift workers out of poverty.

The model, although stylized in some dimensions, is tractable enough to accommodate several extensions. The current paper has shown how to incorporate workers' misperception about working conditions and factories' noncompliance with legal standards. Under these extensions, factory wages and the level of working conditions are lower than in the benchmark case. This allows southern factories to undertake the manufacturing stage at lower costs. As a consequence, more northern firms outsource production in the South, and the firms that were already engaged in southern outsourcing are able to generate even higher profits.

The benchmark model and the two extensions studied in this paper should be seen as a first step in our understanding of the interrelationship between outsourcing and working conditions. The model might be fruitfully extended to capture other dimensions of the debate on brand companies and their global labor practices. Other important issues that require further research include the presence of immigrant and underage workers at contract factories and the impact of codes of conduct on working conditions.

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Online Appendix

Why do they JUST DO IT?
A theory of outsourcing and working conditions

Alejandro Donado[24]

This Online Appendix shows how to solve all maximization problems and how to solve the model. It also provides some details that were left out of the paper due to space constraints. The main sections correspond to the section with the same name in the paper.

A Individuals

This section shows how to compute the demand functions in (3) and how to obtain the indirect utility function in (5). For simplicity, the section drops the occupation and country indices.

A.1 Demand functions

The computation of the demand functions in (3) requires two stages.[25]

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[25] Fujita, Krugman, and Venables (1999: 46-48) explain how to solve a similar two-stage maximization problem.

- **First stage: Demand for y and X**

In the first stage, individuals divide their total income w between consumption of the homogeneous good y and of the manufacturing varieties aggregate X. That is, individuals choose X and y to maximize their utility

$$u = z(s)\, X^{\alpha} y^{1-\alpha} - u_{\min} \tag{32}$$

subject to their budget constraint

$$PX + p_y y = w,$$

where P is the price index associated with (32). The Lagrangian is

$$\mathcal{L} = z(s)\, X^{\alpha} y^{1-\alpha} - u_{\min} - \lambda \left(PX + p_y y - w\right).$$

The first-order conditions are

$$\frac{\partial \mathcal{L}}{\partial X} = z(s)\, \alpha X^{\alpha-1} y^{1-\alpha} - \lambda P = 0 \overset{(32)}{\iff} \alpha \frac{u + u_{\min}}{PX} = \lambda,$$

$$\frac{\partial \mathcal{L}}{\partial y} = z(s)\, X^{\alpha} (1-\alpha)\, y^{1-\alpha-1} - \lambda p_y = 0 \overset{(32)}{\iff} (1-\alpha) \frac{u + u_{\min}}{p_y y} = \lambda.$$

Equalizing the first-order conditions gives

$$\alpha \frac{u + u_{\min}}{PX} = (1-\alpha) \frac{u + u_{\min}}{p_y y}$$

$$\iff p_y y = \frac{(1-\alpha)}{\alpha} PX. \tag{33}$$

Plugging this in the budget constraint yields the demand for X

$$PX + \frac{(1-\alpha)}{\alpha} PX = w$$

$$\iff X = \alpha \frac{w}{P}. \tag{34}$$

Inserting this in (33) yields the demand for y

$$p_y y = \frac{(1-\alpha)}{\alpha} P\alpha \frac{w}{P}$$

$$\iff y = (1-\alpha) \frac{w}{p_y}. \tag{35}$$

- **Second stage: Demand for** $x(\omega)$

Equation (34) also makes clear that individuals wish to devote PX to manufacturing goods. PX is a fraction α of their total income w. In the second stage, individuals allocate their income for manufacturing goods PX to different manufacturing varieties. Thus, individuals choose $x(\omega)$ to maximize

$$X = \left(\int_{\in\Omega} x(\omega)^{(\sigma-1)/\sigma} d\omega \right)^{\sigma/(\sigma-1)} \tag{36}$$

subject to

$$\int_{\in\Omega} p(\omega) x(\omega) d\omega = PX. \tag{37}$$

The Lagrangian is

$$\mathcal{L} = \left(\int_{\in\Omega} x(\omega)^{(\sigma-1)/\sigma} d\omega \right)^{\sigma/(\sigma-1)} - \lambda \left(\int_{\in\Omega} p(\omega) x(\omega) d\omega - PX \right).$$

The first-order condition is

$$\frac{\partial \mathcal{L}}{\partial x(\omega)} = \frac{\sigma}{(\sigma-1)} \left(\int_{\in\Omega} x(\omega)^{(\sigma-1)/\sigma} d\omega \right)^{\frac{\sigma}{(\sigma-1)}-1} \frac{(\sigma-1)}{\sigma} x(\omega)^{\frac{(\sigma-1)}{\sigma}-1} - \lambda p(\omega) = 0$$

$$\overset{(36)}{\iff} x(\omega) = \frac{X}{(\lambda p(\omega))^{\sigma}}. \tag{38}$$

Plugging this in (37) yields

$$\int_{\in\Omega} p(\omega) \frac{X}{(\lambda p(\omega))^{\sigma}} d\omega = PX \iff \lambda^{\sigma} = \frac{\int_{\in\Omega} p(\omega)^{1-\sigma} d\omega}{P}.$$

Inserting this in (38) gives

$$x(\omega) = \frac{p(\omega)^{-\sigma}}{P^{1-\sigma}} PX, \tag{39}$$

where

$$P=\left(\int_{\in\Omega}p\left(\omega\right)^{1-\sigma}d\omega\right)^{1/(1-\sigma)}.$$

Finally, plugging (34) in (39) gives the demand for each manufacturing variety

$$x\left(\omega\right)=\frac{p\left(\omega\right)^{-\sigma}}{P^{1-\sigma}}\alpha w.$$

A.2 Indirect utility function

To obtain the indirect utility function in (5), plug (34) and (35) in (32). This yields

$$\begin{aligned}u&=z\left(s\right)\left(\alpha\frac{w}{P}\right)^{\alpha}\left(\left(1-\alpha\right)\frac{w}{p_y}\right)^{1-\alpha}-u_{\min}\\&=z\left(s\right)\frac{w}{\Lambda}\Phi-u_{\min},\end{aligned}$$

where

$$\Lambda\equiv P^{\alpha}p_y^{1-\alpha}\qquad\text{and}\qquad\Phi\equiv\alpha^{\alpha}\left(1-\alpha\right)^{1-\alpha}.$$

B Manufacturing sector

This section shows how to solve the northern firms' maximization problem in (9) - (11), how to obtain the profit flows in (12) and (13), and derives other results that are necessary for solving the model in section D.

