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ABSTRACT

Protection and International Sourcing*

We study the impact of import protection on relationship-specific investments, organizational choice and welfare. We show that a tariff on intermediate inputs can improve social welfare through mitigating hold-up problems. It does so if it discriminates in favor of the investing parties, which the tariff achieves by making trade with outsiders more costly. On the other hand, a tariff can prompt inefficient organizational choices if it discriminates in favor of less productive domestic suppliers or if integration costs are low. Protection distorts organizational choices because tariff revenue, which is external to the firms, drives a wedge between the private and social gains to offshoring and integration. Since contract incompleteness affects investment and production decisions differently depending on the organization form, the intensity of this externality varies with organization form. Hence, protection mitigates domestic hold-up problems but inefficiently curbs offshoring. This suggests a role for moderate protection of inputs trade for firms outsourcing domestically, if the protection is coupled with incentives for offshoring activities.

JEL Classification: F13, L22, L23 and D23
Keywords: international trade, tariffs, hold-up problem, sourcing organizational form

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1 Introduction

International trade in intermediate goods has become increasingly important worldwide. It accounts for about a third of the large increase in global trade flows in recent years (Hummels, Ishii and Yi 2001). Conventional models focusing on final-good trade can explain only part of the overall increase in trade flows (Baier and Bergstrand 2001). These phenomena have sparked considerable research effort in developing microfoundations specific to trade in intermediate goods. The hope is that, by identifying new channels through which changes in technology and trade costs drive changes in trade flows, we can better understand the dynamics of globalization and more accurately assess the welfare impact of policies in a highly interconnected world economy.

There are many industries in which both intermediate inputs and final goods cross national borders. Models that recognize that tariffs have multiple effects on trade flows while otherwise retaining neoclassical market-clearing in trade of intermediate goods can explain some, but not all of the gap between the data and trade theory (Yi 2003). Thus, it appears crucial to recognize that trade in intermediate goods is qualitatively different from trade in final goods. Most notably, such trade often involves tailor-made components that lock in a buyer and a seller to each other. It is well known that lock-in can lead to underinvestment in component-specific technology due to "hold-up problems." For example, a buyer of specific components can, by renegotiating terms of trade, hold up the seller and force a new bargain that gains him some of the surplus created by the seller's sunk investment. When contracts are incomplete, the seller anticipates such a renegotiation prior to investing and underinvests. The same is true for the incentives of the buyer in carrying out relationship-specific investments.

In this setting, we study how interemdiate-input tariffs affect specialized investments, the choice of organizational structure, and welfare. We ask: Is import protection necessarily bad? Can protection affect the *social* desirability of domestic *vs.* offshore supply of inputs, and of arm's-length trading *vs.* vertical integration? And does protection distort the efficiency of equilibrium organizational forms?

We show that a tariff can improve social welfare through mitigating hold-up problems. By increasing the cost of substitute foreign inputs, tariffs motivate domestic specialized firms to increase investment in technology improvements. Essentially, the tariff worsens the outside option of the related parties, making trade of specialized components relatively more attractive. Since under free trade the related domestic parties would underinvest due to hold-up problems, a tariff that is not too high (i.e., that does not generate excessive deadweight losses by artificially inflating the price of substitutes) improves welfare. By contrast, protection does not promote investment when the downstream buyer is related to a foreign specialized supplier. If the tariff affects the cost of the related party's inputs just as it affects the cost of their substitutes, the tariff does not discriminate in favor of specialized input trade, and hence it has no impact on relationship-specific investments. Thus, under offshoring, a tariff lowers the total imports of inputs without affecting the trade of customized inputs. This generates the empirically testable prediction that, for offshoring firms, the share of imported inputs that are differentiated should rise with the tariff, because only the marginal standardized inputs are dropped. On the other hand, tariffs should not affect the share of imported differentiated inputs that are intra-firm, because the lack of effects on relationship-specific investments would leave organizational decisions unchanged.

Hold-up problems can be ameliorated also through vertical integration, but integration comes at the expense of higher governance costs. In a strictly domestic environment, profit-maximizing firms tend to make efficient integration decisions. This is not generally the case in a (partially) open economy. The reason is that tariffs create welfare-reducing organizational externalities. Because firms do not capture tariff revenue, protection drives a wedge between the private and the social gains of using a domestic specialized supplier and of vertically integrating. Since the tariff discriminates in favor of domestic suppliers, buyers (ignoring the country's lost tariff revenue) will choose to deal with such suppliers even in some cases where a foreign supplier would be more productive. This is not so surprising. However, since relationship-specific investments are higher under vertical integration, the use of customized inputs is higher and the demand for imported substitutes is lower under integration. Thus, when buyers deal with domestic specialized suppliers, the intensity of the tariff revenue externality is lower under vertical integration. As a result, buyers will choose to vertically integrate even in cases where the cost of integration is too high relative to its (social) benefits through reducing hold-up problems. Hence, if one observes a surge in integration caused by increases in tariffs, then such changes are necessarily inefficient.

We believe our analysis, and our findings, have important practical implications. First, we are discussing relevant phenomena, at least as long as we can infer from the quantitative importance of differentiated inputs. Nunn (2007), for example, estimates that all of 342 final-good industries in the United States used some differentiated inputs in 1997, and he identifies at least 20 industries using over 80% differentiated inputs.[1] Lileeva and Van Biesebroeck (2008, p. 21) similarly find differentiated inputs comprised 42% of total inputs for Canadian firms in 1988 and 1996. While neither of these studies directly considers imported inputs, our analysis of US Bureau of Economic Analysis data shows quantitatively consistent results—in 2002, the differentiated share of inputs imported into the United States was about 42%.[2]

Moreover, our results suggest that the effects of tariffs on welfare are far more nuanced than normally believed. First, organizational forms are (conditionally) socially efficient under free trade but free trade may not maximize welfare. Indeed, if we observe domestic outsourcing under free trade, some protection would be socially desirable. On the other hand, observing offshoring under a very protectionist regime would provide evidence that the economy would benefit from freer trade. Second, there is a qualitative difference between the effects of tariffs and of unrecoverable trade costs on organizational form. While increases in trade costs affect equilibrium organizational choices, conditional on the positive trade costs such decisions are efficient when tariffs are zero. In contrast, organizational decisions are inefficient conditional on positive tariffs. Indeed, our model predicts that countries with high tariffs tend to have too many integrated firms.

Our analysis also contributes to current policy debates. There has been, for example, an intense debate in the United States about the merits and demerits of the tax rules on the foreign activities of American multinational firms, which currently pay taxes on their foreign profits only when they are repatriated. Because firms can choose when to repatriate profits, some (including at least part of the current Administration) consider this a subsidy to offshoring corporations.[3] Our analysis suggests that such a "subsidy" may actually be efficiency-enhancing—*if* it is coupled with some moderate levels of protection. The tariffs would lessen hold-up problems and boost relationship-specific investments for firms outsourcing domestically. In turn, subsidies for offshoring would curb

[1] The data are by Input-Output industry (US Bureau of Economic Analysis). See Nunn (2007, pp. 576-78, especially Table II).

[2] The source for our estimate is the Bureau of Economic Analysis "Import Matrix from the 2002 Benchmark Input-Output Accounts" (http://www.bea.gov/industry/io_benchmark.htm). We classify goods as differentiated/non-differentiated following Rauch (1999) and as intermediate/final following Feenstra and Jensen (2009). See Appendix A for details.

[3] See e.g. the May 2009 document "Leveling the Playing Field: Curbing Tax Havens and Removing Tax Incentives For Shifting Jobs Overseas" (http://www.whitehouse.gov/the_press_office/leveling-the-playing-field-curbing-tax-havens-and-removing-tax-incentives-for-shifting-jobs-overseas), although the Administration's official view may be changing due to intense lobbying by American multinationals (see Neil King Jr. and Elizabeth Williamson, "Business Fends Off Tax Hit," Wall Street Journal, October 14, 2009, http://online.wsj.com/article/SB125539099758581443.html).

the propensity of the affected firms to excessively cut on their offshoring activities.

Surely, to effectively prescribe policy we would need a full-blown general equilibrium model amenable to calibration and counterfactual analyses. This is well beyond the scope of this paper. Instead, we design the model as to make the economic forces we uncover as clear as possible. First, we set up the model so that standard motivations for active trade policy are shut down. Second, we specify that a uniform tariff applies to both generic and customized inputs. This assumption, which is central for the distinct analyses of foreign and domestic specialized sourcing, is quite relevant in practice.[4] It does not, in any case, affect the more general points we make, that hold-up problems are mitigated by tariffs that discriminate in favor of the investing parties and that those tariffs can distort organizational choices. Third, we restrict attention to dual sourcing of inputs: the downstream buyer purchases both customized inputs from a (foreign or domestic) specialized supplier and "generic" inputs from a competitive industry whose domestic price is defined by the world market and the country's tariff. Dual, or "second" sourcing has been common practice for decades in several industries.[5] However, our emphasis on dual sourcing is mainly pedagogical, as it generates the simplest environment in which a tariff always affects the buyer's costs from at least one source of supply and to which we can easily add endogenous organizational form. This assumption allows us to present our results sharply, avoiding a cumbersome taxonomy. It also sacrifices surprisingly little generality. The qualitative results from our model carry over, for example, into an environment where only one source of supply is ultimately chosen but there is ex ante uncertainty about which supplier will have the lowest price, i.e. where two sources "expect" to produce inputs with some probability.[6]

Our work relates to the literature studying the choice between arm's-length trading and foreign direct investment,[7] but is closest conceptually to papers using models of incomplete contracts à la Grossman and Hart (1986) to study optimal sourcing decisions and organizational form in an international context.[8] It contributes also to the law-and-economics and industrial organization literatures that seek to identify contractual and institutional "solutions" to the hold-up problem. These solutions usually require either a commitment to not renegotiate contracts or the ability of courts to punish contract breach.[9] If renegotiation cannot be prevented and courts cannot always enforce contracts, the standard underinvestment problem remains. We show that import tariffs

[4] Due to bounded rationality of policy makers, this phenomenon will obtain whenever newly innovated (i.e. specialized and unanticipated) inputs satisfy pre-existing tariff schedule definitions and compete with older, more-commoditized inputs subject to the same tariff. In practice, tariff uniformity often applies well beyond the specialized/generic distinction, to wide ranges of related but different goods. For example, in the United States automobile industry, a uniform 2.5% tariff applies to all non-cast-iron component parts for non-agricultural cars and trucks (38 distinct 8-digit HS codes from 8708.10.30 to 8708.99.81), while in the semiconductor industry, a uniform zero tariff applies to all products in the diodes and integrated circuits categories (17 distinct 8-digit HS codes from 8541.10.00 to 8542.90.00).

[5] Two prominent examples are defense contracting (Lyon 2006) and semiconductors (Shepard 1987; Farrell and Gallini 1988). Researchers have argued that dual sourcing may help to prevent bottlenecks, to induce competition among oligopolistic suppliers, and to achieve commitment from buyers. We abstract from commitment issues and strategic competition among suppliers by modeling the second source as a purely competitive "fringe."

[6] In previous work (Ornelas and Turner 2008), we use a "single source under uncertainty" model to show that tariffs have multiple potential effects on trade flows under contractual incompleteness.

[7] This literature began with the contributions of Helpman (1984), Markusen (1984) and Ethier (1986).

[8] See for example McLaren (1999, 2000), Antràs and Helpman (2004, 2008), Grossman and Helpman (2005), and Ornelas and Turner (2008).

[9] For example, Rogerson (1992) shows that the hold-up problem may be solved with properly specified initial contracts as long as it is possible to prohibit renegotiation, whereas Spier and Whinston (1995) and Edlin and Reichelstein (1996) show that well-tuned fixed-price contracts may solve the investment problem depending on the breach remedy enforced by courts.

can, sometimes, be useful in that context.[10]

Our clearest contribution is to the trade policy literature. First, we identify, and qualify, a novel circumstance where protection can enhance welfare—mitigating hold-up problems. Second, and in contrast, we uncover a new channel through which protection promotes inefficiency—distorting organizational choices.

The independent work by Antràs and Staiger (2010) relates to our first point. They build on the modeling framework developed by Antràs and Helpman (2004) to identify a new role for international trade agreements in correcting international hold-up problems and preventing inefficient manipulation of unilateral trade policies aimed at affecting bargaining over supply prices. To highlight their main points, Antràs and Staiger focus on a single source of supply and treat organizational form as exogenous (all upstream firms outsource abroad). In contrast, we do not explicitly consider the role of trade agreements. This allows us to isolate the differential effects of tariffs depending on the location of specialized suppliers and the ownership structure, as well as their role in defining those organizational choices, from confounding forces that arise when governments set trade policies actively. But as we discuss in the conclusion, expanding our setting to consider the role of trade agreements presents itself as a natural, and potentially very interesting, extension.

In turn, the recent paper by Conconi, Legros and Newman (2009) relates to our second point that international trade can affect the efficiency of organizational choices. Their environment, reasoning and predictions are entirely different from ours, however. In their setting, inefficient organizations arise because managers care about the private costs of their actions, and this leads to insufficient coordination between related firms. By affecting coordination incentives, international trade may induce either socially inefficient integration or socially inefficient disintegration.

In terms of structure, the model is closest to Ornelas and Turner's (2008). In both papers we consider the sourcing decisions of a single buyer who can purchase either specialized inputs from a pre-defined supplier or a homogenous competitive alternative whose price is determined exogenously. The investment of the specialized supplier suffers from a hold-up problem whose intensity is affected by import tariffs and can be eliminated through vertical integration, at a fixed cost. However, the model in the current paper is more general in several respects; for example, there are two—rather than one—potential specialized suppliers, which significantly enriches the analysis of both the effects of tariffs on investments and the choice of organizational form. Moreover, and most importantly, the aims of the two papers are entirely distinct. In Ornelas and Turner (2008), the goal is purely positive: to study the impact of tariffs on trade flows. Here, as explained above, the goal is mostly normative: to study how protection affects welfare through its effects on investment incentives and on organizational choices.

