Offshoring and the Role of Trade Agreements[†]

By Pol Antràs and Robert W. Staiger*

The rise of offshoring of intermediate inputs raises important questions for commercial policy. Do the distinguishing features of offshoring introduce novel reasons for trade policy intervention? Does offshoring create new problems of global policy cooperation whose solutions require international agreements with novel features? In this paper we provide answers to these questions, and thereby initiate the study of trade agreements in the presence of offshoring. We argue that the rise of offshoring will make it increasingly difficult for governments to rely on traditional GATT/WTO concepts and rules—such as market access, reciprocity and non-discrimination—to solve their trade-related problems. (JEL F12, F13, L24)

International trade in intermediate inputs is a prominent feature of the world economy. Using input-output and bilateral trade data for 87 countries and regions, Johnson and Noguera (2012) conclude that, in 2001, imports of intermediate goods comprised as much as two-thirds of total merchandise imports for a large number of OECD countries. Moreover, several authors have noted that, as a share of world trade, intermediate inputs appear to have increased significantly in recent years. This surge in the importance of input trade seems to have been accompanied by a parallel increase in the share of differentiated products in the total volume of world trade, and an associated fall in the share of homogeneous goods (as measured by the share of goods traded on organized exchanges). Although part of this trend is explained by the changing nature of final good trade, a significant portion of it reflects a disproportionate increase in world trade in differentiated intermediate inputs. For instance, applying the methodology suggested by Schott (2004) to identify international trade in intermediate goods and using the "liberal" classification of Rauch (1999) to distinguish between differentiated and homogeneous goods, one finds that the share of differentiated inputs in world trade more than

doubled between 1962 and 2000 while the share of homogeneous goods was cut in half over the same period.[1]

Recent developments in international trade theory have attempted to bridge the apparent gap between the characteristics of international trade in the data and the standard representation of these trade flows in terms of homogeneous final goods in neoclassical trade theory. One branch of this new literature has focused on incorporating input trade in otherwise standard models with homogeneous goods, perfectly competitive markets and frictionless contracting.[2] Another branch of the literature has emphasized that modeling "offshoring" as simply an increase in the fragmentation of production across countries misses important characteristics of intermediate input trade.[3] Prominent among these characteristics is that intermediate input purchases tend to be associated with significant lock-in effects for both buyers and sellers. For example, differentiated intermediate inputs are frequently customized to the needs of their intended buyers and hence embody a disproportionate amount of relationship-specific investments, which may be hard to recoup when transacting with alternative parties. Moreover, offshoring often involves the costly search for suitable foreign suppliers or foreign buyers, which makes separations costly and thereby provides another source of lock in. Because contracts involving international transactions are especially hard to enforce, the cross-border exchange of intermediate inputs cannot generally be governed by the same contractual safeguards that typically accompany similar exchanges occurring within borders. As a consequence, these lock-in effects naturally result in international terms of trade between buyers and sellers that are determined by bilateral negotiations, and that are therefore not (fully) disciplined by market-clearing considerations. Though other factors might have contributed to it, we view the recent increase in the importance in world trade of differentiated intermediate inputs (and the associated fall in trade of homogenous goods) as a manifestation of the quantitative importance of these distinctive features of offshoring. The recent empirical studies of Feenstra and Hanson (2005), Yeaple (2006), Levchenko (2007), Nunn (2007), and Nunn and Trefler (2008) also substantiate this claim.

The rise of offshoring raises important questions for commercial policy. Do the distinguishing features of offshoring introduce novel reasons for trade policy intervention? Does offshoring create new problems of global policy cooperation motivating international agreements with novel features? Can trade agreements that are designed to address problems that arise when trade is predominantly in final goods still perform in a world where offshoring is prevalent? In this paper we provide answers to these questions, and thereby initiate the study of trade agreements in the presence of offshoring. We highlight the implications of offshoring associated with

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[1] Specifically, the share of homogeneous goods trade in total trade fell from 33.86 percent in 1962 to 16.46 percent in 2000. And trade in differentiated inputs increased from 10.56 percent to 24.85 percent of world trade over the same period, though these shares understate the importance of differentiated-input trade because Schott's (2004) approach identifies as inputs only those goods for which import product codes explicitly contain the words "parts" or "components." We have computed these shares combining Schott's input data and Rauch's "liberal" classification of differentiated goods, and have used in the process a concordance table available on Jon Haveman's website.