B.1 Maximization problem

Consider first a firm outsourcing in the South. Since the southern factory's participation constraint in (11) is binding, the problem can be reformulated as

$$\max_{h^S,m^S}\pi^S=r^S\left(h^S,m^S\right)-w_y^Nh^S-\tau p_m^Sm^S-w_y^Nf^S,\tag{40}$$

where the revenue is defined as

$$r^S\left(h^S, m^S\right) = p^S\left(q^S\left(h^S, m^S\right)\right) q^S\left(h^S, m^S\right).$$

Before we solve this problem, first note that the aggregate demand for a final good whose manufacturing stage was outsourced in the South is

$$q^S = \frac{\left(p^S\right)^{-\sigma}}{P^{1-\sigma}} \alpha E.$$

Plugging (see eq. (14))

$$B \equiv \frac{1}{\sigma}\left(\frac{\sigma-1}{\sigma}\right)^{\sigma-1} \frac{\alpha E}{P^{1-\sigma}} \iff \frac{\alpha E}{P^{1-\sigma}} = \frac{\sigma^\sigma B}{\left(\sigma-1\right)^{\sigma-1}}$$

and rearranging yields

$$q^S = \left(p^S\right)^{-\sigma} \frac{\sigma^\sigma B}{\left(\sigma-1\right)^{\sigma-1}}$$

$$\iff p^S = B^{1/\sigma}\sigma\left(\sigma-1\right)^{-(\sigma-1)/\sigma}\left(q^S\right)^{-1/\sigma}.$$

The revenue is then

$$r^S = p^S q^S = B^{1/\sigma}\sigma\left(\sigma-1\right)^{-(\sigma-1)/\sigma}\left(q^S\right)^{-1/\sigma} q^S$$

$$= B^{1/\sigma}\sigma\left(\sigma-1\right)^{-(\sigma-1)/\sigma}\left(q^S\right)^{(\sigma-1)/\sigma}.$$

Plugging $q^S\left(\varphi\right) = \varphi\left(\frac{h^S}{\eta}\right)^\eta\left(\frac{m^S}{1-\eta}\right)^{1-\eta}$ (see eq. (7)) yields

$$r^S = B^{1/\sigma}\sigma\left(\sigma-1\right)^{-(\sigma-1)/\sigma}\left(\varphi\left(\frac{h^S}{\eta}\right)^\eta\left(\frac{m^S}{1-\eta}\right)^{1-\eta}\right)^{(\sigma-1)/\sigma}$$

$$= B^{1/\sigma}\sigma\left(\sigma-1\right)^{-(\sigma-1)/\sigma}\varphi^{(\sigma-1)/\sigma}\left(\frac{h^S}{\eta}\right)^{\eta(\sigma-1)/\sigma}\left(\frac{m^S}{1-\eta}\right)^{(1-\eta)(\sigma-1)/\sigma}. \tag{41}$$

Using this revenue, we can now solve the maximization problem in (40). The first-order conditions are

$$B^{1/\sigma}\sigma\left(\sigma-1\right)^{-(\sigma-1)/\sigma}\varphi^{(\sigma-1)/\sigma}$$

$$\cdot\frac{\eta\left(\sigma-1\right)}{\sigma}\left(h^S\right)^{\frac{\eta(\sigma-1)}{\sigma}-1}\left(\frac{1}{\eta}\right)^{\eta(\sigma-1)/\sigma}\left(\frac{m^S}{1-\eta}\right)^{(1-\eta)(\sigma-1)/\sigma} = w_y^N$$

$$\overset{(41)}{\iff} \frac{\eta(\sigma-1)}{\sigma}\frac{r^S}{h^S} = w_y^N$$

$$\iff h^S(\varphi) = \frac{(\sigma-1)\eta}{\sigma w_y^N} r^S(\varphi) \tag{42}$$

and

$$B^{1/\sigma}\sigma(\sigma-1)^{-(\sigma-1)/\sigma}\varphi^{(\sigma-1)/\sigma} \cdot \left(\frac{h^S}{\eta}\right)^{\eta(\sigma-1)/\sigma} \frac{(1-\eta)(\sigma-1)}{\sigma}\left(m^S\right)^{\frac{(1-\eta)(\sigma-1)}{\sigma}-1}\left(\frac{1}{1-\eta}\right)^{(1-\eta)(\sigma-1)/\sigma} = \tau p_m^S$$

$$\overset{(41)}{\iff} \frac{(1-\eta)(\sigma-1)}{\sigma}\frac{r^S}{m^S} = \tau p_m^S$$

$$\iff m^S(\varphi) = \frac{(\sigma-1)(1-\eta)}{\sigma\tau p_m^S} r^S(\varphi). \tag{43}$$

The problem of a firm outsourcing in the North can be solved similarly. The first-order conditions are then given by

$$h^N(\varphi) = \frac{(\sigma-1)\eta}{\sigma w_y^N} r^N(\varphi) \qquad \text{and} \qquad m^N(\varphi) = \frac{(\sigma-1)(1-\eta)}{\sigma p_m^N} r^N(\varphi). \tag{44}$$

B.2 Profit flows

This section shows how to compute the profit flow of the firm outsourcing in the South in (13). The profit flow of the firm outsourcing in the North in (12) can be computed similarly.

Plugging the first-order conditions (42) and (43) in the revenue function (41) gives

$$r^S = B^{1/\sigma}\sigma(\sigma-1)^{-(\sigma-1)/\sigma}\varphi^{(\sigma-1)/\sigma}\left(\frac{\frac{(\sigma-1)\eta}{\sigma w_y^N}r^S}{\eta}\right)^{\eta(\sigma-1)/\sigma}\left(\frac{\frac{(\sigma-1)(1-\eta)}{\sigma\tau p_m^S}r^S}{1-\eta}\right)^{(1-\eta)(\sigma-1)/\sigma}$$

$$\iff r^S = B^{1/\sigma}\sigma^{1/\sigma}\varphi^{(\sigma-1)/\sigma}\left(\left(w_y^N\right)^\eta\left(\tau p_m^S\right)^{(1-\eta)}\right)^{(1-\sigma)/\sigma}\left(r^S\right)^{\frac{(\sigma-1)}{\sigma}}$$

$$\iff \left(r^S\right)^{\frac{1}{\sigma}} = B^{1/\sigma}\sigma^{1/\sigma}\varphi^{(\sigma-1)/\sigma}\left(\left(w_y^N\right)^\eta\left(\tau p_m^S\right)^{(1-\eta)}\right)^{(1-\sigma)/\sigma}$$

$$\iff r^S(\varphi) = \sigma\varphi^{\sigma-1}B\left(\left(w_y^N\right)^\eta\left(\tau p_m^S\right)^{(1-\eta)}\right)^{1-\sigma}. \tag{45}$$

Now, plugging the first-order conditions (42) and (43) in the profit function yields

$$\pi^S = r^S - w_y^N \frac{(\sigma-1)\,\eta}{\sigma w_y^N} r^S - \tau p_m^S \frac{(\sigma-1)\,(1-\eta)}{\sigma \tau p_m^S} r^S - w_y^N f^S$$

$$\iff \pi^S = \frac{r^S(\varphi)}{\sigma} - w_y^N f^S. \tag{46}$$

Finally, inserting (45) gives

$$\pi^S = \varphi^{\sigma-1} B \left(\left(w_y^N\right)^\eta \left(\tau p_m^S\right)^{(1-\eta)} \right)^{1-\sigma} - w_y^N f^S.$$

B.3 Some useful results

This and the following section derive some results that are necessary for solving the model in section D.