The relationship between tariffs and industrial structure has received very little empirical scrutiny, possibly because the theoretical models have been developed only recently. There are, however, a couple of very recent attempts at doing that.[11] Using firm-level data from Korea, Hyun and Hur (2009) find that trade liberalization is associated with less intra-firm trade and more offshoring, both intra-firm and at arm's length. Similarly, using a rich data set encompassing over 100 countries, Alfaro et al. (2010) find that higher tariffs tend to incite vertical integration. While neither of these papers were designed to test our model, their main findings are consistent with our results.

After describing the model, we study the effect of specific tariffs on investment decisions under each possible organizational form (section 2). We study the welfare implications of protectionist

[10] In a closed economy, Rosenkranz and Schmitz (2007) show that government intervention, through domestic taxation, may solve hold-up problems caused by bilateral spillovers of one-sided investments.

[11] See also Diez (2009), who find different effects of "southern" and "northern" tariffs on organization structure.

policies, first, under each type of organization, taken as given (section 3), and then taking into account also their effects on organizational forms (section 4). In section 5 we discuss the robustness of our findings to ad valorem tariffs and when there is an exporting domestic industry of standardized inputs. We conclude in section 6.

2 Model

2.1 Basic Structure

Consider the economy of a country called Home. There are two final goods. A numéraire good x is traded freely and enters in the objective function of (identical) consumers linearly, whereas consumption of good y increases the utility of consumers at a decreasing rate. Thus, if consumers purchase any amount of x, any extra income will also be directed to the consumption of good x. We assume the relative price of good y is such that consumers purchase both goods.

Production of one unit of good x requires one unit of labor, and the market for good x is perfectly competitive. This sets the wage rate in the economy to unity whenever good x is produced. Production of y requires transforming an intermediate input under conditions of decreasing returns to scale. There is a single producer of good y in the Home economy, but he has no market power because the price of y is determined in the world market, which the Home producer cannot influence. Good y can be either exported or imported. We assume away any trade taxes/subsidies on good y, so that we can focus on the effects of protection in the market for inputs. At the current price of good y, the Home producer—whom we call *the buyer*, B—obtains revenue $V(Q)$ when he purchases and processes Q units of inputs, with $V' > 0$ and $V'' < 0$.

The buyer has two sourcing options. He can purchase customized inputs from a supplier at a price they negotiate. This supplier, which we denote by S^j, could be either domestic ($j = d$) or foreign ($j = f$). If she is foreign, the buyer also has to incur a (specific) tariff t for each unit of input he buys from her.[12] Alternatively, B can purchase standardized inputs. We consider that Home is an importer of these generic inputs. This would be the case, for example, if Home were a developed economy with a comparative advantage in more elaborated goods, like the final product y.[13] The import-competing industry of generic inputs is competitive and takes prices in the world market as given. Let the price of each generic input in the world market be p^w; its domestic price is therefore $p^w + t$. Generic and customized inputs are substitutes for the buyer, although the degree of substitutability is generally not one-to-one. Generic inputs may be of different quality, for example. We normalize units to take these differences into account, so that each unit of either generic or customized input has the same revenue-generating potential—i.e. they enter Q additively.

The buyer incurs costs when using inputs. Processing of generic inputs requires a constant cost per unit, θ. To economize on notation, we normalize $\theta = 0$.[14] Now, to use specialized inputs, the buyer has first to adapt his technology toward the inputs of either S^d or S^f. If B adapts toward S^j, the inputs of S^i, $i \neq j$, become worthless to him. The inputs of S^j have the same value to B regardless of the identity of j, conditional on B adapting toward S^j. We consider that the fixed cost of this adaptation, which is independent of the supplier, is small enough so that adapting towards either S^d or S^f is always optimal for B; for convenience, we normalize this cost to zero. In turn, B's variable cost to turn specialized inputs into final products is $C^b(q, \iota)$ labor units, where q denotes the number of specialized inputs processed and $\iota \in [0, \overline{I}]$ represents a cost-reducing

[12] In subsection 5.1 we consider the case of ad valorem tariffs.

[13] In subsection 5.2 we discuss the case where Home is an exporter of generic imputs.

[14] Without this normalization, the total cost of each unit of generic input for B would be $p^w + t + \theta$. Conceptually, this would have no important impact on our analysis.

investment carried out by B in anticipation of future trade with S^j. The buyer's investment, which is non-contractible, costs $I(\iota)$ labor units.

The cost function of the domestic industry of generic inputs is $G(Q)$, with $G' > 0$ and $G'' < 0$. In turn, S^j's cost of producing specialized inputs is $C^j(q, i)$, where $i \in [0, \overline{I}]$ represents a cost-reducing investment carried out by S^j in anticipation of future trade with B. All costs are measured in terms of Home's labor units, and we assume labor costs are fixed also in S^f's country due to the production of the numéraire good x. If S^j does not produce specialized inputs, she produces the numéraire good and earns a payoff of zero. The supplier's investment, which is also non-contractible, costs $I(i)$ labor units.

Letting subscripts of capital letters denote partial derivatives, function C^j satisfies $C^j_q > 0$, $C^j_i < 0$ and $C^j_{qi} < 0$, with C^j_{qi} a constant, $j = d, f$. The latter assumption specifies that a marginal increase in investment brings S^j's marginal cost curve down but does not affect its slope or curvature. The same properties apply to function C^b. Furthermore, $C^j_q(0,0) + C^b_q(0,0) < p^w$, $C^j_{qq} > 0$ and $C^b_{qq} > 0$, so the related parties have a cost advantage in trading specialized inputs at low levels of q, but their technology's marginal cost increases with q. Function $I(.)$, in turn, has the following properties: $I(0) = 0$, $I'(0) = 0$, $I' > 0$ for $i, \iota > 0$, $I'' > 0$ and $\lim_{i \to \overline{I}} I' = \infty$.

Thus, S^j's total cost function is $\Gamma^j(q, i) \equiv C^j(q, i) + I(i)$, whereas B's cost function, net of inputs purchases, is $\Gamma^b(q, \iota) \equiv C^b(q, \iota) + I(\iota)$. To ensure that the second-order necessary condition for both B's and S^j's investment choices are satisfied, we assume $\Gamma^j(q, i)$ and $\Gamma^b(q, \iota)$ are each strictly convex.[15]

If firms B and S^j trade at arm's length, B and S^j choose their investments according to the anticipated impact of i and of ι on their own profits. If B and S^j vertically integrate, we follow Hart and Tirole (1990) in assuming that they choose their investments to maximize their joint profit. On the other hand, the firms incur higher governance costs under vertical integration, which we model as a fixed cost of $K > 0$ labor units. Since there are no wealth effects in our environment, the Coase Theorem implies that B and S^j will choose to vertically integrate if and only if their joint profit under integration is larger than their joint profit under arm's length by at least K. Figure 1 shows the four possible organizational forms, along with terminology we use to describe them.

The domestic supply of generic inputs, Q^h, is pinned down by the cost of the imported alternative and the industry's marginal cost:

$$G'(Q^h(t)) \equiv p^w + t. \tag{1}$$

To ensure that B always buys at least some other input under free trade, we assume $V'(Q^h) > p^w$.

Now, whenever we observe dual sourcing with imports, where B buys both specialized inputs from S^j and standardized inputs from the rest of the world, B's total demand for inputs, Q^*, equalizes the marginal gain and the marginal cost from acquiring an extra generic input. This quantity is implicitly defined by

$$V'(Q^*(t)) \equiv p^w + t. \tag{2}$$

Dual sourcing is efficient when the marginal cost of producing and processing specialized inputs from S^j exceeds the cost of imported generic inputs at $Q^*(t)$. To highlight how import tariffs affect organizational form and welfare, and to avoid an extensive taxonomy, we restrict the analysis to such cases. Let $\overline{t^j}$ denote the tariff that (just) forecloses imports of generic inputs when $i = \iota = \overline{I}$,

[15] Strict convexity of $\Gamma^j(q, i)$ requires $C^j_{qq} > 0$, which follows from the convexity of C^j in q, $I'' + C^j_{ii} > 0$, and $C^j_{qq}(I'' + C^j_{ii}) - (C^j_{qi})^2 > 0$. Analogously, strict convexity of $\Gamma^b(q, \iota)$ follows from $C^b_{qq} > 0$.

Ownership Structure	*Specialized Supplier* S^f	S^d
Vertical Integration	Foreign (Offshore) Integration	Domestic (Onshore) Integration
Arm's-Length Trading	Foreign (Offshore) Outsourcing	Domestic (Onshore) Outsourcing

Figure 1: Organizational Form

and the specialized supplier is S^j. These tariffs are defined implicitly by

$$\begin{aligned} C_q^b(Q^*(\overline{t^d}) - Q^h(\overline{t^d}), \overline{I}) + C_q^d(Q^*(\overline{t^d}) - Q^h(\overline{t^d}), \overline{I}) &\equiv p^w + \overline{t^d} \quad \text{and} \\ C_q^b(Q^*(\overline{t^f}) - Q^h(\overline{t^f}), \overline{I}) + C_q^f(Q^*(\overline{t^f}) - Q^h(\overline{t^f}), \overline{I}) &\equiv p^w. \end{aligned}$$

As it follows from (1), (2), $G'' < 0$ and $V'' < 0$, $Q^*(t) - Q^h(t)$ is a strictly decreasing function. Hence, for any $t < \overline{t^d}$, $i, \iota \in [0, \overline{I}]$. $C_q^b(Q^*(t) - Q^h(t), \iota) + C_q^d(Q^*(t) - Q^h(t), i) > p^w + t$ and it is efficient to import some generic inputs when B sources specialized components from S^d. Similarly, for any $t < \overline{t^f}$, $i, \iota \in [0, \overline{I}]$, $C_q^b(Q^*(t) - Q^h(t), \iota) + C_q^f(Q^*(t) - Q^h(t), i) > p^w$ and it is efficient to import some generic inputs when B sources from S^f.

Given previous restrictions on C^b and C^j, the following assumption ensures that there is dual sourcing under free trade:

$$A1 : C_q^b(Q^*(0) - Q^h(0), \overline{I}) + C_q^j(Q^*(0) - Q^h(0), \overline{I}) > p^w.$$

In turn, assumption $A2$ guarantees dual sourcing for all positive tariffs considered in our analysis:

$$A2 : t < \min\left\{\overline{t^d}, \overline{t^f}\right\}.$$

Having B's total demand for inputs pinned down by $p^w + t$ according to (2) and his purchase of domestic generic inputs determined by (1), only one element of sourcing remains be determined, namely how B chooses the *mix* of generic and customized inputs in each case. This offers the advantage of simplifying the analysis while not surrendering too much generality. If, for example, p^w were uncertain for the firms before the investment decision, we would find similar results even if we imposed single sourcing *ex post*, provided that the firms anticipated positive probabilities of generic and customized sourcing.

Absent integration, the parties cannot use contracts to ensure efficient decisions. As is standard in the incomplete contracts literature, investments are observed by both B and S^j. Due to bounded rationality, however, these investments are not verifiable by an outside observer such as a court; hence, they are non-contractible. Furthermore, B and S^j cannot use contracts to affect their trade decision,[16] nor can tariff schedules distinguish between specialized and generic inputs.

The timing of the game is as follows. The tariff, applied on all imported inputs, is given exogenously. In the first period, firm B chooses between the domestic and the foreign specialized supplier and specializes toward her. Upon the choice of supplier by B, the two partners decide whether to vertically integrate by comparing their joint profits when trading at arm's length and when integrated.[17] Under integration, they pay the fixed cost of integration K and choose jointly the levels of the relationship-specific investments and the volume of specialized inputs to produce. Under outsourcing, each party keeps control of his/her own assets and chooses his/her own relationship-specific investment. After investments have been sunk, the buyer and the specialized supplier bargain over price and quantity of customized inputs. In all types of organizations, B buys generic inputs at $p^w + t$ while trading customized inputs with the specialized supplier.

We analyze this problem recursively. First, we take investments and the identity of the specialized supplier as given and study production and sourcing decisions conditional on investments. We return to the choice of investments later in this section, and study the choice of organization form in section 4. When pertinent, we add subscript $k \in \{a, v\}$ to endogenous variable to distinguish between equilibria under arm's-length (a) and vertically-integrated (v) relationships.

2.2 Sourcing

We consider that the related parties cannot commit, *ex ante*, to trade any quantity of specialized inputs; instead, they bargain *ex post* (i.e. after investments are sunk) over their terms of trade. Consistent with the property rights literature, we assume that ex post bargaining implements efficient sourcing decisions conditional in investments. This requires that specialized inputs are traded up to the point where their total marginal cost, inclusive of the tariff, equates the cost of the standardized substitute.

Consider first the case where B has adapted toward the domestic supplier, S^d. Once investments i and ι have been made, privately efficient sourcing requires that B purchase q^d units from S^d, where q^d satisfies

$$C_q^b(q^d, \iota) + C_q^d(q^d, i) = p^w + t. \tag{3}$$

Hence, S^d produces up to the point where her marginal cost of production, added by B's marginal cost of processing specialized inputs, equalizes the world price, inclusive of the tariff (notice that, under $A1$, $q^d < Q^*$).

Consider now the case where B is specialized toward the foreign supplier, S^f. In this case, the tariff has the same effect on the cost of specialized and standardized inputs. Once investments are

[16] This would be the case, for example, if S^j could produce either high-quality or low-quality specialized inputs, with low-quality inputs entailing a negligible production cost for the seller but being useless to the buyer. Similar assumptions have been used by several authors studying the impact of incomplete contracts on international trade—e.g. Grossman and Helpman (2002), Antràs (2003) and Antràs and Staiger (2010).