[2] See for instance Feenstra and Hanson (1996); Jones (2000); Deardorff (2001); Antràs, Garicano, and Rossi-Hansberg (2006); or Grossman and Rossi-Hansberg (2008). Antràs and Rossi-Hansberg (2009) review this literature.

[3] Theoretical developments include the work of McLaren (2000); Grossman and Helpman (2002, 2005); Antràs (2003, 2005); and Antràs and Helpman (2004). See Helpman (2006) and Antràs and Rossi-Hansberg (2009) for surveys of this literature.

lock in, and we suggest that the implied relaxation of market-clearing discipline on the international terms of trade between buyers and sellers could have profound impacts on the purpose and design of trade agreements.

We adopt the simplest setting that can capture the main features of offshoring that we wish to study, and then later show that our main points are robust to a variety of generalizations. We consider two "small" countries, Home and Foreign, who face a fixed world price for a single homogeneous final good. Production of the final good requires a customized input; all final good producers are located in Home; and all input suppliers are located in Foreign. Contracts between suppliers and producers are incomplete, and so the terms of trade between input suppliers and final good producers are determined by bargaining ex post (after investment in input supply has already been determined). As is evident, for the most part, we illustrate the emergence of a lock-in effect by appealing to customization of inputs. We will demonstrate, however, that our model can be interpreted as a reduced form of a dynamic model where this lock-in effect stems from search frictions even when inputs are not customized.

From this starting point, we investigate the role of trade policies. We assume that each country can apply taxes/subsidies to trade in the input and/or the final good. We abstract initially from political economy concerns, and take real aggregate income as our measure of national and world welfare. We first consider the case for free trade in this environment. As might be expected, with relationship-specific investments creating lock-in effects and with contracts between buyers and producers being incomplete, an international hold-up problem arises, and this leads to an inefficiently low volume of input trade across countries under free trade. It is therefore natural that an activist role for trade policy exists in our model, because trade policies which encourage input trade volume can substitute for the more standard contractual safeguards available in domestic transactions and can thereby help bring countries closer to the efficiency frontier. In fact we show that an appropriate choice of input trade subsidies, combined with free trade in final goods, can fully resolve the international hold-up problem and allow countries to attain the first-best. Importantly, though, the mechanism by which trade policies affect input trade volumes in this environment is by altering the conditions of ex post *bargaining* between foreign suppliers and domestic producers, not by shifts in foreign export supply and/or domestic import demand mediated through international market-clearing conditions as is standard in the commercial policy literature.

We next ask whether the Nash equilibrium policy choices of governments coincide with the internationally efficient policies (i.e., those that maximize world aggregate income). We find that they do not, and we identify two dimensions of international inefficiency that arise under Nash policies. A first dimension is an inefficiently low input trade volume. Intuitively, trade policy serves a dual role in this environment. On the one hand, as indicated above, subsidies to the exchange of intermediate inputs can serve as a substitute for more standard contractual safeguards available in domestic transactions and can thus increase the volume of input trade toward its efficient level. On the other hand, input trade taxes can be used to redistribute surplus across countries, thereby shifting some of the cost of intervention on to trading partners. For instance, although an export tax may reduce the incentive of foreign suppliers to invest, these suppliers will be able to pass part of the cost of the tax on to

Home final-good producers in their ex post bargaining. Moreover, we show that the home government will also distort trade in the *final* good away from its free-trade level in order to reduce the domestic final good price and further shift bargaining surplus from foreign input suppliers to home final good producers. This leads to the second dimension of international efficiency that arises under Nash policies: an inefficiently low final good price in the home market.

When we introduce the possibility that governments are motivated in part by political economy/redistributive concerns, we find that such motives can have significant effects on the level and even the sign of equilibrium policies, but we confirm that the implications of offshoring for the comparison between Nash and efficient trade policies as described above is preserved. More specifically, we establish that sufficiently politically motivated governments will adopt import tariffs and export subsidies in the Nash equilibrium, but we show that Nash policies still imply inefficiently low input trade volume and an inefficiently low price of the final good in the home market.