First note that, similarly to (45), the revenue of the firm outsourcing in the North is given by

$$r^N(\varphi) = \sigma \varphi^{\sigma-1} B \left(\left(w_y^N\right)^\eta \left(p_m^N\right)^{1-\eta} \right)^{1-\sigma}.$$

This together with (45) imply

$$\frac{r^i(\varphi_1)}{r^i(\varphi_2)} = \left(\frac{\varphi_1}{\varphi_2}\right)^{\sigma-1} \tag{47}$$

and

$$\frac{r^S(\varphi)}{r^N(\varphi)} = \left(\frac{p_m^N}{\tau p_m^S}\right)^{(1-\eta)(\sigma-1)}. \tag{48}$$

Similar relationships can be obtained for $h^i(\varphi)$ and $m^i(\varphi)$ using (42), (43), and (44). In particular,

$$\frac{h^i(\varphi_1)}{h^i(\varphi_2)} = \frac{m^i(\varphi_1)}{m^i(\varphi_2)} = \frac{r^i(\varphi_1)}{r^i(\varphi_2)} = \left(\frac{\varphi_1}{\varphi_2}\right)^{\sigma-1},$$

$$\frac{h^S(\varphi_1)}{h^N(\varphi_2)} = \frac{r^S(\varphi)}{r^N(\varphi)} = \left(\frac{p_m^N}{\tau p_m^S}\right)^{(1-\eta)(\sigma-1)},$$

$$\frac{m^S(\varphi)}{m^N(\varphi)} = \frac{p_m^N}{\tau p_m^S}\frac{r^S(\varphi)}{r^N(\varphi)} = \frac{p_m^N}{\tau p_m^S}\left(\frac{p_m^N}{\tau p_m^S}\right)^{(1-\eta)(\sigma-1)} = \left(\frac{p_m^N}{\tau p_m^S}\right)^{(1-\eta)(\sigma-1)-1},$$

$$\frac{h^S(\varphi)}{m^S(\varphi)} = \frac{\eta}{1-\eta}\frac{\tau p_m^S}{w_y^N},$$

and

$$\frac{h^N(\varphi)}{m^N(\varphi)} = \frac{\eta}{1-\eta}\frac{p_m^N}{w_y^N}.$$

Also note that analogously to (46), the profit function of the firm outsourcing in the North is

$$\pi^N = \frac{r^N(\varphi)}{\sigma} - w_y^N f^N.$$

Using this, we can also determine the revenue of the firm with productivity φ^N (that is, of the firm with $\pi^N = 0$) as

$$\pi^N = \frac{r^N\left(\varphi^N\right)}{\sigma} - w_y^N f^N = 0$$

$$\iff r^N\left(\varphi^N\right) = \sigma w_y^N f^N.$$

This result is useful since together with (47), we have

$$r^N(\varphi) = \left(\frac{\varphi}{\varphi^N}\right)^{\sigma-1} r^N\left(\varphi^N\right)$$

$$\iff r^N(\varphi) = \left(\frac{\varphi}{\varphi^N}\right)^{\sigma-1} \sigma w_y^N f^N. \tag{49}$$

B.4 Cost functions and final-good prices

The cost function of a firm that outsources in the North is

$$c^N\left(w_y^N, p_m^N, q^N\right) = w_y^N f^N + \frac{q^N}{\varphi}\left(w_y^N\right)^\eta \left(p_m^N\right)^{1-\eta}$$

and of a firm that outsources in the South is

$$c^S\left(w_y^N, p_m^S, q^S\right) = w_y^N f^S + \frac{q^S}{\varphi}\left(w_y^N\right)^\eta \left(\tau p_m^S\right)^{1-\eta}.$$

In a monopolistic competition framework, final-good prices are equal to a constant mark-up $\sigma/(\sigma-1)$ over marginal costs:

$$p^N(\varphi) = \frac{\sigma}{\sigma-1}\frac{\partial c^N\left(w_y^N, p_m^N, q^N\right)}{\partial q^N} = \frac{\sigma}{\sigma-1}\frac{\left(w_y^N\right)^\eta \left(p_m^N\right)^{1-\eta}}{\varphi} \tag{50}$$

and

$$p^S(\varphi) = \frac{\sigma}{\sigma-1}\frac{\partial c^S\left(w_y^N, p_m^S, q^S\right)}{\partial q^S} = \frac{\sigma}{\sigma-1}\frac{\left(w_y^N\right)^\eta \left(\tau p_m^S\right)^{1-\eta}}{\varphi}. \tag{51}$$

C Contract factories

This section shows how to obtain the factory variables in (18), (19), and (20). The factory's problem is

$$\max_{w_m^i, s_m^i} \pi_m^i = p_m^i - w_m^i - \gamma s_m^i$$

subject to the participation constraint

$$\begin{aligned} z\left(s_m^i\right)\frac{w_m^i}{\Lambda}\Phi - u_{\min} &= \frac{w_y^i}{\Lambda}\Phi - u_{\min} \\ \iff z\left(s_m^i\right) w_m^i = w_y^i &\overset{(17)}{\iff} \frac{s_m^i}{1+s_m^i} w_m^i = w_y^i \\ \iff w_m^i &= w_y^i\left(\left(s_m^i\right)^{-1} + 1\right). \end{aligned} \tag{52}$$

Using this last equation, the problem can be simplified to

$$\max_{s_m^i} \pi_m^i = p_m^i - w_y^i\left(\left(s_m^i\right)^{-1}+1\right) - \gamma s_m^i.$$

The first-order condition is

$$\begin{aligned} w_y^i\left(s_m^i\right)^{-2} - \gamma &= 0 \\ \iff s_m^i &= \left(\frac{w_y^i}{\gamma}\right)^{1/2}. \end{aligned} \tag{53}$$

This is the factory level of working conditions. Now, inserting (53) in (52) and rearranging yields the factory wages

$$w_m^i = \left(w_y^i \gamma\right)^{1/2} + w_y^i. \tag{54}$$

The manufacturing production price can be obtained from

$$\pi_m^i = 0 \iff p_m^i = w_m^i + \gamma s_m^i \overset{(53),(54)}{=} \left(w_y^i \gamma\right)^{1/2} + w_y^i + \gamma \left(\frac{w_y^i}{\gamma}\right)^{1/2}$$

$$\iff p_m^i = 2\left(w_y^i \gamma\right)^{1/2} + w_y^i.$$

D Equilibrium

This section shows how to solve the model under the assumption that the productivity φ is Pareto distributed, a standard assumption in the literature (see, e.g., Antràs and Yeaple 2014: 81). We begin by obtaining φ^N, φ^S, and B. With these three variables at hand, we can then compute all other variables in the model, including the number of manufacturing varieties and the manufacturing price index.

D.1 Finding φ^N, φ^S, and B

Equations (22), (23), and (24) jointly determine φ^N, φ^S, and B. To see this, first solve (22) and (23) for B and equalize the resulting equations

$$\left(\frac{\left(w_y^N\right)^\eta \left(p_m^N\right)^{1-\eta}}{\varphi^N}\right)^{\sigma-1} w_y^N f^N = \frac{\left(w_y^N\right)^{1-\eta(1-\sigma)}\left(f^S - f^N\right)}{\left(\tau p_m^S\right)^{(1-\eta)(1-\sigma)} - \left(p_m^N\right)^{(1-\eta)(1-\sigma)}} \frac{1}{\left(\varphi^S\right)^{\sigma-1}}$$

$$\iff \varphi^S = \left(\frac{\left(w_y^N\right)^{1-\eta(1-\sigma)}\left(f^S - f^N\right)}{\left(\tau p_m^S\right)^{(1-\eta)(1-\sigma)} - \left(p_m^N\right)^{(1-\eta)(1-\sigma)}} \frac{1}{w_y^N f^N}\left(\frac{1}{\left(w_y^N\right)^\eta \left(p_m^N\right)^{1-\eta}}\right)^{\sigma-1}\right)^{\frac{1}{\sigma-1}} \varphi^N$$

$$\iff \varphi^S = \left(\frac{f^S/f^N - 1}{\left(p_m^N/\tau p_m^S\right)^{(1-\eta)(\sigma-1)} - 1}\right)^{\frac{1}{\sigma-1}} \varphi^N. \tag{55}$$