[17] Naturally, B and S^j will agree to integrate only if each of them earn under integration at least as much as their expected payoff under arm's-length trading. If their joint profit, net of K, is higher under vertical integration, this can be accomplished through appropriate side payments. Since the precise division of surplus in the bargain that implements integration does not affect any endogenous variable, it is unnecessary to model this further.

sunk, privately efficient sourcing, which is also socially efficient in this case, requires

$$C^b_q(q^f, \iota) + C^f_q(q^f, i) = p^w, \tag{4}$$

where q^f denotes the quantity of specialized inputs purchased from S^f. Since the cost of generics for B is $p^w + t$ but he must pay the tariff also on the specialized inputs he purchases, B and S^f trade up to the point where B-S^f's total marginal cost of using specialized inputs equalizes the world price, *not* including the tariff.

Obviously, this depends on a uniform tariff applying to generic and specialized inputs. This phenomenon arises naturally when innovative firms produce and trade new (specialized) inputs that satisfy tariff schedule definitions for pre-existing (generic) goods, but could also stem from governments' lack of technical expertise to distinguish between types of inputs. Alternatively, customs authorities may be unable to verify distinctions—e.g. if the inputs' main difference involves quality specifications. Either way, the implication is a common tariff for generic and specialized inputs. Inspection of the US structure of tariffs corroborates the view that this is an empirically relevant case.

2.3 First-best Investment

Before studying investment decisions, we calculate the first-best level of investment—*conditional on the tariff*. This provides a benchmark for the analysis of equilibrium investment under each organizational form.

We first define *total profit*, U^j, as the sum of B's and S^j's payoffs. When S^d is chosen, total profit is

$$U^d(i, \iota, t) = V(Q^*) - (p^w + t)(Q^* - q^d) - C^d(q^d, i) - C^b(q^d, \iota) - I(i) - I(\iota) - 1[k = v]K, \tag{5}$$

where $1[\bullet]$ denotes an indicator function that is turned on when the buyer and supplier vertically integrate. When S^f is chosen, total profit is given instead by

$$U^f(i, \iota, t) = V(Q^*) - (p^w + t)(Q^* - q^f) - tq^f - C^f(q^f, i) - C^b(q^f, \iota) - I(i) - I(\iota) - 1[k = v]K. \tag{6}$$

Besides the potentially distinct cost functions, C^d and C^f, the difference between the two expressions is that specialized inputs incur the tariff only if S^f is the specialized supplier.

We next define *social welfare*. Notice first that labor income is fixed in all countries, given by their population sizes times the unit wage rate, which is the price of the numéraire good. Since the price of final good y is fixed throughout the analysis, changes in income affect only the consumption of the numéraire good, which enters linearly in the utility function of consumers. Changes in social surplus/welfare are therefore equivalent to changes in national incomes. We assume that Home's tariff revenue is rebated back to consumers in a lump-sum fashion.

Under domestic specialized supply, social welfare (omitting constant terms) corresponds to $\Omega^d(i, \iota, t) = U^d(i, \iota, t) + tM^d(i, \iota, t) + [(p^w + t)Q^h - G(Q^h)] - 1[k = v]K$, where $M^d(i, \iota, t)$ represents B's imports of inputs when supplier S^d is chosen. The differences between U^d and Ω^d are that the latter concept recognizes that the tariff duties paid by B do not constitute a social loss, and that it incorporates the quasi-rents absorbed by the domestic industry of generic inputs. Notice also that, under domestic specialized sourcing, all changes in Ω^d are absorbed by Home, so changes in global welfare correspond to changes in Home's national welfare. Using (5), we can rewrite $\Omega^d(i, \iota, t)$ as

$$\Omega^d(i, \iota, t) = V(Q^*) - p^w(Q^* - Q^h - q^d) - G(Q^h) - C^d(q^d, i) - C^b(q^d, \iota) - I(i) - I(\iota) - 1[k = v]K. \tag{7}$$

The first-best levels of investment maximize (7) conditional on the tariff. Taking the first-order conditions for (7) with respect to i and ι and using condition (3) for privately optimal sourcing, we obtain two expressions defining the first-best levels of investments, denoted as i^d_{fb} and ι^d_{fb}:

$$-C^d_i(q^d(i^d_{fb},\iota^d_{fb}),i^d_{fb}) = I'(i^d_{fb}) + t\frac{dq^d}{di}, \tag{8}$$

$$-C^b_\iota(q^d(i^d_{fb},\iota^d_{fb}),\iota^d_{fb}) = I'(\iota^d_{fb}) + t\frac{dq^d}{d\iota}. \tag{9}$$

A marginal increase in i or ι lowers the cost of production by C^d_i or C^b_i, respectively.[18] On the other hand, an increase in either investment costs I', and the increase in investment raises domestic specialized production at the expense of imports. This has no social cost in the absence of tariffs. But if $t > 0$, society saves p^w on the marginal imported unit to spend $C^d_q + C^b_q$ producing an extra unit. Since $C^d_q + C^b_q > p^w$ when $t > 0$, this is inefficient, implying a lower socially-optimal level of investment.

If B adapts instead toward S^f, the expression for social surplus, $\Omega^f(i,\iota,t)$, is analogous to equation (7), but replaces q^d with q^f and $C^d(.)$ with $C^f(.)$. Naturally, in this case changes in global welfare need not correspond to changes in Home's national welfare. Using condition (4) for privately optimal sourcing, we find that the first-best investments i^f_{fb} and ι^f_{fb} satisfy[19]

$$-C^f_i(q^f(i^f_{fb},\iota^f_{fb}),i^f_{fb}) = I'(i^f_{fb}),$$

$$-C^b_\iota(q^f(i^f_{fb},\iota^f_{fb}),\iota^f_{fb}) = I'(\iota^f_{fb}).$$

Since the tariff does not distort sourcing decisions when the specialized supplier is abroad, it has no impact on first-best investments.

Note that, regardless of the supplier's identity, i and ι are complementary. Intuitively, a higher q^j elevates the marginal return to investment because $C^j_{qi}, C^j_{q\iota} < 0$. If, for example, the supplier's investment i is higher, then q^j is higher and the buyer's marginal return to investment ι is higher.

2.4 Investment and Protection

To study equilibrium choices of investment, we consider each organizational form in turn. We look first at the cases where B and S^j operate at arm's length; we then move to the case where they are vertically integrated.

Since under arm's length each of the two involved parties chooses his/her own investment independently, in that case we focus on their Nash equilibrium levels of investment. This distinction is necessary because the investment of one party influences the investment incentives of the other party by affecting the volume of trade of specialized inputs. We consider that each investing party anticipates correctly the other party's choice of investment.

2.4.1 Domestic Outsourcing

Under arm's-length trading, the ex post bargaining over terms of trade that the two parties engage in gives rise to a bilateral holdup. Since at that point S^d's investment is sunk, B can "hold up"

[18] Notice that the second-order necessary conditions associated with i^d_{fb} and ι^b_{fb} being maxima of (7) are satisfied, as they correspond to $SONC^d_{fb} \equiv -C^d_{ii} - I'' + \left(C^d_{iq}\right)^2 / \left(C^d_{qq} + C^b_{qq}\right) < 0$, and $SONC^b_{fb} \equiv -C^b_{ii} - I'' + \left(C^b_{iq}\right)^2 / \left(C^d_{qq} + C^b_{qq}\right) < 0$, where the negative signs follow from the convexity of Γ^d and Γ^b.

[19] The convexity of Γ^f and Γ^f ensure that i^f_{fb} and ι^f_{fb} corresponds to maxima of $\Omega^f(i,\iota,t)$.

S^d by negotiating a price that takes advantage of the lower production cost due to S^d's investment without properly compensating S^d for the cost of her investment. The same is true about B's investment, which allows S^d to hold up B at the bargaining table.

The quantity and price at which B and S^d trade are therefore determined by a bargain between them in light of their post-investment cost structures. If bargaining is successful, the parties implement the efficient sourcing decision described by (2) and (3), trading q^d units between themselves while B purchases $Q^* - q^d$ units of generic inputs. The bargaining price p^d divides the surplus generated by S^d selling q^d units to B (instead of B purchasing all Q^* units of generic inputs) according to exogenous bargaining powers. We assume the generalized Nash bargaining solution applies, with α and $1-\alpha$ denoting S^d's and B's bargaining powers, respectively, where $\alpha \in [0,1]$. If B does not buy any specialized input, S^d obtains a payoff of zero. Thus, if negotiation breaks down, *ex post* payoffs net of investments are

$$\begin{cases} u_b^0 = V(Q^*) - (p^w + t)Q^* \\ u_s^0 = 0 \end{cases}$$

for B and S^d, respectively. By contrast, if the two parties agree in their negotiation, *ex post* payoffs net of investments are

$$\begin{cases} u_b^{1d} = V(Q^*) - (p^w + t)(Q^* - q^d) - C^b(q^d, \iota) - p^d q^d \\ u_s^{1d} = p^d q^d - C^d(q^d, i). \end{cases} \tag{10}$$

Thus, B's gain from negotiating is his savings from purchasing q^d units of inputs at a price lower than the world price, inclusive of the tariff and net of processing costs: $u_b^{1d} - u_b^0 = q^d(p^w + t - p^d) - C^b(q^d, \iota)$. For S^d, the net gain is simply her profit from the transaction: $u_s^{1d} - u_s^0 = p^d q^d - C^d(q^d, i)$. Total negotiation surplus (NS^d) is therefore

$$\begin{aligned} NS^d &\equiv (u_b^{1d} - u_b^0) + (u_s^{1d} - u_s^0) \\ &= (p^w + t)q^d - C^d(q^d, i) - C^b(q^d, \iota). \end{aligned} \tag{11}$$

According to the generalized Nash bargaining solution, the parties' negotiated price $\widetilde{p}^d$ satisfies

$$\widetilde{p}^d = \arg\max_{p^d} (u_b^{1d} - u_b^0)^{1-\alpha} (u_s^{1d} - u_s^0)^{\alpha}.$$

It is straightforward to find that

$$\widetilde{p}^d = (1-\alpha)C(q^d, i)/q^d + \alpha \left[p^w + t - C^b(q^d, \iota)/q^d \right]. \tag{12}$$

Thus, $\widetilde{p}^d$ is a weighted average of S^d's average cost of production and of the difference between the cost of a generic input and B's average cost of processing S^d's inputs. Clearly, a higher α implies that S^d absorbs a greater share of the saving costs from her *ex ante* cost-reducing investment, whereas B absorbs a lower share of the saving costs from his *ex ante* cost-reducing investment.

Both parties anticipate the outcome of the bargaining process. Thus, the domestic supplier's ex ante payoff is

$$u_s^d(i, \iota, t) = \alpha \left[(p^w + t)q^d - C^d(q^d, i) - C^b(q^d, \iota) \right] - I(i). \tag{13}$$

Or equivalently, S^d anticipates receiving a share α of the negotiation surplus NS^d while bearing the full cost of her investment. In turn, the buyer's ex ante payoff is

$$u_s^b(\iota, i, t) = (1-\alpha)\left[(p^w + t)q^d - C^d(q^d, i) - C^b(q^d, \iota)\right] - I(\iota), \tag{14}$$

so B receives a share $1-\alpha$ of NS^d while bearing the full cost of his investment.

The domestic supplier and the buyer choose investments non-cooperatively to maximize (13) and (14), respectively. They reach a Nash equilibrium in investments, with equilibrium values denoted by i_a^d and ι_a^d. Using equation (3), the equilibrium conditions satisfy

$$-\alpha C_i^d(q_a^d, i_a^d) = I'(i_a^d), \tag{15}$$
$$-(1-\alpha)C_\iota^b(q_a^d, \iota_a^d) = I'(\iota_a^d), \tag{16}$$

where $q_a^d \equiv q^d(i_a^d(t), \iota_a^d(t), t)$ is the resulting number of inputs produced by S^d.[20] The equilibrium yields a bilateral hold-up problem. The left-hand side of (15) denotes the fraction of the reduction in the cost of production induced by a marginal increase in i that is absorbed by S^d, whereas the right-hand side represents the cost of this extra unit of investment. If $\alpha = 0$, the supplier's hold-up problem is extreme and S^d does not have any incentive to invest. As α rises, her level of investment increases. A direct comparison between i_{fb}^d and i_a^d makes clear that, under free trade, the seller underinvests relative to the socially optimal level whenever $\alpha < 1$. Similarly, if $\alpha = 1$, the buyer's hold-up problem is extreme and B does not have any incentive to invest. As α falls, the level of his investment increases. A direct comparison between ι_{fb}^d and ι_a^d makes clear that, under free trade, the buyer underinvests relative to the socially optimal level whenever $\alpha > 0$.

Under import protection ($t > 0$), however, B's and S^d's investments can be either too little or too large, relative to the first best. While weak protection of the supplier's investment ($\alpha < 1$) induces her to underinvest, import protection fosters *over*investment, because when investing the seller does not internalize the social inefficiency from the displacement of imports caused by the subsequent increase in q_a^d. An analogous reasoning applies for the buyer's investment whenever $\alpha > 0$. The next proposition proves these points. All proofs are in Appendix B.