We then turn to the role of trade agreements in this setting. Since its creation in 1947, a defining feature of the General Agreement on Tariffs and Trade (GATT) and now its successor, the World Trade Organization (WTO), has been an emphasis on "shallow integration" as embodied in the market access commitments that governments negotiate through the exchange of tariff concessions. We show, however, that in the presence of offshoring it is necessary to achieve "deep integration"—extending beyond a narrow market-access focus in ways that we formalize below—in order to arrive at internationally efficient policies. In effect, deep integration is required in the presence of offshoring because, as we have described above, the inefficiencies associated with Nash policy choices extend beyond the low-trade-volume problem that an exchange of market access might reasonably address. When combined with the insights from the "terms-of-trade" theory of trade agreements, which is a theory developed from the standard commercial-policy perspective that international prices are determined through market clearing conditions and which has been shown by Bagwell and Staiger (1999, 2001a, 2002) to provide strong support for the market-access focus of the GATT/WTO, our findings indicate that the rise in offshoring and its implication for international price determination is likely to erode the effectiveness of the traditional market-access focus of the GATT/WTO.[4]

We also find that the nature of the underlying problem for a trade agreement to solve in the presence of offshoring varies with the preferences of member governments. More specifically, we show that this problem can be given an international cost-shifting/terms-of-trade manipulation interpretation along the lines of the terms-of-trade theory when governments seek only to maximize real national income with their trade policy choices, but that when governments have political economy motives and seek to use trade policies for purposes of redistribution there arises an additional problem in the presence of offshoring with which a trade agreement must contend. In effect, as we demonstrate, in the presence of offshoring

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[4] In this regard, the statements in a recent speech by WTO Director General Pascal Lamy seem relevant: "…we have not yet figured out how to deal with the interdependent world economy we have created. This [GATT] system was initially designed to tackle problems specific to the mid-twentieth century… The basic architecture of the system reflected its origins in an Atlantic-centric world of shallow integration. The question now is what is needed to manage a globalized world of deep integration…" Lamy (2010). Our result suggests that the rise of offshoring could be an important force in generating the WTO's efforts to evolve in this manner.

a trading partner's policies can help provide a more efficient means of redistributing income toward specific groups in a country than can be achieved with that country's own policies alone; and when governments value this redistribution, the need for additional international policy coordination beyond that required to eliminate terms-of-trade manipulation is then implied. This finding contrasts sharply with the predictions of the terms-of-trade theory, where Bagwell and Staiger (1999, 2002) find that the presence of political economy motives has no impact on the nature of the problem that a trade agreement must solve. And as Bagwell and Staiger establish, their finding implies that the GATT/WTO pillars of reciprocity and non-discrimination can be interpreted as simple rules that, under a broad range of possible political economy motives, work to eliminate international cost-shifting and help governments achieve efficient policies through negotiation. Our findings here thus indicate that the rise in offshoring, and its implications for international price determination, is likely to diminish the effectiveness of the pillars of the GATT/WTO architecture.

Taken together and viewed in light of the contrasting results from the terms-of-trade theory, our findings therefore suggest that as the prevalence of offshoring rises, effective trade agreements and the institutions that support them will have to evolve, from a market access focus toward a focus on deep integration, and from a reliance on simple and broadly-applied rules, such as reciprocity and non-discrimination that guide the member-governments in their negotiations and shape their agreements, toward a collection of more-individualized agreements that can better reflect member-specific idiosyncratic needs. From this perspective, the rise of offshoring can be seen to present the WTO with a profound institutional challenge.