Also note that the free entry condition in (24) can be expressed with (12) and (13) as

$$\int_{\varphi^N}^{\varphi^S} \left(\varphi^{\sigma-1} B \left(\left(w_y^N\right)^\eta \left(p_m^N\right)^{1-\eta}\right)^{1-\sigma} - w_y^N f^N\right) g(\varphi)\, d\varphi$$
$$+ \int_{\varphi^S}^{\infty} \left(\varphi^{\sigma-1} B \left(\left(w_y^N\right)^\eta \left(\tau p_m^S\right)^{1-\eta}\right)^{1-\sigma} - w_y^N f^S\right) g(\varphi)\, d\varphi = w_y^N f_e.$$

Rearranging and plugging $\int_{\varphi^N}^{\varphi^S} \varphi^{\sigma-1} g(\varphi)\, d\varphi = \int_{\varphi^N}^{\infty} \varphi^{\sigma-1} g(\varphi)\, d\varphi - \int_{\varphi^S}^{\infty} \varphi^{\sigma-1} g(\varphi)\, d\varphi$ yields

$$B\left(\left(w_y^N\right)^\eta \left(p_m^N\right)^{1-\eta}\right)^{1-\sigma} \left(\int_{\varphi^N}^{\infty} \varphi^{\sigma-1} g(\varphi)\, d\varphi - \int_{\varphi^S}^{\infty} \varphi^{\sigma-1} g(\varphi)\, d\varphi\right)$$
$$- w_y^N f^N \left(G\left(\varphi^S\right) - G\left(\varphi^N\right)\right)$$
$$+B\left(\left(w_y^N\right)^\eta \left(\tau p_m^S\right)^{1-\eta}\right)^{1-\sigma} \int_{\varphi^S}^{\infty} \varphi^{\sigma-1} g(\varphi)\, d\varphi - w_y^N f^S \left(1 - G\left(\varphi^S\right)\right) = w_y^N f_e. \tag{56}$$

The Pareto cumulative distribution function is given by

$$G(\varphi) = 1 - \left(\frac{\underline{\varphi}}{\varphi}\right)^\kappa, \tag{57}$$

where κ is the shape parameter of the distribution, and $\underline{\varphi} > 0$ denotes the minimum productivity level that a northern firm can draw. Under the assumption that $\kappa > \sigma - 1$, it can be shown that[26]

$$\int_{\hat{\varphi}}^{\infty} \varphi^{\sigma-1} g(\varphi)\, d\varphi = \frac{\kappa \underline{\varphi}^\kappa \hat{\varphi}^{\sigma-1-\kappa}}{\kappa - (\sigma - 1)}. \tag{58}$$

We can express (56) using (57) and (58) as

$$B\left(\left(w_y^N\right)^\eta \left(p_m^N\right)^{1-\eta}\right)^{1-\sigma} \left(\frac{\kappa \underline{\varphi}^\kappa \left(\varphi^N\right)^{\sigma-1-\kappa}}{\kappa - (\sigma - 1)} - \frac{\kappa \underline{\varphi}^\kappa \left(\varphi^S\right)^{\sigma-1-\kappa}}{\kappa - (\sigma - 1)}\right)$$
$$- w_y^N f^N \left(1 - \left(\frac{\underline{\varphi}}{\varphi^S}\right)^\kappa - \left(1 - \left(\frac{\underline{\varphi}}{\varphi^N}\right)^\kappa\right)\right)$$
$$+ B\left(\left(w_y^N\right)^\eta \left(\tau p_m^S\right)^{1-\eta}\right)^{1-\sigma} \frac{\kappa \underline{\varphi}^\kappa \left(\varphi^S\right)^{\sigma-1-\kappa}}{\kappa - (\sigma - 1)} - w_y^N f^S \left(1 - \left(1 - \left(\frac{\underline{\varphi}}{\varphi^S}\right)^\kappa\right)\right)$$
$$= w_y^N f_e$$

$$\iff \frac{B\left(\left(w_y^N\right)^\eta \left(p_m^N\right)^{1-\eta}\right)^{1-\sigma} \kappa \underline{\varphi}^\kappa}{\kappa - (\sigma - 1)} \left(\left(\varphi^N\right)^{\sigma-1-\kappa} - \left(\varphi^S\right)^{\sigma-1-\kappa}\right)$$
$$+ \frac{B\left(\left(w_y^N\right)^\eta \left(\tau p_m^S\right)^{1-\eta}\right)^{1-\sigma} \kappa \underline{\varphi}^\kappa}{\kappa - (\sigma - 1)} \left(\varphi^S\right)^{\sigma-1-\kappa}$$
$$- w_y^N f^N \underline{\varphi}^\kappa \left(\left(\varphi^N\right)^{-\kappa} - \left(\varphi^S\right)^{-\kappa}\right) - w_y^N f^S \underline{\varphi}^\kappa \left(\varphi^S\right)^{-\kappa} = w_y^N f_e.$$

[26] The assumption that $\kappa > \sigma - 1$ is standard in the literature (see, e.g., Antràs and Yeaple 2014: 81).

Plugging $\varphi^N = \left(\frac{w_y^N f^N}{B}\right)^{\frac{1}{\sigma-1}} \left(w_y^N\right)^\eta \left(p_m^N\right)^{1-\eta} \iff B = \left(\frac{\left(w_y^N\right)^\eta \left(p_m^N\right)^{1-\eta}}{\varphi^N}\right)^{\sigma-1} w_y^N f^N$ (see (22)) and (55) gives

$$
\begin{aligned}
&\left(\frac{\left(w_y^N\right)^\eta \left(p_m^N\right)^{1-\eta}}{\varphi^N}\right)^{\sigma-1} w_y^N f^N \frac{\left(\left(w_y^N\right)^\eta \left(p_m^N\right)^{1-\eta}\right)^{1-\sigma} \kappa \underline{\varphi}^\kappa}{\kappa-(\sigma-1)} \\
&\cdot \left(\left(\varphi^N\right)^{\sigma-1-\kappa} - \left(\left(\frac{f^S/f^N-1}{\left(p_m^N/\tau p_m^S\right)^{(1-\eta)(\sigma-1)}-1}\right)^{\frac{1}{\sigma-1}} \varphi^N\right)^{\sigma-1-\kappa}\right) \\
&+ \left(\frac{\left(w_y^N\right)^\eta \left(p_m^N\right)^{1-\eta}}{\varphi^N}\right)^{\sigma-1} w_y^N f^N \frac{\left(\left(w_y^N\right)^\eta \left(\tau p_m^S\right)^{1-\eta}\right)^{1-\sigma} \kappa \underline{\varphi}^\kappa}{\kappa-(\sigma-1)} \\
&\cdot \left(\left(\frac{f^S/f^N-1}{\left(p_m^N/\tau p_m^S\right)^{(1-\eta)(\sigma-1)}-1}\right)^{\frac{1}{\sigma-1}} \varphi^N\right)^{\sigma-1-\kappa} \\
&- w_y^N f^N \underline{\varphi}^\kappa \left(\left(\varphi^N\right)^{-\kappa} - \left(\left(\frac{f^S/f^N-1}{\left(p_m^N/\tau p_m^S\right)^{(1-\eta)(\sigma-1)}-1}\right)^{\frac{1}{\sigma-1}} \varphi^N\right)^{-\kappa}\right) \\
&-w_y^N f^S \underline{\varphi}^\kappa \left(\left(\frac{f^S/f^N-1}{\left(p_m^N/\tau p_m^S\right)^{(1-\eta)(\sigma-1)}-1}\right)^{\frac{1}{\sigma-1}} \varphi^N\right)^{-\kappa} = w_y^N f_e
\end{aligned}
$$