Proposition 1 *The domestic specialized supplier's equilibrium investment i_a^d is strictly increasing in his bargaining power α and $i_a^d > 0$ unless $\alpha = 0$, when $i_a^d = 0$. Analogously, the buyer's equilibrium investment ι_a^d is strictly decreasing in the supplier's bargaining power α and $\iota_a^d > 0$ unless $\alpha = 1$, when $\iota_a^d = 0$. For $\alpha \in (0,1)$, both investments are strictly increasing in the tariff. Moreover, $i_a^d(t^d) < i_{fb}^d(t^d)$ if and only if $\alpha < 1$ and the tariff is sufficiently low, whereas $\iota_a^d(t^d) < \iota_{fb}^d(t^d)$ if and only if $\alpha > 0$ and the tariff is sufficiently low.*

The possibility of hold up implies that the marginal benefit of investment is always dampened under free trade for at least one of the parties, and for both of them whenever bargaining powers in the ex post negotiation are not extreme. However, Proposition 1 shows that a tariff could solve the hold-up problems, potentially raising investments to their first-best levels, given the tariff. This is possible because the tariff worsens the parties' outside option. This translates into a higher negotiation surplus NS^d, which unambiguously raises the incentives of both parties to invest and attenuates hold-up problems whenever $\alpha \in (0,1)$. Put differently, under domestic specialized sourcing a tariff promotes relationship-specific investments by discriminating in favor of specialized

[20] The second derivative of $u_s^d(i, \iota, t)$ with respect to i is $SONC_s^d \equiv \alpha\left[\frac{(C_{iq}^d)^2}{C_{qq}^d + C_{qq}^b} - C_{ii}^d\right] - I''$. The convexity of Γ^d ensures that $SONC_s^d < 0$, so that i_a^d denotes indeed a maximum of (13). The same holds for the second derivative of $u_s^b(i, \iota, t)$ with respect to ι, $SONC_s^b$.

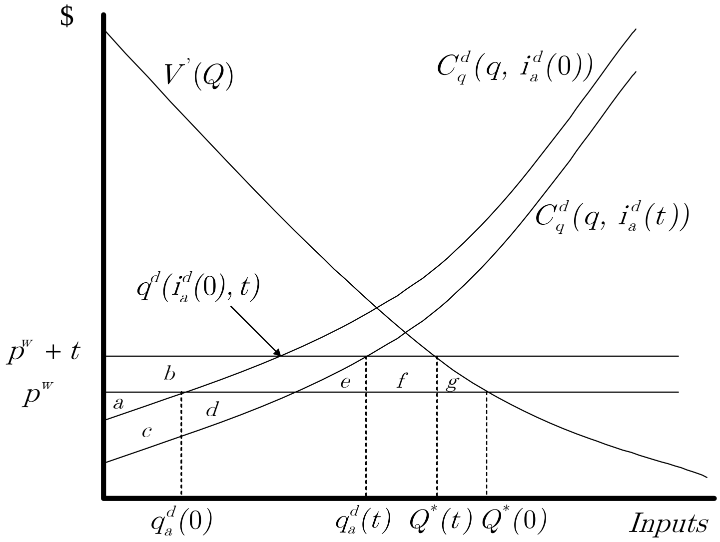

Figure 2: The Effects of a Tariff under Domestic Outsourcing

inputs, which are produced domestically. For S^d, the higher incentive for investment comes about through a higher negotiated price $\widetilde{p}^d$, provided $\alpha > 0$ (see expression 12). Since $d\widetilde{p}^d/dt = \alpha$, the tariff also increases B's incentive to invest whenever $\alpha < 1$, because it raises B's cost of specialized supply in a 1-to-α proportion but the cost of B's alternative source of supply in a 1-to-1 fashion.

A tariff can also induce *too much* incentive for investment: if the tariff is sufficiently high, the parties invest more than is socially optimal, because they do not internalize the tariff revenue that imported inputs generate. This is most easily seen by noting that any positive tariff induces supplier's investment that exceeds the first-best if $\alpha = 1$; the same is true for the buyer's investment if $\alpha = 0$.

Figures 2 and 3 illustrate the effects of the tariff when $\alpha > 0$. For the sake of visual clarity, in the figures we consider that only the supplier has the option to carry out an ex ante relationship-specific investment and that there is no domestic supply of generic inputs; specifically, we set $C_\iota^b(q, \iota) \equiv 0$ and $G'(0) > p^w + \max\{\overline{t^d}, \overline{t^f}\}$.[21] Figure 2 shows the supplier's marginal cost curve and optimal sourcing decisions under free trade and under a strictly positive tariff. Under free trade, the negotiation surplus is given by area a, between the horizontal line that represents p^w and the marginal cost curve $C_q^d(q, i_a^d(0))$. The optimal number of specialized inputs sold is $q_a^d(0)$. Any further investment would push the C_q^d curve down, increasing NS^d, but would also be costly for the supplier. As Figure 3 illustrates, the supplier's choice of investment, $i_a^d(0)$, is such that α times the increase in NS^d brought about by a marginal increase in investment equals the cost of the additional investment.

Once a tariff is introduced, generic inputs become more expensive, worsening the parties' joint outside option. Then, at the initial level of investment, NS^d increases to include area b—hypothetically, S^d would produce $q^d(i_a^d(0), t)$ inputs if it continued to invest $i_a^d(0)$. This implies

[21] Alternatively, one could reinterpret B's total demand for inputs $V'(Q)$ as his demand for inputs net of domestic purchases of generics.

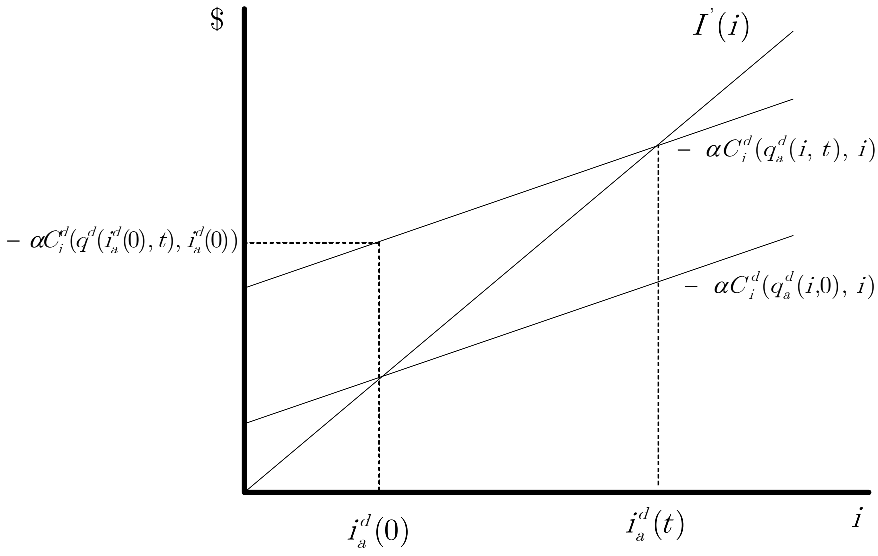

Figure 3: Tariffs and Optimal Investment Under Domestic Outsourcing

that S^d's marginal gain from increasing investment jumps—unlike the investment cost, which is unrelated to the tariff. Figure 3 represents this with the upward shift that the tariff causes on the $dNS^d(t)/di \equiv -\alpha C_i^d(q_a^d, i)$ curve. If the supplier were to naively continue to invest $i_a^d(0)$, then her marginal gain to investment would rise to $-\alpha C_i^d(q^d(i_a^d(0), t), i_a^d(0))$, as shown along the y-axis. But the supplier optimally increases her investment until the point where her marginal gain and the marginal cost of investment are equalized again, to $i_a^d(t)$. At that level of investment, S^d produces $q_a^d(t)$.

2.4.2 Foreign Outsourcing

When the foreign supplier S^f is chosen and the two parties trade under arm's-length, if the bargaining between B and S^f breaks down, *ex post* payoffs are just as they were for B and S^d under domestic outsourcing. By contrast, if the two parties agree in their negotiation, *ex post* payoffs net of investment costs are

$$\begin{cases} u_b^{1f} = V(Q^*) - (p^w + t)Q^* + (p^w - p^f)q^f - C^b(q^f, \iota) \\ u_s^{1f} = p^f q^f - C^f(q^f, i), \end{cases} \tag{17}$$

where p^f is the price reached under Nash bargaining. Thus, B's net gain from negotiating is his savings from purchasing q^f units of inputs at a price p^f, net of processing costs: $u_b^{1f} - u_b^0 = q^f(p^w - p^f) - C^b(q^f, \iota)$. For S^f, the net gain is her profit from the transaction: $u_s^{1f} - u_s^0 = p^f q^f - C^f(q^f, i)$. Total negotiation surplus (NS^f) is therefore

$$NS^f = p^w q^f - C^f(q^f, i) - C^b(q^f, \iota). \tag{18}$$

Since S^f anticipates getting a fraction α of the negotiation surplus, her ex ante payoff is

$$u_s^f(i, \iota, t) = \alpha \left[p^w q^f - C^f(q^f, i) - C^b(q^f, \iota) \right] - I(i). \tag{19}$$

The buyer's payoff follows (14), except that the notation changes to reflect the different supplier. He and the foreign supplier choose investments non-cooperatively and reach a Nash equilibrium in investments, where equilibrium values are denoted i_a^f and ι_a^f. The equilibrium conditions satisfy

$$-\alpha C_i^f(q_a^f, i_a^f) = I'(i_a^f), \quad (20)$$
$$-(1-\alpha)C_\iota^b(q_a^f, \iota_a^f) = I'(\iota_a^f), \quad (21)$$

where $q_a^f \equiv q^f(i_a^f, \iota_a^f)$ is the resulting number of inputs produced by S^f.[22] Equations (20) and (21) have the same interpretation of equations (15) and (16). However, i_a^f and ι_a^f are unaffected by the tariff. The reason is that, when the specialized supplier is abroad, a tariff has the same effect on the parties' payoffs regardless of the success of the bargaining between them. As a result, the negotiation surplus is unaffected by the tariff, implying that the tariff is incapable of promoting investment in this case.

Proposition 2 *The foreign specialized supplier's equilibrium investment i_a^f is strictly increasing in his bargaining power α and $i_a^f > 0$ unless $\alpha = 0$, when $i_a^f = 0$. Analogously, the buyer's equilibrium investment ι_a^f is strictly decreasing in the supplier's bargaining power α and $\iota_a^f > 0$ unless $\alpha = 1$, when $\iota_a^f = 0$. Moreover, $i_a^f < i_{fb}^f$ unless $\alpha = 1$ and $\iota_a^f < \iota_{fb}^f$ unless $\alpha = 0$. However, neither investment is affected by the tariff.*

Figure 4 shows, when $C^b(q^f, \iota) \equiv 0$ and there is no domestic industry of generic inputs, the effective marginal cost curves under free trade ($t = 0$) and under a positive tariff $t > 0$. Because the tariff affects the cost of purchasing specialized inputs from S^f in the same way it affects the cost of purchasing standardized inputs, it does not affect B-S^f's negotiation surplus, NS^f: area a is identical in size to area b. Hence, the tariff does not affect investment incentives.

2.4.3 Vertical Integration

Suppose now that B and S^j have vertically integrated prior to their investment decisions. Investments are then chosen to maximize total profit, defined in expression (5) if $j = d$ and in expression (6) if $j = f$. Equilibrium investments under integration, i_v^j and ι_v^j, satisfy

$$-C_i^j(q_v^j, i_v^j) = I'(i_v^j), \quad (22)$$
$$-C_\iota^b(q_v^j, \iota_v^j) = I'(\iota_v^j), \quad (23)$$

where $q_v^j \equiv q^j(i_v^j(t), \iota_v^j(t), t)$ denotes specialized inputs produced when B integrates with S^j.

Under domestic supply, equilibrium investment levels under integration are larger than the first-best, $i_v^d(t) > i_{fb}^d(t)$ and $\iota_v^d(t) > \iota_{fb}^d(t)$, for any positive tariff, since the right-hand side of (22) is smaller than the right-hand side of (8) and the right-hand side of (23) is smaller than the right-hand side of (9) when $t > 0$. The domestic integrated firm does not internalize the full social costs from sub-optimal sourcing induced by the tariff, so it overinvests unless there is free trade. By contrast, investment under integration equals the first best under offshore specialized supply, when the tariff does not distort sourcing decisions.

[22] The second derivative of (19) with respect to i is $SONC_s^f \equiv \alpha \left[\frac{(C_{iq}^f)^2}{C_{qq}^f + C_{qq}^b} - C_{ii}^f \right] - I''$. The convexity of Γ^f ensures that $SONC_s^f < 0$, so that i_a^f denotes indeed a maximum of (19). Similar reasoning applies for ι_a^f.

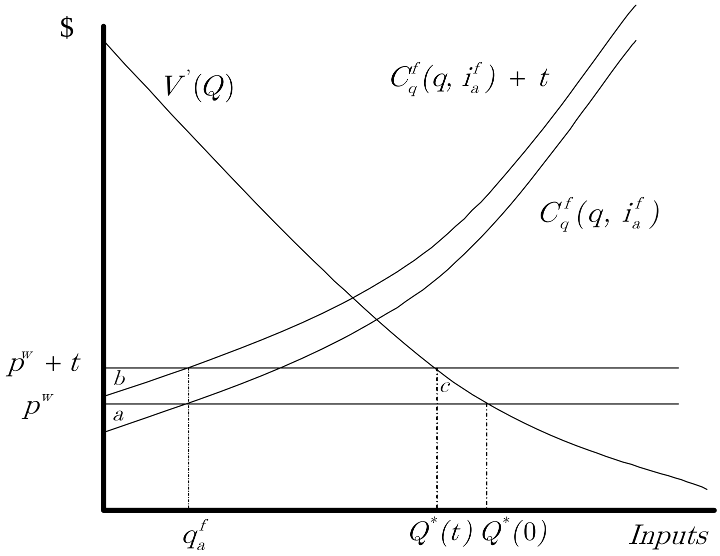

Figure 4: The Effects of a Tariff under Foreign Outsourcing

3 Protection and Welfare

We can now study the welfare impact of protectionist policies. In this section we keep organizational form as given, analyzing the effect of tariffs in each of the four possible organization structures. In the next section we look at how protection influences equilibrium organizational forms.