As an illustration of the potential empirical relevance of our results, Figure 1 provides suggestive evidence that the outcomes of tariff negotiations in the WTO can depend crucially on the type of good over which the negotiations occur. Specifically, for a sample of 16 countries that joined the WTO after its creation in 1995, Figure 1 shows that tariff concessions were markedly greater in sectors with low levels of input customization—which we measure, following Nunn (2007), as the share of an industry's inputs not traded in organized exchanges—than in sectors with high levels of input customization.[5] While only suggestive, the pattern displayed in Figure 1 points to the possibility that countries have more difficulty liberalizing trade through WTO negotiations in sectors where customized inputs are especially prevalent, broadly in line with our message above.[6]

Our paper is related to several literatures. First, as emphasized above, by exploring the role of trade agreements in a model with intermediate input trade and in an environment with relationship-specific investments and incomplete contracting, we

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[5] Figure 1 is constructed using the same data and methodology as Figure 1 in Bagwell and Staiger (2011) (see that paper for details). Nunn's (2007) input contractibility measure was merged into the dataset using a concordance available from the BEA website, http://www.bea.gov/industry/xls/HSConcord.xls. Nunn (2007) also proposes an alternative measure that treats goods referenced in trade publications as homogenous goods. With that alternative measure, the relationship between tariff concessions and the degree of input customization is less clear-cut.

[6] This possibility is reinforced from a different angle by the empirical results of Orefice and Rocha (2011). They find that the importance of trade in parts and components between two countries as a share of their total trade is a significant predictor that the two countries will sign a "deep" preferential agreement containing provisions of a domestic regulatory nature. As we discuss further in the conclusion, such findings suggest that WTO-member governments whose countries have experienced significant increases in offshoring may see preferential agreements as a way to achieve the deep integration and idiosyncratic bargains that WTO commitments in their current form can not adequately provide.
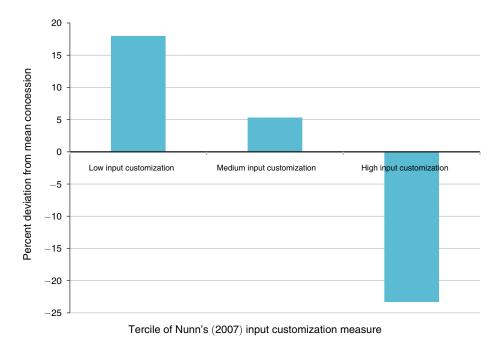
FIGURE 1. PERCENT DEVIATION FROM MEAN CONCESSION BY TERCILE OF INPUT CUSTOMIZATION MEASURE

complement and extend an established literature on international trade agreements (see Bagwell and Staiger 2010, for a recent review). In suggesting a novel rationale for trade agreements, our paper also complements the recent papers of Ossa (2011) and Mrázová (2009). Second, by considering endogenous trade policy choices in this environment, we complement and extend a recent literature that has begun to study the impacts of (exogenous) tariffs on international hold-up problems. Ornelas and Turner (2008a) develop a model in which import tariffs on intermediate inputs are shown to aggravate the hold-up problem in international vertical relationships, with the implication that trade liberalization may lead to a larger increase in trade flows than in standard models. Ornelas and Turner do not, however, study optimal trade policies or the possibility of trade agreements in their framework.[7,8] McLaren (1997) studies the desirability of announcing a future trade liberalization in a model where producers incur sunk costs to service foreign markets, but his framework emphasizes commitment problems from which we completely abstract.[9]

Finally, while the broad conclusions we emphasize above do not require that bilateral bargaining over price necessarily leads to a hold-up problem, we choose to derive our results in a setting where the international hold-up problem would arise in the absence of government intervention. In this regard there is a large literature proposing

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[7] The independent paper of Ornelas and Turner (2008b) does begin to explore the welfare implications of tariffs in this kind of environment, but they do not consider the role of trade agreements.

[8] Similarly, Antràs and Helpman (2004) and Díez (2008) study the effect of trade frictions on the choice of organizational form of firms contemplating offshoring, but they also treat trade frictions as exogenous.

[9] Yarbrough and Yarbrough (1992) also emphasize commitment problems associated with trade relationships that involve substantial relationship- (or market-) specific investments, but they focus on how these issues affect the choice between unilateral liberalization, bilateral agreements, and multilateral agreements.

a variety of mechanism-design resolutions to the hold-up inefficiencies caused by incomplete contracts. These resolutions, however, generally rely on the ability of parties to commit not to renegotiate an initial contract and also on the existence of a third party that can enforce off-the-equilibrium-path penalties.[10] We view our international context as one in which these alternative resolutions of the hold-up problem are naturally more problematic, and thus trade taxes and subsidies may be particularly useful in resolving these inefficiencies. For this same reason, we find it natural to simplify our model in a way that downplays sources of domestic hold-up inefficiencies.[11]

The rest of the paper is organized as follows. In Section I, we develop a Benchmark Model of offshoring. In Section II, we consider Nash equilibrium policy choices when governments maximize national income and show that Nash policies are inefficient. Section III extends the analysis of the Benchmark Model to include political economy motives. In Section IV, we explore the role and design of trade agreements in this setting. Section V considers a variety of further extensions of the model. We offer some concluding remarks in Section VI.