$$
\begin{aligned}
\iff &\frac{w_y^N f^N \kappa \underline{\varphi}^\kappa \left(\varphi^N\right)^{-\kappa}}{\kappa-(\sigma-1)} \left(1 - \left(\frac{f^S/f^N-1}{\left(p_m^N/\tau p_m^S\right)^{(1-\eta)(\sigma-1)}-1}\right)^{\frac{\sigma-1-\kappa}{\sigma-1}}\right) \\
&+ \left(\frac{p_m^N}{\tau p_m^S}\right)^{(1-\eta)(\sigma-1)} \frac{w_y^N f^N \kappa \underline{\varphi}^\kappa \left(\varphi^N\right)^{-\kappa}}{\kappa-(\sigma-1)} \left(\frac{f^S/f^N-1}{\left(p_m^N/\tau p_m^S\right)^{(1-\eta)(\sigma-1)}-1}\right)^{\frac{\sigma-1-\kappa}{\sigma-1}} \\
&- w_y^N f^N \underline{\varphi}^\kappa \left(\varphi^N\right)^{-\kappa} \left(1 - \left(\frac{f^S/f^N-1}{\left(p_m^N/\tau p_m^S\right)^{(1-\eta)(\sigma-1)}-1}\right)^{\frac{-\kappa}{\sigma-1}}\right) \\
&-w_y^N f^S \underline{\varphi}^\kappa \left(\varphi^N\right)^{-\kappa} \left(\frac{f^S/f^N-1}{\left(p_m^N/\tau p_m^S\right)^{(1-\eta)(\sigma-1)}-1}\right)^{\frac{-\kappa}{\sigma-1}} = w_y^N f_e.
\end{aligned}
$$

$$
\iff \varphi^N = \left(\frac{\sigma-1}{\kappa-(\sigma-1)} \frac{f^N}{f_e} \left(1 + \left(\left(\frac{p_m^N}{\tau p_m^S}\right)^{(1-\eta)(\sigma-1)} - 1\right)^{\frac{\kappa}{\sigma-1}} \left(\frac{f^S}{f^N} - 1\right)^{\frac{\sigma-1-\kappa}{\sigma-1}}\right)\right)^{\frac{1}{\kappa}} \underline{\varphi}
$$

$$
\iff \varphi^N = \left(\frac{\sigma-1}{\kappa-(\sigma-1)} \frac{f^N + \left(\left(\frac{p_m^N}{\tau p_m^S}\right)^{(1-\eta)(\sigma-1)} - 1\right)^{\frac{\kappa}{\sigma-1}} \left(\frac{\left(f^N\right)^\kappa}{\left(f^S - f^N\right)^{\kappa-(\sigma-1)}}\right)^{\frac{1}{\sigma-1}}}{f_e}\right)^{\frac{1}{\kappa}} \underline{\varphi}.
$$

This is the solution for φ^N. Using this, we can obtain φ^S from (55) and B from $B = \left(\frac{(w_y^N)^\eta (p_m^N)^{1-\eta}}{\varphi^N}\right)^{\sigma-1} w_y^N f^N$ (see eq. (22)).

D.2 Average productivities

As in Melitz (2003), this section computes average productivities that are useful for expressing aggregate variables in the model. Begin by denoting by n the equilibrium mass of manufacturing firms (and of varieties), by

$$n^N = n\left(\frac{G(\varphi^S) - G(\varphi^N)}{1 - G(\varphi^N)}\right)$$

the mass of firms outsourcing in the North, and by

$$n^S = n\left(\frac{1 - G(\varphi^S)}{1 - G(\varphi^N)}\right) \tag{59}$$

the mass of firms outsourcing in the South, so that $n = n^N + n^S$.

Now, the average productivity of firms outsourcing in the North is

$$\bar{\varphi}^N = \left(\int_{\varphi^N}^{\varphi^S} \varphi^{\sigma-1} \frac{g(\varphi)}{G(\varphi^S) - G(\varphi^N)} d\varphi\right)^{\frac{1}{\sigma-1}}, \tag{60}$$

and the average productivity of firms outsourcing in the South is

$$\bar{\varphi}^S = \left(\int_{\varphi^S}^{\infty} \varphi^{\sigma-1} \frac{g(\varphi)}{1 - G(\varphi^S)} d\varphi\right)^{\frac{1}{\sigma-1}}. \tag{61}$$

Then, the combined average productivity is (since $n = n^N + n^S \iff n^N = n - n^S$)

$$\bar{\varphi} = \left(\frac{(n - n^S)(\bar{\varphi}^N)^{\sigma-1} + \left(\frac{p_m^N}{\tau p_m^S}\right)^{(1-\eta)(\sigma-1)} n^S (\bar{\varphi}^S)^{\sigma-1}}{n}\right)^{\frac{1}{\sigma-1}}. \tag{62}$$

For the Pareto distribution, $\bar{\varphi}^N$ and $\bar{\varphi}^S$ are given by

$$\begin{aligned}
\bar{\varphi}^N &= \left(\int_{\varphi^N}^{\varphi^S} \varphi^{\sigma-1} \frac{g(\varphi)}{G(\varphi^S) - G(\varphi^N)} d\varphi\right)^{\frac{1}{\sigma-1}} = \left(\frac{1}{G(\varphi^S) - G(\varphi^N)} \int_{\varphi^N}^{\varphi^S} \varphi^{\sigma-1} g(\varphi)\, d\varphi\right)^{\frac{1}{\sigma-1}} \\
&= \left(\frac{1}{G(\varphi^S) - G(\varphi^N)} \left(\int_{\varphi^N}^{\infty} \varphi^{\sigma-1} g(\varphi)\, d\varphi - \int_{\varphi^S}^{\infty} \varphi^{\sigma-1} g(\varphi)\, d\varphi\right)\right)^{\frac{1}{\sigma-1}} \\
&\overset{(57),(58)}{=} \left(\frac{1}{1 - \left(\frac{\underline{\varphi}}{\varphi^S}\right)^{\kappa} - \left(1 - \left(\frac{\underline{\varphi}}{\varphi^N}\right)^{\kappa}\right)} \left(\frac{\kappa \underline{\varphi}^{\kappa} \left(\varphi^N\right)^{\sigma-1-\kappa}}{\kappa - (\sigma-1)} - \frac{\kappa \underline{\varphi}^{\kappa} \left(\varphi^S\right)^{\sigma-1-\kappa}}{\kappa - (\sigma-1)}\right)\right)^{\frac{1}{\sigma-1}} \\
&= \left(\frac{\kappa}{\kappa - (\sigma-1)} \frac{\left(\varphi^S\right)^{\sigma-1-\kappa} - \left(\varphi^N\right)^{\sigma-1-\kappa}}{\left(\varphi^S\right)^{-\kappa} - \left(\varphi^N\right)^{-\kappa}}\right)^{\frac{1}{\sigma-1}} \qquad (63)
\end{aligned}$$