3.1 Domestic Outsourcing

Taking into account how B and S^d choose investment as a function of the tariff, we find the impact of protection on social welfare under domestic outsourcing by differentiating $\Omega^d(i_a^d(t), \iota_a^d(t), t)$ with respect to t:

$$\frac{d\Omega^d(i_a^d(t), \iota_a^d(t), t)}{dt} = t\frac{dM_a^d(t)}{dt} - \frac{di_a^d(t)}{dt}\left[C_i^d(q_a^d, i_a^d(t)) + I'(i_a^d(t))\right] - \frac{d\iota_a^d(t)}{dt}\left[C_\iota^b(q_a^d, \iota_a^d(t)) + I'(\iota_a^d(t))\right], \tag{24}$$

where we have used equations (1), (2) and (3) to simplify (24). For given investment, the tariff inefficiently reduces imports by both lowering Q^* and increasing Q^h. The (negative) first term in the right-hand side of (24) represents these distortions. On the other hand, a tariff mitigates the inefficiencies in investment decisions. Starting from free trade, and for a given level of imports, more investment from both parties is socially beneficial whenever $\alpha \in (0, 1)$, because B and S^d invest too little due to hold up fears (equations 15 and 16). We know that a tariff stimulates investment for both of them (Proposition 1). The second and third terms in the right-hand side of (24) represent the social gain from a marginal increase in the supplier's investment and in the buyer's investment, respectively, each of them being strictly positive unless $\alpha = 1$ or $\alpha = 0$. Because of this effect, for $\alpha \in (0, 1)$ national welfare is maximized at a strictly positive tariff. Assuming for expositional simplicity that Ω^d is strictly concave,[23] we denote this tariff as t_a^d.

Proposition 3 *If bargaining powers are extreme ($\alpha = 0$ or $\alpha = 1$), the welfare-maximizing tariff under domestic outsourcing is nil: $t_a^d = 0$. Otherwise, $t_a^d > 0$.*

To our knowledge, the benefit of protection underlying $t_a^d > 0$ is entirely novel in the literature.[24] Here, all standard motivations for protection are absent. Still, a tariff can help by alleviating underinvestment by both the buyer and the supplier; this enhances global welfare. The reason is simple. Because the tariff discriminates in favor of specialized inputs, the parties anticipate earning rents from their investment on a greater volume of specialized inputs trade; they increase their investments accordingly.

Returning to Figure 2 (where for simplicity we only consider investment by the supplier and no domestic supply of generic inputs), we see that the higher investment by the supplier lowers C_q^d, which further increases S^d's supply, to $q_a^d(t)$. As a result, national surplus increases by area c due to the supplier's lower marginal cost for the units she already produced. Because the supplier now produces more, national surplus increases also by area d, which corresponds to savings relative to the country's cost of imported inputs, p^w, on the extra units produced by S^d. In turn, national surplus falls by area e due to the wedge that the tariff drives between the private cost of generic and specialized inputs. The tariff also causes the aggregate purchase of inputs, $Q^*(t)$, to fall, producing the additional deadweight loss shown in area g.[25] As Figure 3 indicates, the investment cost also increases, as the seller's investment rises from $i_a^d(0)$ to $i_a^d(t)$. Still, for a sufficiently small tariff the social cost from inefficient sourcing is of second order, whereas the social net gain from the enhanced investment is of first order, warranting a strictly positive optimal tariff.

Note however that, although $t_a^d > 0$ whenever $\alpha \in (0, 1)$, this tariff does *not* induce the first-best levels of investment.

Proposition 4 *For any non-extreme level of bargaining power, the induced levels of investment at t_a^d are lower than the first-best for at least one party: $i_a^d(t_a^d) < i_{fb}^d(t_a^d)$ and/or $\iota_a^d(t_a^d) < \iota_{fb}^d(t_a^d)$.*

The reason for this result is that solving the hold-up problems brings its own distortions. The tariff inefficiently reduces B's total purchases of inputs (area g in Figure 2) and promotes excessive domestic production (area e). Both effects work as "brakes" on how far protectionist policies can go in raising welfare in the presence of domestic hold-up problems.[26]

3.2 Domestic Integration

When B and S^d are vertically integrated, there is no hold-up problem. The salutary effect of the tariff vanishes and the welfare-maximizing policy is free trade. Differentiating $\Omega^d(i_v^d(t), \iota_v^d(t), t)$ with

[23] Global concavity holds, for example, if C_{qqq}^d, C_{qqq}^b and the curvatures of $V'(.)$ and $I'(.)$ are sufficiently close to zero.

[24] The exception is the independent work of Antràs and Staiger (2010), who also study trade policy in the presence of hold-up problems, but under a very different model and with very different aims.

[25] If in Figure 2 B's total demand for inputs were reinterpreted as his demand for inputs net of domestic purchases of generic inputs, area g would correspond to the sum of deadweight losses from the innefficient reduction of Q^* and from the inefficient promotion of the domestic supply of generic inputs Q^h. Area f, which under free trade is absorbed by B, goes to the government in the form of tariff revenue.

[26] This trade-off arises because, in the tradition of the property rights literature (e.g. Grossman and Hart 1986), we distinguish investment from production decisions. In this context, tariffs boost *ex ante* investment only at the cost of promoting excessive *ex post* domestic production. This trade-off does not arise in the setting of Antràs and Staiger (2010), where there is a one-to-one correspondence between investment and production. Internationally efficient trade taxes fully solve hold-up problems in their setting.

respect to t, we find the marginal loss from protection:

$$\frac{d\Omega^d(i_v^d(t),\iota_v^d(t),t)}{dt} = t\left[\frac{dQ^*(t)}{dt} - \frac{dQ^h(t)}{dt} - \frac{dq_v^d(t)}{dt}\right] \leq 0. \tag{25}$$

Hence $t_v^d = 0$.

3.3 Offshoring

Under offshoring, a tariff does not affect investment under any ownership k. Thus, protection inefficiently lowers imports without ameliorating any hold up problem. Differentiating $\Omega^f(i_k^f,\iota_k^f,t)$ with respect to t, we have:

$$\frac{d\Omega^f(i_k^f,\iota_k^f,t)}{dt} = t\left[\frac{dQ^*(t)}{dt} - \frac{dQ^h(t)}{dt}\right] \leq 0. \tag{26}$$

Hence, $t_a^f = t_v^f = 0$. Figure 4 shows the deadweight loss from protection when only the foreign supplier has the opportunity to carry out ex ante investments and all generic inputs are imported (area c).

3.4 The Impact of Protection under Different Organizational Structures

The welfare-maximizing organizational form satisfies

$$Max_{j\in\{d,f\},k\in\{a,v\}}\left\{U^j(i_k^j(t),\iota_k^j(t),t) + tM_k^j(i_k^j(t),\iota_k^j(t),t) + \left[(p^w+t)Q^h(t) - G(Q^h(t))\right] - 1[k=v]K\right\}. \tag{27}$$

Our analysis makes clear that a tariff can affect the solution of this problem. Some protection is helpful under domestic specialized outsourcing but is harmful under the other types of organizations. We can also rank the (un)desirability of protection in those cases. Specifically, by comparing expressions (24), (25) and (26), we have that, for $t \in (0, t_a^d)$,

$$\frac{d\Omega^d(i_v^d,\iota_v^d,t)}{dt} < \frac{d\Omega^f(i_v^f,\iota_v^f,t)}{dt} = \frac{d\Omega^f(i_a^f,\iota_a^f,t)}{dt} < 0 < \frac{d\Omega^d(i_a^d,\iota_a^d,t)}{dt}. \tag{28}$$

The reason why protection is more harmful when B and S^d integrate than when B sources from S^f is simple. A tariff inefficiently lowers Q^* and raises Q^h by the same amount in all cases, but under domestic supply it lowers imports further, by distorting sourcing toward S^d. Under arm's-length trading this additional inefficiency is more than compensated by the mitigation of hold-up problems for $t < t_a^d$, but not under integration. The following example illustrates these points.

3.5 An Example

Let $V(Q) = AQ - \frac{Q^2}{2}$, $C^j(q,i) = (C_0^j - i)q + \frac{q^2}{2}$, $I(i) = i^2$, with A large relative to $\{C_0^j\}$. For simplicity, let $C^b(q,\iota) \equiv 0$, so that the buyer does not engage in relationship-specific investments, and assume all generic inputs are imported. This yields linear "supply" (C_q^j) and "demand" (V') curves, with $C_0^j - i^j$ denoting the intercept of S^j's marginal cost curve. With this specification, it is straightforward to find Q^*, $\{q_k^j\}$, $\{i_k^j\}$ and t_a^d.

Consider optimal organizational form. Under free trade, the foreign technology yields higher investment, conditional on ownership k, if $C_0^f < C_0^d$. In that case, $\Omega^f > \Omega^d$. Integration yields higher welfare than outsourcing if K is sufficiently low. Figure 5 shows how the socially optimal

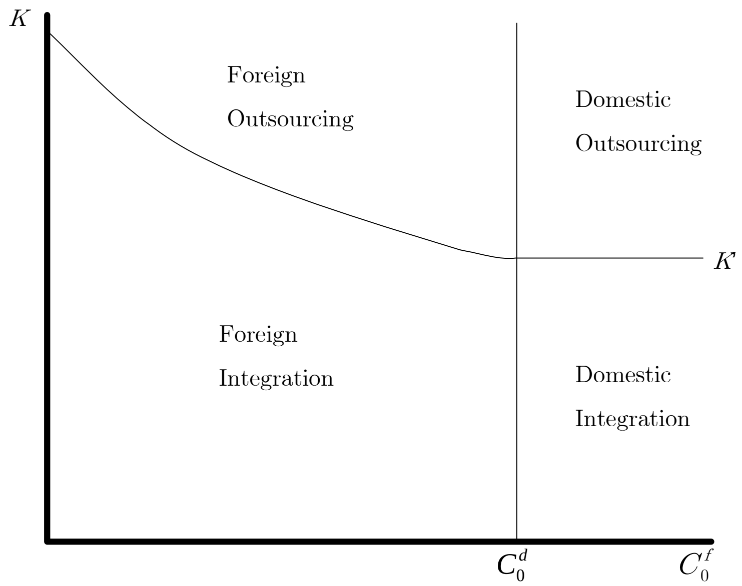

Figure 5: Socially Optimal Organizational Forms under Free Trade

organizational form (i.e., the solution to problem 27) varies with C_0^f and K. Foreign specialized supply is optimal if $C_0^f < C_0^d$, and integration is optimal when K is relatively low. Conditional on $C_0^f < C_0^d$, the level of K such that foreign outsourcing yields higher welfare than foreign integration falls with C_0^f.[27] For $C_0^f > C_0^d$, domestic specialized supply is optimal and, for $K \geq K'$, outsourcing is optimal.[28]

Now let there be a tariff $t \in (0, t_a^d)$. Figure 6 shows optimal organization forms in this case, including dashed lines that show the corresponding regions from Figure 5. The tariff enhances social surplus under domestic outsourcing relative to each other organizational form. Domestic outsourcing is now preferred to foreign outsourcing and foreign integration for a range of parameter values such that S^d's fundamental technology is worse than S^f's (represented in Figure 6 by the range $C_0^f \in [C_0^d - \delta, C_0^d]$, $0 < \delta < t$). Intuitively, the tariff improves S^d's investment incentives to a point where its post-investment marginal cost curve is lower than S^f's post-investment marginal cost curve (not including the tariff).[29] In essence, the tariff gives S^d a *productivity advantage*.

Under protection, domestic outsourcing is also preferred to domestic integration for some levels of K where the opposite was true under free trade (represented in Figure 6 by the range $K \in [K' - \Delta, K']$, $\Delta > 0$). The reason is that, as discussed above, a moderate tariff is welfare-improving under domestic outsourcing but lowers welfare under domestic integration. Finally, conditional on integration, the tariff tilts socially optimal supply toward offshoring, consistent with (28)—in

[27] The maximum K under which vertical integration is optimal (conditional on offshoring) declines with C_0^f because, as C_0^f increases, q^f falls for given level of investment, lowering the return of investment. This makes the hold-up problem less severe, reducing the gains from vertical integration.

[28] The level of C_0^d also affects the cutoff value of K, but since C_0^d is fixed in Figure 5, the cutoff is represented by a horizontal line (as it does not depend on C_0^f in this region).

[29] This is most easily seen by considering the limiting case where C_0^f approaches C_0^d. With no tariff, S^d has the same investment incentives as S^f. With a positive tariff, S^d invests more than S^f, so its marginal-cost curve shifts down more.

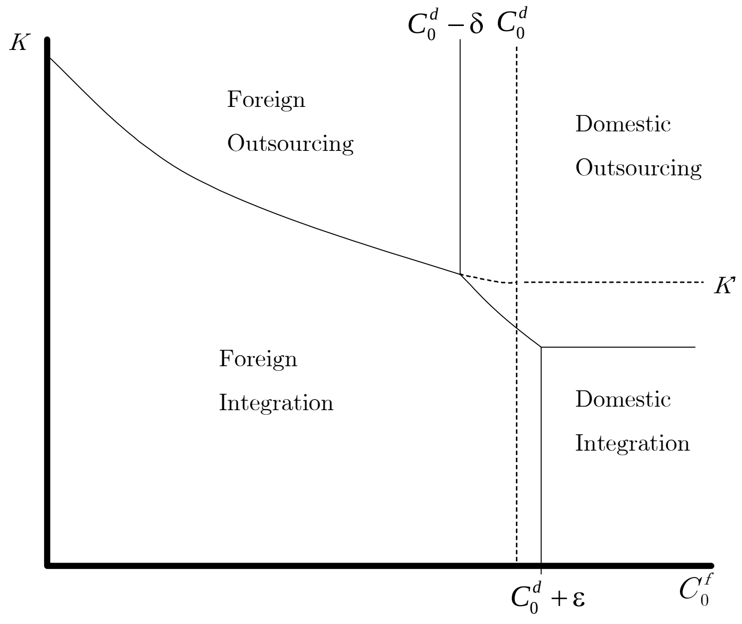

Figure 6: Socially Optimal Organizational Forms under Protection

Figure 6, this happens for $C_0^f \in [C_0^d, C_0^d + \varepsilon]$, $\varepsilon > 0$.