I. The Benchmark Model

We begin this section by describing a benchmark two-small-country trade model in which final good producers in the home country import inputs from suppliers in the foreign country. We refer to this model as the *Benchmark Model*. While simple and special along a number of dimensions, the Benchmark Model is meant to highlight the essential features of international price determination in the presence of offshoring and the basic international hold-up problem which arises under free trade. After presenting the setup and characterizing the free-trade equilibrium, we derive the (constrained efficient) trade policies that maximize world welfare.

A. *Setup*

We consider a world of two small countries, Home (H) and Foreign (F), and a large rest-of-world whose only role in the model is to fix the price at which a final good 1 is available to H and F on world markets (the direction of trade in good 1 is not specified and is immaterial). Consumer preferences are identical in H and F and given by

$$(1) \qquad\qquad U^j \,=\, c_0^j \,+\, u(c_1^j),$$

where c_i^j is consumption of good $i \in \{0, 1\}$ in country $j \in \{H, F\}$, and where $u' > 0$ and $u'' < 0$. Good 0, which we take to be the numeraire, is assumed to be costlessly traded and available in sufficient quantities that it is always consumed in positive amounts in both H and F. Good 1 is produced with a customized intermediate input x according to the production function $y(x)$, with $y(0) = 0$, $y'(x) > 0$, $y''(x) < 0$, $\lim_{x\to 0} y'(x) = +\infty$, and $\lim_{x\to\infty} y'(x) = 0$. By choice of units for measuring the quantity of good 1, we set its (fixed) price on world markets equal to 1. For now we

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[10] Bolton and Dewatripont (2005, chapter 12) review the insights and limitations of this literature.

[11] In related work, Rosenkranz and Schmitz (2007) show that, in a closed economy setup, a government can use taxation to alleviate the hold-up problem between domestic buyers and sellers.

assume that trade in good 1 is free, so that its price is equal to 1 everywhere in the world. Notice that the concavity of $y(x)$ implies $y(x)/x > y'(x)$ for $x > 0$.[12]

We suppose that the home country H is inhabited by a unit measure of producers of the final good 1, while the foreign country F is inhabited by a unit measure of suppliers of the intermediate input x. Hence, to produce the final good 1, producers in H must import inputs from suppliers in F. Suppliers in F tailor their inputs specifically to the needs of a final good producer in H and, for simplicity, these inputs are assumed to be useless to alternative final good producers. We assume that the marginal cost of input production in F (measured in terms of the numeraire) is constant and, through choice of the units in which inputs are measured, we normalize it to 1. For now, we also assume that trade in x is free.

We next turn to focus on the nature of the bilateral relationship between a final good producer in H and an input supplier in F, which comprises the essence of the model. We adopt a setting of incomplete contracts between final good producers and input suppliers, where no (enforceable) contracts can be signed between suppliers and producers prior to the initial supplier investment decisions.[13] Without an initial contract, the price at which each supplier in F sells its inputs to a producer in H is then decided ex post through (Nash) bargaining.

We now describe the structure of the bilateral producer-supplier relationship in detail. We assume that all agents have an ex ante zero outside option. The sequence of events is as follows:

Stage 1: The unit measure of producers in H and suppliers in F are randomly matched, producing a unit measure of matches. Each agent decides whether to stay with his match or exit the market. In the former case, the producer provides the supplier with a list of customized input specifications. In the latter case, each agent obtains his ex ante outside option (equal to zero).

Stage 2: Each supplier decides on the amount x of customized input to be produced (at marginal cost of 1).

Stage 3: Each producer-supplier pair bargains over the price of the intermediate input. We consider the generalized Nash bargaining solution with weights α and $1 - \alpha$ for the home producer and foreign supplier, respectively, where $\alpha \in (0, 1)$.