and

$$\begin{aligned}
\bar{\varphi}^S &= \left(\frac{1}{1 - G(\varphi^S)} \int_{\varphi^S}^{\infty} \varphi^{\sigma-1} g(\varphi)\, d\varphi\right)^{\frac{1}{\sigma-1}} \overset{(57),(58)}{=} \left(\frac{1}{1 - \left(1 - \left(\frac{\underline{\varphi}}{\varphi^S}\right)^{\kappa}\right)} \frac{\kappa \underline{\varphi}^{\kappa} \left(\varphi^S\right)^{\sigma-1-\kappa}}{\kappa - (\sigma-1)}\right)^{\frac{1}{\sigma-1}} \\
&= \left(\frac{\kappa}{\kappa - (\sigma-1)} \left(\varphi^S\right)^{\sigma-1}\right)^{\frac{1}{\sigma-1}} = \left(\frac{\kappa}{\kappa - (\sigma-1)}\right)^{\frac{1}{\sigma-1}} \varphi^S. \qquad (64)
\end{aligned}$$

It is clear from (63) and (64) that the average productivities $\bar{\varphi}^N$ and $\bar{\varphi}^S$ are completely determined by the cutoffs φ^N and φ^S computed in section D.1.

D.3 Number of manufacturing varieties

This section shows how to determine the number of manufacturing varieties n. For this purpose, we can use the homogeneous goods equilibrium condition, which equalizes aggregate supply $Y = Y^N + Y^S = a^N L_y^N + a^S L_y^S$ and aggregate demand $Y = (1-\alpha)\frac{E}{p_y}$, so that

$$a^N L_y^N + a^S L_y^S = (1-\alpha)\frac{E}{p_y}. \qquad (65)$$

Before proceeding, we still need to find L_y^N, L_y^S, and E. To pin down L_y^N and L_y^S, we respectively use the labor equilibrium condition in the North and in the South. Once we have obtained these two variables, we can compute E.

- **Finding L_y^N**

Individuals in the North can work in one of five different types of occupations, either providing headquarter services, manufacturing services (i.e., in factory jobs), fixed costs services, entry costs services, or producing the homogeneous good. The total amount of workers employed in each of these occupations is respectively denoted by L_h^N, L_m^N, L_f^N, L_e^N, and L_y^N. In equilibrium, labor supply equals labor demand,

$$\begin{aligned} L^N &= L_h^N + L_m^N + L_f^N + L_e^N + L_y^N \\ &= \left[n^N h^N\left(\bar{\varphi}^N\right) + n^S h^S\left(\bar{\varphi}^S\right)\right] + n^N m^N\left(\bar{\varphi}^N\right) + \left[n^N f^N + n^S f^S\right] + n_e f_e + L_y^N, \end{aligned} \tag{66}$$

where n_e represents the mass of northern firms that pay the sunk entry costs, of which only $n = \left(1 - G\left(\varphi^N\right)\right) n_e$ survive.

Before continuing, it is important to emphasize the usefulness of Melitz' (2003) approach to represent aggregate variables using average productivities. For instance, $h^N\left(\bar{\varphi}^N\right)$ is the amount of headquarter services produced by firms with the average productivity $\bar{\varphi}^N$. Thus, multiplying $h^N\left(\bar{\varphi}^N\right)$ by n^N gives the *aggregate* headquarter services of firms outsourcing (their manufacturing stage) in the North. Similarly, $n^S h^S\left(\bar{\varphi}^S\right)$ represents the aggregate headquarter services of firms outsourcing in the South. Since the production of all headquarter services takes place in the North, $n^N h^N\left(\bar{\varphi}^N\right) + n^S h^S\left(\bar{\varphi}^S\right)$ represents the aggregate headquarter services when combining all manufacturing firms in the economy. To produce $n^N h^N\left(\bar{\varphi}^N\right) + n^S h^S\left(\bar{\varphi}^S\right)$, firms demand the amount L_h^N of labor; and since headquarter services are produced one-to-one with labor, then $n^N h^N\left(\bar{\varphi}^N\right) + n^S h^S\left(\bar{\varphi}^S\right) =$

L_h^N.[27] The same idea also applies to manufacturing services. Consequently, $n^N m^N\left(\bar{\varphi}^N\right)$ denotes the aggregate production of manufacturing services of firms outsourcing in the North. Since manufacturing services are also produced one-to-one with labor, the amount of labor in the North employed producing manufacturing services L_m^N equals aggregate production $n^N m^N\left(\bar{\varphi}^N\right)$.

Now, to determine L_y^N, solve (66) for L_y^N and rewrite the right-hand side using $n = \left(1-G\left(\varphi^N\right)\right) n_e \iff n_e = n/\left(1-G\left(\varphi^N\right)\right)$, $n = n^N + n^S \iff n^N = n - n^S$, and (59) to obtain

$$L_y^N = L^N - n\left(\begin{array}{c}\left(\frac{1-G\left(\varphi^S\right)}{1-G\left(\varphi^N\right)}\right)\left(h^S\left(\bar{\varphi}^S\right)-h^N\left(\bar{\varphi}^N\right)-m^N\left(\bar{\varphi}^N\right)+f^S-f^N\right) \\ +h^N\left(\bar{\varphi}^N\right)+m^N\left(\bar{\varphi}^N\right)+f^N+\frac{f_e}{1-G\left(\varphi^N\right)}\end{array}\right). \tag{67}$$

It is useful to understand why equation (67) completely determines L_y^N. First, L^N, f^i, and f_e are exogenously given. Second, $G\left(\varphi^i\right)$ can be computed using the Pareto cumulative distribution function in (57) and the cutoffs from section D.1. Third, $h^S\left(\bar{\varphi}^S\right)$, $h^N\left(\bar{\varphi}^N\right)$, and $m^N\left(\bar{\varphi}^N\right)$ can be pinned down using the first-order conditions in (42) to (44) and the

[27] Note that we can equalize L_h^N either to $n^N h^N\left(\bar{\varphi}^N\right)+n^S h^S\left(\bar{\varphi}^S\right)$ or to $n h^N\left(\bar{\varphi}\right)$ since $L_h^N = n^N h^N\left(\bar{\varphi}^N\right)+n^S h^S\left(\bar{\varphi}^S\right) = n h^N\left(\bar{\varphi}\right)$. To see this, compute