Interestingly, if domestic integration is just barely socially optimal under free trade, a small increase in K and a small decrease in C_0^f could make foreign outsourcing optimal. In contrast, with a positive tariff relatively large changes in K and C_0^f are necessary to tilt the socially optimal organization form from domestic integration to foreign outsourcing (note that the Foreign Outsourcing and Domestic Integration regions in Figure 6 do not share a boundary). The reason is twofold. First, the tariff affects the social benefits from offshoring differently depending on B's ownership status: offshoring becomes relatively more socially beneficial if B is integrated but less so if B trades at arm's length. Second, the tariff affects the social benefits from vertical integration differently depending on B's sourcing status: while those benefits are unaffected under offshoring, they fall under onshoring.

4 Organizational Structure

We now study the equilibrium *choice* of organizational form. After the buyer chooses between S^d and S^f, the parties decide whether they want to integrate. For expositional clarity, we say the buyer makes all decisions regarding organizational structure. This would be the case for example if B could make a take-it-or-leave-it offer to a supplier before investment decisions are made. Clearly, results under this assumption are identical to those obtained by relying on the Coase Theorem, where comparisons of the parties' joint profit under each organizational form define equilibrium organizational structure.

Protection makes offshoring relatively less attractive, both because of the tariff's direct effect on the cost of imported specialized inputs and because of its indirect effect on investment incentives under onshoring, which reduces the reliance of the buyer on the now more expensive imported generic inputs. The higher cost of generic inputs also increases the attractiveness of domestic integration relative to domestic outsourcing, although the alleviation of hold-up problems under domestic outsourcing works in the opposite direction, favoring domestic outsourcing over domestic integration. As we now show, however, the buyer's enhanced incentives to onshore and to integrate are often not socially optimal.

The firms' organizational form problem is

$$Max_{j\in\{d,f\},k\in\{a,v\}}\left\{U^j(i_k^j(t),\iota_k^j(t),t)-1[k=v]K\right\}. \tag{29}$$

Since Q^h is the same regardless of organization form, the solution to this maximization problem is identical to the solution of (27) under free trade ($t=0$), when the equilibrium organizational form is efficient. But when tariffs are positive, there are organizational externalities. Since tariff revenue is not captured by the firms, when it is different across organizational forms it can distort the firms' choice away from the welfare-maximizing one. The distortions arise in the supplier and in the ownership decisions.

Consider first the ownership decision, conditional on specialized supplier S^j's being chosen. Assuming B chooses integration when the payoffs are the same, the firms integrate if and only if

$$\Delta U^j \equiv U^j(i_v^j(t),\iota_v^j(t),t)-U^j(i_a^j(t),\iota_a^j(t),t)\geq K, \tag{30}$$

that is, if the *private gains to integration*, ΔU^j, exceed the integration fixed cost. By contrast, integration maximizes social welfare if and only if

$$\Delta\Omega^j \equiv U^j(i_v^j(t),\iota_v^j(t),t)-U^j(i_a^j(t),\iota_a^j(t),t)-t\left[M_a^j(t)-M_v^j(t)\right]\geq K, \tag{31}$$

that is, if the *social gains to integration*, $\Delta\Omega^j$, exceed the integration fixed cost.

Since tariffs do not affect investment under offshoring ($j=f$), the social gains to integration do not depend on the tariff in this case. Furthermore, tariff revenue does not depend on whether integration is chosen,[30] because the volume of imported inputs is unchanged $[M_a^f(t)=M_v^f(t)=Q^*(t)-Q^h(t)]$. The private gains to integration equal the social gains. Therefore, tariffs do not distort the integration decision when the specialized supplier is foreign.

On the other hand, integration does affect tariff revenue under onshoring ($j=d$). Since the number of specialized inputs sold is greater, imports and tariff revenue are lower under integration than under outsourcing $[M_a^d(t)=Q^*(t)-Q^h(t)-q_a^d(t)>Q^*(t)-Q^h(t)-q_v^d(t)=M_v^d(t)]$. As a result, when tariffs are positive, the private gains to integrating exceed the social gains.

Proposition 5 *Under free trade, the equilibrium ownership decision is socially efficient. For any $t>0$, if the firms choose outsourcing over integration, it is the socially efficient ownership structure. If the firms integrate, it is socially efficient if S^f is selected but may be inefficient if S^d is chosen.*

Hence, protection promotes excessive domestic integration. This happens because contract incompleteness, through its effect on investment, affects production differently depending on the type of ownership. This results in lower imports and lower tariff revenue under domestic integration than under domestic outsourcing. Since the firms disregard tariff revenue, this effect induces excessive vertical integration.

[30] This statement, and its implications, relies on the tariff being specific. When the tariff is ad valorem, the inefficiency of the ownership decision under onshoring observed below extends to offshore specialized supply. We show this in subsection 5.1.

Consider next the supply decision, conditional on ownership k being chosen. Assuming B chooses S^d when the payoffs are the same, B specializes toward S^d if and only if

$$\Delta U_k \equiv U^d(i_k^d(t), \iota_k^d(t), t) - U^f(i_k^f, \iota_k^f, t) \geq 0. \tag{32}$$

By contrast, social surplus is higher under domestic specialized sourcing if and only if

$$\Delta \Omega_k \equiv U^d(i_k^d(t), \iota_k^d(t), t) - U^f(i_k^f, \iota_k^f, t) - t\left[M_k^f(t) - M_k^d(t)\right] \geq 0. \tag{33}$$

Again, the supplier decision need not be socially optimal because it disregards tariff revenue. For $t > 0$, imports and tariff proceeds are lower under onshore specialized supply because tariffs are paid on generic inputs only: $M_k^f(t) > M_k^d(t)$ for any k. As a result, the difference between the firms' total payoff and social welfare is smaller under onshoring than under offshoring.

Proposition 6 *Under free trade, the equilibrium supply decision is socially efficient. For any $t > 0$, if S^f is chosen, it is the socially efficient supplier. If S^d is chosen, it may be inefficient under either outsourcing or integration.*

4.1 Unrecoverable Trade Costs

We have so far focused on the effects of tariffs. Much of our analysis carries through analogously if we consider the effects of physical trade costs, like transportation costs. However, the effects of such trade costs are qualitatively distinct from the effects of tariffs in one important way, as we now show.

As in the model of Antràs and Helpman (2004), changes in unrecoverable trade costs may alter equilibrium organizational form also in our model. Here, a per-unit trade cost essentially worsens the technology of the foreign specialized supplier, promoting domestic sourcing relative to the zero-trade-cost case. By raising the price of generic inputs, it also potentially affects the integration decision, just as a tariff would.[31]

Consider now the case of a per-unit physical trade cost $T > 0$ (setting $t = 0$). We have that

$$\Omega^j(i_k^j(T), \iota_k^j(T), T) = U^j(i_k^j(T), \iota_k^j(T), T) + \left[(p^w + T)Q^h(T) - G(Q^h(T))\right] - 1[k = v]K. \tag{34}$$

Unlike in the case of tariffs (see (27)), resources spent on trade costs, $TM_k^j(i_k^j(T), \iota_k^j(T), T)$, are not recovered and do not enter into social welfare. As the socially optimal organizational form maximizes (34), the private gains to integration equal the social gains, $\Delta U^j = \Delta \Omega^j$, and the private gains to choosing the domestic supplier equal the social gains, $\Delta U_k = \Delta \Omega_k$. Hence, conditional on T, equilibrium organizational form is efficient.

4.2 An Example, continued

We now consider equilibrium organizational form (i.e., the solution to problem 29) using the example described in subsection 3.5. Under free trade, the equilibrium organizational form is socially efficient conditional on the (zero) tariff. This is not true when tariffs are positive. As propositions 5 and 6 show, onshore supply may be privately optimal but socially inefficient under protection, because the firms neglect the lost tariff revenue under domestic supply. This distortion is highlighted by

[31] This is more involved, as a trade cost affects both ex ante investment incentives by S^j and the level of savings from importing fewer generic inputs. The effects of an unrecoverable trade cost on the integration decision are nevertheless exactly the same as those of per-unit tariffs, discussed in the final paragraph of section 4.2.

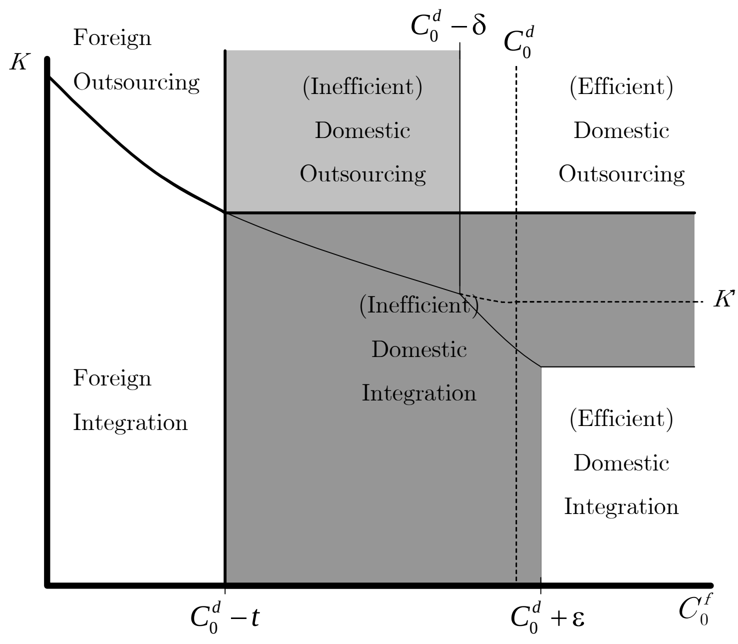

Figure 7: Equilibrium Organizational Forms under Protection

the light gray region in Figure 7. Domestic outsourcing (when K is sufficiently high) is chosen for $C_0^f > C_0^d - t$ because the renegotiation surplus is higher and S^d chooses a higher investment.[32] However, domestic outsourcing is socially inefficient for $C_0^f < C_0^d - \delta$, because S^d produces at a higher marginal cost than S^f (not including the tariff). Intuitively, in that region welfare is higher if B chooses S^f and the Home country captures some tariff revenue on specialized inputs. Because B does not get that tariff revenue, he chooses S^d.

In turn, domestic integration (when K is sufficiently low) is chosen for $C_0^f > C_0^d - t$ but is socially inefficient (relative to foreign integration) for $C_0^f < C_0^d + \varepsilon$. This distortion is represented by the dark gray region in Figure 7. Domestic outsourcing is inefficient for a smaller range than domestic integration because of the salutary effect of the tariff on investment under domestic outsourcing.

Importantly, tariffs also distort the ownership decision when S^d is chosen. This is highlighted by the dark gray area for intermediate levels of K. Since tariff revenue is lower under integration and the firms do not factor this into their ownership decision, they integrate for values of K that are too high from a social welfare standpoint.

Contrast this with the case where there is no tariff but there is a per-unit unrecoverable trade cost $T > 0$. Supplier decisions differ from those made under zero trade costs ($T = 0$) because foreign inputs become more expensive to use. Foreign specialized supply will be favored only when $C_0^f < C_0^d - T$, i.e. less often. However, organizational choices, conditional on the trade costs, are efficient because such costs are unrecoverable and are internalized by the firms.[33]

Note also that the dark gray area need not go beyond K', as it does in this example. That is, it is possible that some protection will prompt (welfare-maximizing) domestic outsourcing. The

[32] The easiest way to see this is to note that, if $C_0^f = C_0^d - t$, the renegotiation surplus is the same under foreign and domestic outsourcing. Hence, investments by S^f and S^d are the same. As C_0^f increases, the renegotiation surplus under foreign outsourcing shrinks, so she invests less.

[33] Replacing t with T in Figure 7, equilibrium choices would be the same, but they would be conditionally efficient.

reason is that the private gains to integrating, conditional on domestic specialized supply, may either increase or decrease with tariffs. This result mirrors a finding by Ornelas and Turner (2008). As the tariff rises, S^d increases her investment under outsourcing. This lowers the gain from eliminating the hold-up problem, since this extra investment has a first-order positive effect on the firms' joint surplus under arm's length, when investment is inefficiently low, but not under vertical integration, when investment is chosen to maximize the firms' joint profit. This *mitigation of the hold-up problem* lowers the private gains from integration when the tariff rises. Now, since an increase in the tariff makes imports more expensive, it lowers the joint surplus of the firms, but does so more prominently when they trade under arm's length, and import levels are higher. Because of this *volume of trade effect*, ΔU^d increases when the tariff rises. In general, either of these two effects can dominate, implying that, conditional on onshore specialized sourcing, protection can induce either vertical integration or outsourcing. However, as it follows from Proposition 5, protection will never induce *enough* outsourcing.

4.3 Trade Liberalization

Our paper shows that the nature of distortions caused by tariffs may be far more subtle than normally believed. Because tariffs can simultaneously encourage welfare-enhancing investments and welfare-detracting organizational choices, assessing the magnitude and direction of welfare changes due to changes in tariffs requires careful consideration of substitution between domestic and foreign inputs and between organizational forms. To highlight this, consider the implications of trade liberalization for changes in trade flows, organizational structures and welfare.

Naturally, any model would indicate that, as tariffs fall, we should observe more offshoring relative to onshoring, increasing international trade flows. But our model suggests that this increase can be highly non-linear and disproportionately higher than the tariff changes because of organizational restructuring. This can help to explain the observed puzzling large response of trade flows to tariffs stressed for example by Yi (2003).[34] Furthermore, our model indicates that discrete jumps in trade flows due to organizational changes set off by falling tariffs do not require a change from domestic to foreign specialized partners. For example, if trade liberalization prompted domestic 'disintegration' (in our example, this would happen if K were not much larger than K' and $C_0^d < C_0^f$), there would be a jump in the purchases of imported generic inputs even though the specialized supplier remains domestic.