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[12] In order to ensure that the second-order conditions are met, we will later impose additional assumptions on $y(x)$.

[13] In our Benchmark Model, contractual incompleteness can be rationalized in the following simple way. Following Grossman and Helpman (2002) and Antràs (2003), we suppose that when investing in the supply of x, the supplier can choose between manufacturing a high-quality or a low-quality input, and the latter can be produced at lower cost but is useless to final good producers. The quantity of x is observable to everyone and therefore verifiable by third-parties, but we assume that the quality of x is only observable to the supplier and producer in the particular bilateral relationship, and so quality-contingent contracts are not available. Although parties could still sign a contract specifying a price and a quantity, if they did so, the supplier would always have an incentive to produce the low quality input (at lower cost) and still receive the same contractually stipulated price. Hence, in this environment ex ante contracting does not occur, and prices will be determined ex post (through bargaining) once quality has been chosen. Because parties have symmetric information at the bargaining stage, ex post efficiency ensures that low-quality production will never be chosen by an input supplier in equilibrium, and so only high-quality inputs are produced: as a result, the input-quality dimension of the model can be kept in the background, and it does not factor in to our discussion in the text.

Stage 4: Each producer in *H* imports *x* from its partner-supplier and produces the final good with the acquired *x*, and payments agreed in *stage* 3 are settled.

This 4-stage game features international prices that are determined by bilateral bargaining between foreign suppliers and domestic buyers and generates a simple hold-up problem that provides the starting point for our analysis. A number of dimensions of this setup are worth noting at this point.

First, we rule out the use of ex ante (*stage*-1) lump-sum transfers between producers and suppliers. The feasibility of these transfers is particularly hard to defend in the international context that we study, where such transfers and the obligations associated with them might be difficult to enforce. In Section V, however, we show that our main results are robust to allowing for these transfers. Second, we assume a frictionless matching process in *stage* 1 to keep our Benchmark Model simple: in Section V we introduce (ex ante) search frictions. Third, the role of the specificity of input *x* is to pin down the outside options of the producer and the supplier should their *stage*-3 bargaining breakdown. In our Benchmark Model we take an extreme view of the degree of specificity, so that the breakup of a bargaining pair in *stage* 3 would result in a zero outside option for both producer and supplier. We also relax this assumption in Section V, where we introduce a secondary market for inputs. As argued in the introduction, we could altogether dispense with the assumption of specificity of inputs by introducing (ex post) search frictions, which would again drive a wedge between the value of remaining in a match and the value of dissolving that match. In fact, our Benchmark Model is isomorphic to a model with extreme (ex post) search frictions, in which a separation implies that each party finds an alternative trading partner with probability 0. Our less extreme framework in Section V is isomorphic to a model with less extreme search frictions. Finally, our model also assumes that all suppliers are located in Foreign, and that the hold-up problem is one-sided. These assumptions will also be relaxed in Section V.

Having discussed our model assumptions, we note that production efficiency requires that the customized input is produced at a level x^E which satisfies

$$(2) \qquad\qquad\qquad y'\!\left(x^E\right) \,=\, 1,$$

and thereby equates the marginal revenue generated from an additional unit of the input (recall that the price of the final good is fixed by world markets and equal to 1 under free trade) with the marginal cost of producing an additional unit of the input (which is constant and normalized to 1).

B. *Free Trade Equilibrium*

We now characterize the subgame perfect equilibrium of the 4-stage game described above. The characterization follows very simply from a few key observations. We consider a representative producer in *H* and supplier in *F* that are matched in *stage* 1.

First, if the producer uses the supplier's input to produce the final good in *stage* 4, its revenue is given by $y(x)$. Second, as observed in Section IA, the outside options of both the producer and the supplier in their *stage*-3 Nash bargain are 0, and hence the quasi-rents over which the producer and supplier bargain in *stage* 3 are $y(x)$

(recall that the cost of producing x is sunk at this point). Therefore, in the Nash bargain of *stage* 3, the final good producer in H obtains a payoff equal to $\alpha y(x)$ and the input supplier in F is left with a payoff of $(1 - \alpha) y(x)$.