$$\begin{aligned}
L_h^N &= n^N h^N\left(\bar{\varphi}^N\right)+n^S h^S\left(\bar{\varphi}^S\right) \overset{(42),(44)}{=} \left(n-n^S\right)\frac{(\sigma-1)\eta}{\sigma w_y^N} r^N\left(\bar{\varphi}^N\right)+n^S\frac{(\sigma-1)\eta}{\sigma w_y^N} r^S\left(\bar{\varphi}^S\right) \\
&\overset{(47)}{=} \left(n-n^S\right)\frac{(\sigma-1)\eta}{\sigma w_y^N}\left(\frac{\bar{\varphi}^N}{\bar{\varphi}}\right)^{\sigma-1} r^N\left(\bar{\varphi}\right)+n^S\frac{(\sigma-1)\eta}{\sigma w_y^N}\left(\frac{\bar{\varphi}^S}{\bar{\varphi}}\right)^{\sigma-1} r^S\left(\bar{\varphi}\right) \\
&\overset{(48)}{=} \left(n-n^S\right)\frac{(\sigma-1)\eta}{\sigma w_y^N}\left(\frac{\bar{\varphi}^N}{\bar{\varphi}}\right)^{\sigma-1} r^N\left(\bar{\varphi}\right)+n^S\frac{(\sigma-1)\eta}{\sigma w_y^N}\left(\frac{\bar{\varphi}^S}{\bar{\varphi}}\right)^{\sigma-1}\left(\frac{p_m^N}{\tau p_m^S}\right)^{(1-\eta)(\sigma-1)} r^N\left(\bar{\varphi}\right) \\
&= \frac{(\sigma-1)\eta}{\sigma w_y^N}\frac{r^N\left(\bar{\varphi}\right)}{\bar{\varphi}^{\sigma-1}}\left(\left(n-n^S\right)\left(\bar{\varphi}^N\right)^{\sigma-1}+n^S\left(\bar{\varphi}^S\right)^{\sigma-1}\left(\frac{p_m^N}{\tau p_m^S}\right)^{(1-\eta)(\sigma-1)}\right) \\
&\overset{(62)}{=} \frac{(\sigma-1)\eta}{\sigma w_y^N}\frac{r^N\left(\bar{\varphi}\right)}{\bar{\varphi}^{\sigma-1}} n\bar{\varphi}^{\sigma-1} = n\frac{(\sigma-1)\eta}{\sigma w_y^N} r^N\left(\bar{\varphi}\right) \overset{(44)}{=} n h^N\left(\bar{\varphi}\right).
\end{aligned}$$

results from section B.3. For instance,

$$h^N\left(\bar{\varphi}^N\right) \overset{(44)}{=} \frac{(\sigma-1)\eta}{\sigma w_y^N} r^N\left(\bar{\varphi}^N\right) \overset{(49)}{=} \frac{(\sigma-1)\eta}{\sigma w_y^N}\left(\frac{\bar{\varphi}^N}{\varphi^N}\right)^{\sigma-1}\sigma w_y^N f^N = (\sigma-1)\eta\left(\frac{\bar{\varphi}^N}{\varphi^N}\right)^{\sigma-1} f^N,$$

where φ^N comes from (63) and $\bar{\varphi}^N$ was computed in section D.2. And fourth, n can be determined in a fashion illustrated below (see eq. (70)).

- **Finding** L_y^S

In the South, individuals can only work producing manufacturing services or the homogeneous good. The labor market equilibrium condition in the South is

$$L^S = L_m^S + L_y^S = n^S m^S\left(\bar{\varphi}^S\right) + L_y^S \overset{(59)}{=} n\left(\frac{1-G\left(\varphi^S\right)}{1-G\left(\varphi^N\right)}\right) m^S\left(\bar{\varphi}^S\right) + L_y^S.$$

Solving this for L_y^S gives

$$L_y^S = L^S - n\left(\frac{1-G\left(\varphi^S\right)}{1-G\left(\varphi^N\right)}\right) m^S\left(\bar{\varphi}^S\right). \tag{68}$$

- **Finding** E

In the model, total expenditure is given by $E = w_y^N L^N + \delta^N L_m^N + w_y^S L^S + \delta^S L_m^S$. To understand this, note that factory workers are paid $w_y^i + \delta$, where δ is the compensating wage differential.[28] All other workers are paid w_y^i. Therefore, total expenditure is given

[28] For the particular functional form for the health function in (17), the compensating wage differential is given by $\delta^i = \left(w_y^i \gamma\right)^{1/2}$ (see eq. (19)).

by

$$
\begin{aligned}
E &= w_y^N L^N + \delta^N L_m^N + w_y^S L^S + \delta^S L_m^S \\
&= w_y^N L^N + \delta^N n^N m^N\left(\bar{\varphi}^N\right) + w_y^S L^S + \delta^S n^S m^S\left(\bar{\varphi}^S\right) \\
&= w_y^N L^N + \delta^N\left(n - n^S\right) m^N\left(\bar{\varphi}^N\right) + w_y^S L^S + \delta^S n^S m^S\left(\bar{\varphi}^S\right) \\
&= w_y^N L^N + w_y^S L^S + n\delta^N m^N\left(\bar{\varphi}^N\right) + n^S\left(\delta^S m^S\left(\bar{\varphi}^S\right) - \delta^N m^N\left(\bar{\varphi}^N\right)\right) \\
&\overset{(59)}{=} w_y^N L^N + w_y^S L^S + n\delta^N m^N\left(\bar{\varphi}^N\right) + n\left(\frac{1-G\left(\varphi^S\right)}{1-G\left(\varphi^N\right)}\right)\left(\delta^S m^S\left(\bar{\varphi}^S\right) - \delta^N m^N\left(\bar{\varphi}^N\right)\right) \\
&= w_y^N L^N + w_y^S L^S + n\left(\delta^N m^N\left(\bar{\varphi}^N\right) + \left(\frac{1-G\left(\varphi^S\right)}{1-G\left(\varphi^N\right)}\right)\left(\delta^S m^S\left(\bar{\varphi}^S\right) - \delta^N m^N\left(\bar{\varphi}^N\right)\right)\right).
\end{aligned}
\tag{69}
$$

- **Number of varieties**

To obtain the number of varieties, insert (67), (68), and (69) in (65). Rearranging gives

$$
\begin{aligned}
& a^N\left(L^N - n\left(\begin{array}{c}\left(\frac{1-G\left(\varphi^S\right)}{1-G\left(\varphi^N\right)}\right)\left(h^S\left(\bar{\varphi}^S\right) - h^N\left(\bar{\varphi}^N\right) - m^N\left(\bar{\varphi}^N\right) + f^S - f^N\right) \\ +h^N\left(\bar{\varphi}^N\right) + m^N\left(\bar{\varphi}^N\right) + f^N + \frac{f_e}{1-G\left(\varphi^N\right)}\end{array}\right)\right) \\
& \quad + a^S\left(L^S - n\left(\frac{1-G\left(\varphi^S\right)}{1-G\left(\varphi^N\right)}\right) m^S\left(\bar{\varphi}^S\right)\right) \\
& \quad = \frac{(1-\alpha)}{p_y}\left(\begin{array}{c} w_y^N L^N + w_y^S L^S \\ +n\left(\delta^N m^N\left(\bar{\varphi}^N\right) + \left(\frac{1-G\left(\varphi^S\right)}{1-G\left(\varphi^N\right)}\right)\left(\delta^S m^S\left(\bar{\varphi}^S\right) - \delta^N m^N\left(\bar{\varphi}^N\right)\right)\right)\end{array}\right) \\
\iff\ & a^N p_y\left(L^N - n\left(\begin{array}{c}\left(\frac{1-G\left(\varphi^S\right)}{1-G\left(\varphi^N\right)}\right)\left(h^S\left(\bar{\varphi}^S\right) - h^N\left(\bar{\varphi}^N\right) - m^N\left(\bar{\varphi}^N\right) + f^S - f^N\right) \\ +h^N\left(\bar{\varphi}^N\right) + m^N\left(\bar{\varphi}^N\right) + f^N + \frac{f_e}{1-G\left(\varphi^N\right)}\end{array}\right)\right) \\
& + a^S p_y\left(L^S - n\left(\frac{1-G\left(\varphi^S\right)}{1-G\left(\varphi^N\right)}\right) m^S\left(\bar{\varphi}^S\right)\right) \\
& = (1-\alpha)\left(w_y^N L^N + w_y^S L^S\right) \\
& + n(1-\alpha)\left(\delta^N m^N\left(\bar{\varphi}^N\right) + \left(\frac{1-G\left(\varphi^S\right)}{1-G\left(\varphi^N\right)}\right)\left(\delta^S m^S\left(\bar{\varphi}^S\right) - \delta^N m^N\left(\bar{\varphi}^N\right)\right)\right)
\end{aligned}
$$