Our analysis also provides specific testable predictions about the impact of trade liberalization on organizational form. As well as promoting offshoring generally, lower tariffs will induce more outsourcing, relative to domestic integration, when hold-up problems are weaker (so that their aggravation under arm's length is relatively unimportant) and when the share of generic inputs is higher (so that the greater cost saving due to the lower tariff under outsourcing matters more).

Perhaps more striking are the welfare implications of trade liberalization that emerge from our analysis, which are qualitatively very different from what conventional models suggest. For given organizational structure, welfare rises as tariffs fall due to the regular mechanism of increasing imports. But trade liberalization can also trigger organizational change. If organization structure under protection is $\{k, j\} \neq \{d, a\}$ but changes because of trade liberalization, this would be evidence that tariff revenue externalities effectively distorted organizational choice under protection. Accordingly, the move to free trade would generate additional welfare gains due to the removal of these externalities.

The exception is when the organizational structure under protection is $\{d, a\}$. In that case,

[34] We make a related point in Ornelas and Turner (2008).

welfare gains from trade liberalization are not warranted. The reason is the loss of the productivity advantage brought about by the tariff. If $\{d,a\}$ remains the firms' choice under free trade—and the original tariff were not higher than t_a^d—the move to free trade necessarily implies a welfare loss due to the consequent aggravation of the hold-up problems. If organization form changes as the tariff falls, welfare could go either up or down. In our example, it would go down if K were sufficiently high and $C_0^f \in [C_0^d - \delta, C_0^d]$, in which case the choice of organization would be efficient regardless of the tariff, but the productivity advantage introduced by the tariff would be lost under free trade.

The following corollary summarizes this discussion.

Corollary 1 *As the tariff falls from $t < t_a^d$ to zero:*

a) welfare falls if both the initial and the final organizational structure is $\{d,a\}$;

b) welfare rises when the initial organizational structure is $\{k,j\} \neq \{d,a\}$, especially if an organizational change is triggered;

c) welfare can either increase or decrease if the initial organizational structure is $\{d,a\}$ and the fall in the tariff triggers a change.

Under domestic outsourcing, the optimal tariff depends on many factors, including the efficiency of the domestic supplier relative to the generic market, the bargaining power of the parties and the shape of the buyer's demand curve for inputs. In the one-sided investment example, we find

$$t_a^d = \frac{2\alpha(1-\alpha)}{8(1-\alpha)+3\alpha^2}\left(p^w - C_0^d\right).$$

This expression corresponds to the optimal tariff if K is high enough to make integration suboptimal and if $C_0^f > C_0^d$, so it is optimal to source specialized inputs domestically. The function is non-monotonic in bargaining power α, a feature that is robust to two-sided investment. More importantly, the size of the optimal tariff is proportional to $p^w - C_0^d$, which can be interpreted as the relative efficiency of the domestic supplier. When $p^w - C_0^d$ is high, the domestic supplier sells a relatively high number of inputs even without investing in technology improvements. In that case, the marginal gain to investing is high and a tariff is effective in promoting further efficiency gains. This suggests industries characterized by a relatively high intensity of differentiated inputs and some non-differentiated imports as the prime candidates for efficiency-enhancing tariffs. Though not constructed for the purpose of identifying optimal tariffs, estimates of "contract intensity" along the lines of Nunn (2007), combined with estimates of the import share of inputs, would form a useful benchmark for thinking about which industries are most likely to benefit.

5 Extensions

5.1 Ad Valorem Tariffs

Thus far we have considered only the case of specific import tariffs. As we show in this subsection, our results are broadly equivalent when the import tariff is ad valorem—although some qualifications are warranted. For simplicity, here we allow only the supplier to invest, setting $C^b(q,\iota) \equiv 0$. As it should be clear by now, the economic forces behind B's investment are essentially the same as those behind S^j's investment.

Denote the ad valorem tariff by τ and consider first the case of domestic outsourcing. Privately efficient sourcing requires now that

$$C_q^d(q^d, i) = p^w(1+\tau). \tag{35}$$

We have that $u_s^{1d} - u_s^0 = p^d q^d - C^d(q^d, i)$, whereas $u_b^{1d} - u_b^0 = q^d\left[(1+\tau)p^w - p^d)\right]$. Thus, the surplus from negotiation for the two parties becomes $NS^d = (1+\tau)p^w q^d - C^d(q^d, i)$. Using (35), it is then straightforward to see that S^d's choice of investment is again given by (15), which is the basis of propositions 1, 3 and 4.

The analysis is slightly more involved when B offshores specialized inputs at arm's length. The reason is that, with an ad valorem tariff, the (ex post) division of surplus between B and S^f also affects their total gains from negotiating: while a lower p^f increases the firms' joint surplus—because it induces lower tariff payments on specialized components—it also reduces S^f's share of the surplus. As a result, splitting NS^f according to bargaining power is no longer equivalent to the generalized Nash bargaining solution.

Yet noticing that $u_b^{1f} - u_b^0 = (p^w - p^f)(1+\tau)q^f$, maximization of

$$\left(u_s^{1f} - u_s^0\right)^{\alpha}\left(u_b^{1f} - u_b^0\right)^{1-\alpha}$$

with respect to q^f and p^f still gives us the same solution as before: $C_q^f(q^f, i) = p^w$ as the privately efficient sourcing condition and negotiation price $\widetilde{p}^f = \alpha p^w + (1-\alpha)C^f(q^f, i)/q^f$. We are then back to (20), which is the basis of Proposition 2.

The possible drawback to this result is the incentive of the two parties to underreport their negotiation price, $\widetilde{p}^f$, as a way to lower tariff payments. If customs authorities can effectively limit the extent of such misrepresentation of actual trading prices, our results would remain unaltered.

It is easy to see that, if firms B and S^j are vertically integrated, all of our results under a specific tariff carry through under an ad valorem tariff as well. Again, the only issue regards the incentive of firms to manipulate their transfer prices to reduce duty payments. As in the large literature on multinational firms—with the exception of those concerned specifically with transfer pricing—we sidestep this issue by considering that custom authorities are able to satisfactorily limit transfer price manipulation.

Now, with respect to organizational choice, there *is* a qualitative difference when the tariff is ad valorem, rather than specific. It arises in the integration decision when the specialized supplier is abroad. The reason is that, unlike the situation with specific tariffs, now tariff revenue depends on the mix of generic/customized inputs, since they command different prices. Specifically (and assuming transfer price manipulation issues do not arise, so that B and S^f trade at $\widetilde{p}^f$ regardless of integration), vertical integration is socially optimal in this case if and only if

$$\Delta\Omega^f \equiv U^f(i_v^f(t), t) - U^f(i_a^f(t), t) - (1+\tau)[(p^w - \widetilde{p}^f)(q_v^f(t) - q_a^f(t))] \geq K. \tag{36}$$

Since the expression in square brackets is strictly positive, a situation where $\Delta U^f \geq K > \Delta\Omega^f$ is possible, in which case B and S^f integrate when it is socially inefficient. Hence, with ad valorem tariffs there is a bias toward too much integration also under offshoring.[35]

Since the integration decision under onshoring is just as before, the analog of Proposition 5 under an ad valorem tariff is as follows.

Proposition 7 *Let any tariff be assessed on an ad valorem basis. Under free trade, the equilibrium ownership decision is socially efficient. For any $\tau > 0$, if the firms choose outsourcing over integration, it is the socially efficient ownership. If the firms integrate, it may be socially inefficient under either onshoring or offshoring.*

[35] If firms were more able to engage in transfer price manipulations when they are integrated than when they trade at arm's length, as it is likely to be the case, the size of the square bracket in (36) would be even larger. This would reinforce the bias toward too much integration.

On the other hand, the (in)efficiency of the supply decision is not fundamentally altered by the type of tariffs in use. Accordingly, Proposition 6 holds just as before.

5.2 Domestic Exporting Industry of Standardized Inputs

In the main text we consider that the Home country imports generic inputs in equilibrium. This is a natural assumption if we think of Home as a developed economy with a comparative advantage in relatively sophisticated products. We indicate in this subsection how relaxing that assumption would change our results.

Consider that the competitive domestic industry exports standardized inputs at the world price p^w. This becomes also the price the buyer needs to pay to acquire generic inputs, as the tariff becomes inconsequential for B's purchases of generic inputs. As a result, under domestic specialized sourcing the condition for privately efficient sourcing requires now that q^d satisfies

$$C_q^b(q^d, \iota) + C_q^d(q^d, i) = p^w. \tag{37}$$

It is clear from (37) that q^d will no longer be affected by the tariff. As a result, none of the investments will either.

By contrast, under foreign specialized sourcing the condition for privately efficient sourcing requires now that q^f satisfies

$$C_q^b(q^f, \iota) + C_q^f(q^f, i) = p^w - t. \tag{38}$$

Now, when B trades with S^f, the tariff affects his cost of specialized, but not of generic inputs. This is essentially the opposite case relative to that of domestic specialized sourcing and imported generic inputs. Thus, the results are also essentially opposite those of domestic specialized sourcing and imported generic inputs: now when B offshores under arm's length, a tariff *hurts* relationship-specific investments, aggravating hold-up problems. Hence an import *subsidy* would be called for in this case, provided it does not distort organizational choices.

The general message remains nevertheless the same as before: *a tariff helps to alleviate hold-up problems if it discriminates in favor of specialized input provision.* When Home imports generic inputs, an import tariff is beneficial (given organizational form) under domestic outsourcing because it discriminates in favor of specialized supply, but ineffective under foreign outsourcing, when it is incapable of discriminating between the two types of inputs. If instead Home exports generic inputs, the tariff is ineffective under domestic outsourcing (because it is incapable of discriminating between the two types of inputs) and worsens investment incentives under foreign outsourcing (because it discriminates against specialized supply). Regardless of the case, an import tariff always helps to ameliorate hold-up problems under domestic outsourcing *relative* to hold-up problems under foreign outsourcing.

One could also consider the role of export subsidies when Home exports generic inputs. Denote the (specific) subsidy by s. Under foreign specialized sourcing the condition for privately efficient sourcing would become

$$C_q^b(q^f, \iota) + C_q^f(q^f, i) = p^w + s.$$

It is straightforward to see that, for given organizational form, a strictly positive export subsidy would mitigate hold-up problems just as a tariff would if Home imported generic inputs and outsourced from S^d. Again, the general rule applies: policies that discriminate in favor of specialized outsourcing—as the export subsidy would in this context—help to alleviate hold-up problems.

6 Conclusion

Economists have long known that tariffs distort resource allocation by driving a wedge between the cost of imports and the cost of domestic alternatives. We show that the nature of these distortions can be far more subtle than standard trade theory implies.

First, tariff distortions can improve overall welfare if they help to economize on transactions costs stemming from incomplete contracts. In this sense, our analysis offers a lesson that applies regardless of how governments set trade policies. If protectionist policies are in place, motivated by reasons other than economic efficiency (e.g. politics), our results imply that they are likely to be less harmful (and perhaps even beneficial) from a social standpoint than current theories suggest—if applied on sectors where asset specificity and incomplete contracts are important, and specialized outsourcing is mainly from domestic firms.

Second, protection distorts organizational decisions. Government intervention drives a wedge between the private and the social value to domestic sourcing and to vertical integration. As a result, firms may inefficiently outsource domestically and have inefficiently large boundaries under protection. By contrast, trade unencumbered by tariffs induces firms to choose the "right" organizational form.

Our model allows us to uncover these novel implications of protectionist policies in a rather simple way. But inevitably, and as in most incomplete-contracts models, this requires some restrictions on the industrial organization of the buyer and suppliers. Relaxing those restrictions would affect some results. For example, if the downstream firm has market power in final-good sales, trade policy will affect both hold-up problems and final-good distortions. Hence, industry concentration could affect the extent to which differentiated-input product markets benefit or suffer from tariffs. If the downstream firm could simultaneously source from both foreign and domestic specialized suppliers, tariffs would worsen hold-up problems with foreign suppliers. In that case, the welfare effects of a domestic tariff would depend on the relative productivities of the suppliers.

Still, it should be clear that our main insights about how discriminatory policies affect the severity of hold-up problems and about how protection distorts organization decisions are not an artifact of our environment. In fact, as we point out throughout the text, relaxing many of our simplifying assumptions would have no impact on our fundamental findings. On the other hand, the parsimony of the model makes it amenable to several promising extensions, as we discuss below.

We identify welfare-maximizing tariffs for given organizational form, but do not characterize optimal trade policy when organizational form is endogenous. Acknowledging the endogeneity of organizational form is central if one wants to study optimal trade policy, as a government must recognize that a tariff may prompt inefficient organizations. This can be challenging. For example, under domestic specialized supply, optimal tariffs are positive under outsourcing, but they can trigger inefficient vertical integration. Hence, if integration is privately preferred under protection, the first-best combination of organizational form and trade policy may be impossible to achieve.

We consider that the Home country is small in world markets, unable to affect the world price of generic inputs. That assumption allows us to focus on the new implications of protection that we identify. But considering the case where Home is "large" could prove interesting, especially when specialized outsourcing is mainly domestic. In that case, a tariff would lower the world price of generic inputs, and this would reduce the tariff's impact on the outside option of the related parties. As a result, hold-up problems would not be helped as much. Thus, to mitigate hold-up problems to a certain extent, the government would have to raise the tariff by more than the current analysis suggests, with the resulting lower world price hurting the foreign exporters of generic inputs. This would suggest a greater need for international trade agreements than the standard view proposes (e.g. Bagwell and Staiger 1999), as a large country would seek to affect world prices not only to extract surplus from trade partners, but also to curb purely domestic inefficiencies.