Next, rolling back to *stage* 2, observe that the input supplier chooses x to maximize $(1 - \alpha) y(x) - x$, so the optimal quantity $\hat{x}$ of input satisfies

$$(3) \qquad\qquad (1 - \alpha) y'(\hat{x}) = 1.$$

Given the concavity of $y(x)$, it is clear from a comparison of (3) with (2) that $\hat{x} < x^E$ as long as $\alpha > 0$. This is the under-investment associated with the hold-up problem, and it reflects the fact that the producer and supplier bargain over the price of the input *after* the supplier has already sunk investment in input supply. Only if the supplier were to have full bargaining power ($\alpha \to 0$) would the hold-up inefficiencies disappear.

Finally, consider *stage* 1. If the producer hands the supplier a list of customized input specifications, the producer anticipates obtaining a payoff equal to $\pi^H = \alpha y(\hat{x})$, which exceeds the payoff he would obtain by not providing the specifications (recall that the ex ante outside option of producers is equal to 0). Similarly, by agreeing to form a partnership with the home producer, the supplier anticipates obtaining a payoff of $\pi^F = (1 - \alpha) y(\hat{x}) - \hat{x}$, which also exceeds his ex ante outside option.[14] In sum, no separations will occur at *stage* 1. Note also that the sum of payoffs of the two parties is equal to $y(\hat{x}) - \hat{x}$, which is strictly less than the sum of payoffs that would obtain when investment is chosen at the efficient level x^E defined by (2).

Now consider the measure of social welfare in each country implied by our Benchmark Model. With our assumption of quasilinear preferences, this measure is given by consumer surplus plus profits plus trade tax revenue (the latter being zero under free trade).[15] Using (1), we have that country j's demand for good 1 is given by $D_1(p_1^j) \equiv u'^{-1}(p_1^j)$, with consumer surplus then defined as $CS^j(p_1^j) \equiv \int_{p_1^j}^{\bar{p}} D_1(p) dp$ where $\bar{p}$ is the "choke" price (if any) for country j's demand of good 1. World aggregate welfare under free trade may then be represented by

$$W^W = W^H + W^F = CS^H(1) + CS^F(1) + \pi^H + \pi^F$$

$$= CS^H(1) + CS^F(1) + y(\hat{x}) - \hat{x},$$

which is strictly lower than world welfare in the presence of production efficiency because $y(\hat{x}) - \hat{x} < y(x^E) - x^E$. We summarize this discussion with:

PROPOSITION 1: *In the Benchmark Model, a hold-up problem exists under free trade, leading to an inefficiently low volume of input trade* $(\hat{x} < x^E)$.

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[14] Given (3) and the concavity of $y(x)$, we have $(1 - \alpha) y(\hat{x}) - \hat{x} \geq (1 - \alpha) \hat{x} y'(\hat{x}) - \hat{x} = 0$.

[15] Strictly speaking, social welfare should also include a term related to income earned by other factors of production (say labor) in the economy. But it is straightforward to close the model in a way that makes this term independent of policies in sector 1 (see, for instance, Grossman and Helpman 1994), so we simply ignore it henceforth.

Proposition 1 records the existence of a basic international hold-up problem that arises in the presence of free trade. Intuitively, the combination of incomplete contracting and input customization gives rise to bilateral exchanges that are not fully disciplined by market-wide-clearing prices and partly reflect the characteristics of the agents engaged in the relationship, such as their relative bargaining power. In particular, with free trade, foreign suppliers end up selling their input at a price equal to $(1 - \alpha) y(\hat{x})/\hat{x}$. This ex post haggling over prices leads suppliers to capture only a fraction of the return to their investments, and naturally we have that $\hat{x} < x^E$.

At this point, there are a variety of mechanism-design resolutions to the hold-up inefficiencies caused by incomplete contracts that we might consider. However, as we discussed in the introduction, we view our international context as one in which these mechanism-design resolutions are naturally more problematic. In this light, trade taxes and subsidies may be particularly useful as an alternative route to resolving these inefficiencies. We explore this possibility in the next section.