$$\overset{(6)}{\Longleftrightarrow} w_y^N L^N - n w_y^N \left(\begin{array}{c} \left(\frac{1-G\left(\varphi^S\right)}{1-G\left(\varphi^N\right)}\right)\left(h^S\left(\bar{\varphi}^S\right) - h^N\left(\bar{\varphi}^N\right) - m^N\left(\bar{\varphi}^N\right) + f^S - f^N\right) \\ + h^N\left(\bar{\varphi}^N\right) + m^N\left(\bar{\varphi}^N\right) + f^N + \frac{f_e}{1-G\left(\varphi^N\right)} \end{array} \right)$$

$$+ w_y^S L^S - n w_y^S \left(\frac{1-G\left(\varphi^S\right)}{1-G\left(\varphi^N\right)}\right) m^S\left(\bar{\varphi}^S\right)$$

$$= (1-\alpha)\left(w_y^N L^N + w_y^S L^S\right)$$

$$+ n(1-\alpha)\left(\delta^N m^N\left(\bar{\varphi}^N\right) + \left(\frac{1-G\left(\varphi^S\right)}{1-G\left(\varphi^N\right)}\right)\left(\delta^S m^S\left(\bar{\varphi}^S\right) - \delta^N m^N\left(\bar{\varphi}^N\right)\right)\right)$$

$$\Longleftrightarrow n = \frac{\alpha\left(w_y^N L^N + w_y^S L^S\right)}{\begin{array}{c} (1-\alpha)\,\delta^N m^N\left(\bar{\varphi}^N\right) + (1-\alpha)\left(\frac{1-G\left(\varphi^S\right)}{1-G\left(\varphi^N\right)}\right)\left(\delta^S m^S\left(\bar{\varphi}^S\right) - \delta^N m^N\left(\bar{\varphi}^N\right)\right) \\ + w_y^N \left(\begin{array}{c} \left(\frac{1-G\left(\varphi^S\right)}{1-G\left(\varphi^N\right)}\right)\left(h^S\left(\bar{\varphi}^S\right) - h^N\left(\bar{\varphi}^N\right) - m^N\left(\bar{\varphi}^N\right) + f^S - f^N\right) \\ + h^N\left(\bar{\varphi}^N\right) + m^N\left(\bar{\varphi}^N\right) + f^N + \frac{f_e}{1-G\left(\varphi^N\right)} \end{array} \right) \\ + w_y^S \left(\frac{1-G\left(\varphi^S\right)}{1-G\left(\varphi^N\right)}\right) m^S\left(\bar{\varphi}^S\right) \end{array}}$$

$$\Longleftrightarrow n = \frac{\alpha\left(w_y^N L^N + w_y^S L^S\right)}{\begin{array}{c} \frac{1-G\left(\varphi^S\right)}{1-G\left(\varphi^N\right)}\left(\left((1-\alpha)\,\delta^S + w_y^S\right) m^S\left(\bar{\varphi}^S\right) + w_y^N\left(h^S\left(\bar{\varphi}^S\right) + f^S\right)\right) \\ + \frac{G\left(\varphi^S\right) - G\left(\varphi^N\right)}{1-G\left(\varphi^N\right)}\left(\left((1-\alpha)\,\delta^N + w_y^N\right) m^N\left(\bar{\varphi}^N\right) + w_y^N\left(h^N\left(\bar{\varphi}^N\right) + f^N\right)\right) \\ + w_y^N \frac{f_e}{1-G\left(\varphi^N\right)} \end{array}}. \tag{70}$$

D.4 Price index

This section shows that the price index in (4) can be expressed as $P = n^{\frac{1}{1-\sigma}} p^N(\bar{\varphi})$. To see this, compute

$$\begin{aligned}
P^{1-\sigma} &= \int_{\varphi^N}^{\varphi^S} \left(p^N(\varphi)\right)^{1-\sigma} \left(n - n^S\right) \frac{g(\varphi)}{G(\varphi^S) - G(\varphi^N)} d\varphi \\
&+ \int_{\varphi^S}^{\infty} \left(p^S(\varphi)\right)^{1-\sigma} n^S \frac{g(\varphi)}{1 - G(\varphi^S)} d\varphi \\
&\overset{(50),(51)}{=} \int_{\varphi^N}^{\varphi^S} \left(\frac{\sigma}{\sigma-1} \frac{\left(w_y^N\right)^{\eta} \left(p_m^N\right)^{1-\eta}}{\varphi}\right)^{1-\sigma} \left(n - n^S\right) \frac{g(\varphi)}{G(\varphi^S) - G(\varphi^N)} d\varphi \\
&+ \int_{\varphi^S}^{\infty} \left(\frac{\sigma}{\sigma-1} \frac{\left(w_y^N\right)^{\eta} \left(\tau p_m^S\right)^{1-\eta}}{\varphi}\right)^{1-\sigma} n^S \frac{g(\varphi)}{1 - G(\varphi^S)} d\varphi \\
&\overset{(60),(61)}{=} \left(\frac{\sigma}{\sigma-1} \left(w_y^N\right)^{\eta} \left(p_m^N\right)^{1-\eta}\right)^{1-\sigma} \left(n - n^S\right) \left(\bar{\varphi}^N\right)^{\sigma-1} \\
&+ \left(\frac{\sigma}{\sigma-1} \left(w_y^N\right)^{\eta} \left(\tau p_m^S\right)^{1-\eta}\right)^{1-\sigma} n^S \left(\bar{\varphi}^S\right)^{\sigma-1} \\
&= \left(\frac{\sigma}{\sigma-1} \left(w_y^N\right)^{\eta} \left(p_m^N\right)^{1-\eta}\right)^{1-\sigma} \left(\left(n - n^S\right) \left(\bar{\varphi}^N\right)^{\sigma-1} + \left(\frac{p_m^N}{\tau p_m^S}\right)^{(1-\eta)(\sigma-1)} n^S \left(\bar{\varphi}^S\right)^{\sigma-1}\right) \\
&\overset{(62)}{=} \left(\frac{\sigma}{\sigma-1} \left(w_y^N\right)^{\eta} \left(p_m^N\right)^{1-\eta}\right)^{1-\sigma} n \bar{\varphi}^{\sigma-1} = n \left(\frac{\sigma}{\sigma-1} \frac{\left(w_y^N\right)^{\eta} \left(p_m^N\right)^{1-\eta}}{\bar{\varphi}}\right)^{1-\sigma} \\
&\overset{(50)}{=} n \left(p^N(\bar{\varphi})\right)^{1-\sigma}
\end{aligned}$$

$$\iff P = n^{\frac{1}{1-\sigma}} p^N(\bar{\varphi}).$$

E Additional references

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