One could extend our environment to study also *preferential* trade agreements, such as free trade areas (FTAs). Due to its discriminatory nature, an FTA could be particularly helpful in attenuating hold-up problems and raising welfare among countries that share a significant number of cross-border vertically related (but independent) firms. Intuitively, by favoring "inside" options relative to "outside" options, an FTA could yield *efficiency-enhancing* trade diversion. Intriguingly, multilateral liberalization would *not* help hold-up problems in this case, because it would remove the possibility of discriminatory tariffs. In this sense, regionalism could provide a benign alternative to multilateralism, helping to justify—although with an entirely different reasoning—the "natural trading partners" rationale for preferential liberalization (see e.g. Frankel 1997).

We do not explore varying levels of contract enforcement across countries either. This is potentially important. As Antràs and Helpman (2008) show, different levels of input contractibility can affect organizational form. Indeed, Nunn (2007) presents empirical evidence that the strength of contract enforcement helps to explain patterns of international trade in goods with differentiated intermediate inputs. Bernard, Jensen, Redding and Schott (2010) show further that the interaction between product contractibility and national levels of contract enforcement helps to explain different levels of intra-firm trade. Our framework offers the possibility to study whether contract enforcement and tariffs are strategic complements or substitutes, a topic that has received little attention. Intuitively, stronger contracts would weaken hold-up problems and the need for integration, favoring arm's-length trade and free trade. However, as we show, tariffs are useless if parties cannot enforce contracts and hold-up problems are extreme. As the strength of contract enforcement increases, this could enhance the role of tariffs in promoting relationship-specific investments. The efficacy of tariffs will, however, depend crucially on how damage remedies influence the way parties deal with contract breach.[36] We look forward to further progress in these areas.

7 Appendix A: Statistics on Imported Differentiated Inputs

We rely on 2002 input-output data for the United States archived by the Bureau of National Affairs. Total usage was \$8,508,135 million, of which \$1,390,380 million (16.3%) was imported. The BEA import tables (http://www.bea.gov/industry/io_benchmark.htm) include classification of imports by the 5- and 6-Digit North American Industrial Classification System (NAICS). Using a concordance constructed by Feenstra and Lipsey (http://www.nber.org/lipsey/sitc22naics97/) between the NAICS and the 4-digit Standard International Trade Classification (SITC) system (rev. 2), we classify the BEA data according to 4-digit SITC code.

In many instances, there are multiple potentially relevant SITC codes. The most common scenario occurs for goods classified in the BEA data by 6-digit NAICS code, a finer distinction than is typically made in the Feenstra-Lipsey concordance. In such cases, we capture all SITC 4-digit codes corresponding to the relevant 5-digit NAICS code in the Feenstra-Lipsey concordance. Another common scenario occurs when BEA classifies goods by 4-digit NAICS code, in which case multiple SITC codes correspond.

Rauch (1999) classifies goods, by 4-digit SITC code, according to whether they are traded on an organized exchange (w), listed with a reference price in a trade publication (r) or neither (n). He considers the latter category to be differentiated goods. In classifying imported inputs according to the Rauch distinctions, we denote goods with all SITC 4-digit codes in the "n" category as "pure

[36] For example, starting with Shavell (1980), several studies have shown that the "expectation damages" remedy produces outcomes different than the "reliance damages" remedy. This literature also shows that the possibility of renegotiation and the costliness of disputes are crucial.

differentiated," goods with all SITC 4-digit codes in the "r" and "w" categories as "pure non-differentiated," and all others as "mixed." We do this for both the conservative Rauch classification and the liberal Rauch classification, which treats more goods as non-differentiated.

Using a concordance between NAICS codes and end use categories published by the US Census (http://www.census.gov/foreign-trade/schedules/b/2008/imp-code.txt), we classify the BEA goods by end use category. In many instances, there are multiple end use categories for a given NAICS code. Feenstra and Jensen (2009) classify goods, by end use code, into four categories: (1) intermediate, (2) final, (3) intermediate-and-final, and (4) neither. Using their classification, we identify each BEA category as intermediate, final or both (we ignore goods in the "neither" category). For cases where a BEA category is linked to multiple end use categories, and the end use categories fall into both the intermediate and final classifications according to Feenstra and Jensen (2009), we record the category as intermediate-and-final.

About \$437 billion (31%) of imports cannot be classified along both the differentiation dimension and the intermediate/final dimensions. Of the remaining \$953 billion, roughly \$195 billion are intermediate goods, \$555 billion are intermediate-and-final goods and \$203 billion are final goods.

The statistics are presented in Table A1. Intermediate goods are less differentiated than final goods, but the overall share of differentiated inputs remains significant and in line with related estimates. Roughly 30% of the value of imported intermediate inputs comes from purely differentiated goods, while 58% is purely non-differentiated and 12% is mixed differentiated and non-differentiated. Hence, around 42% of intermediate inputs are either pure differentiated or mixed. This 42% total is unchanged when the "liberal" Rauch classification is used, though a higher share of goods are in the mixed category. By contrast, about 71% of the value of intermediate-and-final goods is purely differentiated, while 23% is mixed. Finally, over 99% of the value of imported final goods is differentiated, while none is purely non-differentiated.

8 Appendix B: Proofs

Proof of Proposition 1. If $\alpha = 0$, it follows directly from (13) that S^d's investment is worthless for S^d, and therefore $i_a^d = 0$. Otherwise, $i_a^d > 0$ because $I'(0) = 0$, and i_a^d satisfies (15). As α rises, the convexity of Γ^d ensures that i_a^d increases. Similarly, if $\alpha = 1$, it follows from (14) that B's investment is worthless for B, and therefore $\iota_a^d = 0$. Otherwise, $\iota_a^d > 0$ because $I'(0) = 0$, and ι_a^d satisfies (16). As α falls, the convexity of Γ^b ensures that ι_a^d increases.

Both investments also increase with the tariff whenever $\alpha \in (0, 1)$:

$$\frac{di_a^d}{dt} = \frac{\alpha C_{qi}^d / \left(C_{qq}^d + C_{qq}^b\right)}{SONC^d} > 0 \text{ and} \tag{39}$$

$$\frac{d\iota_a^d}{dt} = \frac{(1-\alpha) C_{qi}^b / \left(C_{qq}^d + C_{qq}^b\right)}{SONC^b} > 0, \tag{40}$$

where we use the fact that $\partial q^d / \partial t = 1/\left(C_{qq}^d + C_{qq}^b\right)$, which follows from the definition of q^d in (3), and where $SONC_s^d$ and $SONC_s^d$ are defined in footnote 18.

Finally, from the first-order conditions that define i_{fb}^d and i_a^d (equations (8) and (15), respectively), it is clear that $i_a^d < i_{fb}^d$ under free trade whenever $\alpha > 0$. As t rises, i_{fb}^d remains constant (a consequence of C_{iq}^d being constant) while we have just showed that i_a^d increases. Using (8) we have that, when the tariff is set at t', where

$$t' \equiv \frac{(1-\alpha)C_i^d\left(C_{qq}^d + C_{qq}^b\right)}{C_{iq}^d}$$

and all functions are evaluated at $\{i_{fb}^d, \iota_{fb}^d\}$, i_{fb}^d satisfies

$$-C_i^d(q^d, i_{fb}^d) = I'(i_{fb}^d) + \frac{(1-\alpha)C_i^d(q^d, i_{fb}^d)\left[C_{qq}^d(q^d, i_{fb}^d) + C_{qq}^b(q^d, \iota_{fb}^d)\right]}{C_{iq}^d(q^d, i_{fb}^d)}\frac{dq^d}{di}.$$

Since $\frac{dq^d}{di} = -\frac{C_{iq}^d}{C_{qq}^d + C_{qq}^b}$, this expression reduces to (15), implying $i_a^d = i_{fb}^d$. For any tariff above t', $i_a^d > i_{fb}^d$. An analogous reasoning applies to the comparison between ι_a^d and ι_{fb}^d, and the tariff level that equalizes them can be obtained accordingly. ■

Proof of Proposition 2. The proof of the statements in the first three sentences of the proposition is entirely analogous to the proof of Proposition 1. To see that i_a^f and ι_a^f are independent of the tariff, notice that, by (4), q^f is unaffected by the tariff. It then follows from (20) that i_a^f and ι_a^f are also unaffected by the tariff. ■

Proof of Proposition 3. Using (15) and (16), we can write the effect of a marginal increase in the tariff on social welfare as

$$\frac{d\Omega^d(i_a^d(t), \iota_a^d(t), t)}{dt} = t\frac{dM_a^d(t)}{dt} - \frac{di_a^d(t)}{dt}(1-\alpha)C_i^d(q_a^d, i_a^d(t)) - \frac{d\iota_a^d(t)}{dt}\alpha C_\iota^b(q_a^d, \iota_a^d(t)). \tag{41}$$

Suppose that $\alpha \in (0,1)$. Then, both the second and the third terms of (41) are strictly positive, because $\frac{di_a^d}{dt} > 0$, $\frac{d\iota_a^d}{dt} > 0$, $C_i^d < 0$ and $C_\iota^b < 0$. Hence, $\frac{d\Omega^d}{dt} > 0$ if the first term is non-negative. Since $\frac{dM_a^d(t)}{dt} < 0$, that term is nonnegative for any $t \le 0$. Thus it cannot be true that $t_a^d \le 0$. Hence $t_a^d > 0$. Next suppose that $\alpha = 0$. The third term of (41) vanishes. By Proposition 1, $\frac{di_a^d(t)}{dt}(\alpha = 0) = 0$, so (41) collapses to $t\frac{dM_a^d(t)}{dt}$. Since $\frac{dM_a^d(t)}{dt} < 0$, we must have $t_a^d = 0$. If $\alpha = 1$, the second term of (41) vanishes. By Proposition 1, $\frac{d\iota_a^d(t)}{dt}(\alpha = 1) = 0$, so once again $\frac{d\Omega^d(i_a^d(t,0),t)}{dt} = t\frac{dM_a^d(t)}{dt}$, implying $t_a^d = 0$. ■

Proof of Proposition 4. Developing expression (24) and equating it to zero, one finds (dropping the arguments of all functions for brevity)

$$t\left(\frac{1}{V''} - \frac{\partial q^d}{\partial t}\right) - \left\{\frac{di_a^d}{dt}\left[C_i^d + I' + t\frac{dq^d}{di}\right] + \frac{d\iota_a^d}{dt}\left[C_\iota^b + I' + t\frac{dq^d}{d\iota}\right]\right\} = 0.$$

Since $\left(\frac{1}{V''} - \frac{\partial q^d}{\partial t}\right) < 0$, when $t > 0$ the expression in curly brackets must be negative. But we know that $\frac{di_a^d}{dt}, \frac{d\iota_a^d}{dt} > 0$, so at least one of the expressions in square brackets must be strictly negative. When investments are at the first-best, those expressions collapse to zero (see equations 8 and 9). Hence, at t_a^d we must have $i_a^d(t_a^d) < i_{fb}^d$ and/or $\iota_a^d(t_a^d) < \iota_{fb}^d$. ■

Proof of Proposition 5. If $t = 0$, there is no difference between the private and social gains to vertical integration, given respectively by expressions (30) and (31), so the equilibrium ownership decision is clearly efficient.

Now, while the right-hand sides of (30) and (31) are identical, the left-hand side of (30) is greater than the left-hand side of (31) whenever $M_a^j(t) > M_v^j(t)$. Under offshore supply, $M_v^f(t) = M_a^f(t)$

because all specialized inputs are imported regardless of whether the firms integrate, and the increase of specialized inputs traded under integration is exactly compensated by a decrease in the purchases of imported generic inputs. Hence, there is no difference between (30) and (31) in that case. Under onshore supply, $i_v^d > i_a^d$ and/or $\iota_v^d > \iota_a^d$ imply $C_q^d(i_v^d) + C_q^b(\iota_v^d) < C_q^d(i_a^d) + C_q^b(\iota_a^d)$, which in turn implies $M_a^d(t) > M_v^d(t)$. Hence, if condition (31) is satisfied, condition (30) is satisfied as well for any $t \geq 0$. On the other hand, if $t > 0$ there could be situations where

$$U^d(i_v^d(t), \iota_v^d(t), t) - U^d(i_a^d(t), \iota_a^d(t), t) \geq K > U^d(i_v^d(t), \iota_v^d(t), t) - U^d(i_a^d(t), \iota_a^d(t), t) - t\left[M_a^d(t) - M_v^d(t)\right],$$

in which case B and S^d integrate even though vertical integration is not socially optimal. ■

Proof of Proposition 6. If $t = 0$, there is no difference between private and social gains to offshoring, given by expressions (32) and (33), so the equilibrium supply decision is clearly efficient.

Now, whereas the right-hand sides of (33) and (32) are both zero, the left-hand side of (33) is smaller than the left-hand side of (32), since imports are obviously higher when B sources specialized inputs from the foreign supplier. Hence, if condition (33) is satisfied, condition (32) is satisfied as well for any $t \geq 0$. On the other hand, if $t > 0$ there are situations where

$$U^d(i_k^d(t), \iota_k^d(t), t) - U^f(i_k^f, \iota_k^f, t) \geq 0 > U^d(i_k^d(t), \iota_k^d(t), t) - U^f(i_k^f, \iota_k^f, t) - t\left[M_k^f(t) - M_k^d(t)\right],$$

in which case B sources domestically even though offshoring would be socially optimal. ■

Proof of Corollary 1. Part a) follows from (28). Part b) follows from (28) and propositions 5 and 6. If foreign supply is initially chosen, the tariff does not affect the integration decision. Since a fall in the tariff makes foreign supply more appealing, no organizational change will occur. By (28), welfare rises as the tariff falls. If domestic integration is initially chosen, then a change in suppliers due to falling tariffs is clearly efficiency enhancing by Proposition 5. If a drop in the tariff leads to domestic outsourcing, then it is also efficiency enhancing by Proposition 5. Part c) is shown by noting that, on one hand, a falling tariff lowers social welfare conditional on domestic outsourcing by (28). However, a change from domestic outsourcing to foreign outsourcing would, in and of itself, enhance efficiency by Proposition 6. Hence, welfare could either rise or fall as the tariff falls. ■

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