C. Constrained Efficient Trade Policy

How effective can trade policy intervention be as a means of alleviating the hold-up problem identified above? To answer this question, we let τ_x^H denote the trade tax imposed by H on imports of the input x (positive if an import tariff, negative if an import subsidy) defined in specific terms, and we let τ_x^F be the analogous trade tax imposed by F (positive if an export tax, negative if an export subsidy). Furthermore, we let τ_1^H denote the trade tax imposed by H on the home country's trade in the final good 1 (positive if an import tariff or export subsidy, negative if an import subsidy or export tax) also defined in specific terms. We could also allow for a final-good trade tax τ_1^F in the foreign country, but it is intuitively clear (and is easily shown) that there will be no incentive to intervene with such an instrument.[16] We focus on non-prohibitive tariffs throughout. Observe that the price of the final good 1 in H is now given by $p_1^H = 1 + \tau_1^H$, implying $\tau_1^H \geq -1$ to ensure $p_1^H \geq 0$; whereas the price of the input x continues to be determined by Nash bargaining between producers and suppliers (though trade taxes may affect this negotiated price).

We seek to characterize the constrained-efficient trade policies, that is, the set of policies that maximize aggregate world welfare subject to the contractual frictions in producer-supplier relationships. More specifically, we introduce the following *stage* 0 which occurs prior to *stage* 1 of the 4-stage game described in Section IA:

Stage 0: A social planner selects a home-country trade tax τ_1^H on the final good 1, a home-country import tax τ_x^H on home imports of the input x, and a foreign-country export tax τ_x^F on foreign exports of the input x.

After the social planner has selected these import tariffs/subsidies in *stage* 0, the sequence of events is as outlined in Section IA (with trade taxes collected at the time of importation and production/sales in *stage* 4).

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[16] This follows from the fact that τ_1^F could only alter the local price of good 1 in F (owing to F's small size on world markets) and that price has no impact on the hold-up problem between F's input suppliers and H's final good producers. In the online Appendix we discuss the case where F is large in the world market for the final good and a reason for intervention with τ_1^F arises. Note also that we are assuming that all trade taxes are specific. In Section V, we briefly discuss the case of ad valorem taxes and subsidies.

Consider now how these trade policy choices in *stage* 0 affect the equilibrium outcome of the game. In their *stage*-3 bargaining, if the producer and supplier reach an agreement they stand to obtain a joint payoff of (recalling again that the cost of producing x is sunk at that point)

$$J(\tau_1^H, \tau_x, x) \equiv \left(1 + \tau_1^H\right) y(x) - \tau_x x,$$

where we use $\tau_x \equiv \tau_x^H + \tau_x^F$ to denote the sum of the home and foreign tax on input trade. A positive import tariff or export subsidy on the final good $(\tau_1^H > 0)$ raises the joint surplus of the producer and supplier because it raises the price at which the final good is sold in H. Conversely, a positive import tariff $(\tau_x^H > 0)$ or export tax $(\tau_x^F > 0)$ on inputs reduces the joint surplus of the producer and supplier because it transfers part of the surplus to governments.

If the producer and the supplier do not reach an agreement, each is again left with a zero outside option. Hence, the final good producer obtains a payoff equal to $\alpha J(\tau_1^H, \tau_x, x)$ in the Nash bargain of *stage* 3, and the input supplier obtains $(1 - \alpha) J(\tau_1^H, \tau_x, x)$ and chooses x in *stage* 2 to satisfy[17]

(4) $$(1 - \alpha)(1 + \tau_1^H) y'(\hat{x}) = 1 + (1 - \alpha)\tau_x,$$

which implicitly defines $\hat{x}(\tau_1^H, \tau_x)$. It is clear from (4) that $\hat{x}$ is increasing in τ_1^H and decreasing in τ_x, the sum of τ_x^H and τ_x^F. Intuitively, incomplete contracting leads to rent-sharing between the producer and supplier, and the latter's incentives to invest tend to be higher whenever the surplus from investment is higher, that is when τ_1^H is higher and when τ_x is lower. We will confirm in later sections that the positive dependence of $\hat{x}$ on τ_1^H and the negative dependence of $\hat{x}$ on τ_x hold for a variety of specifications of the game played between the producer and supplier.

At *stage* 1, the final good producer in H anticipates a payoff equal to

(5) $$\pi^H = \alpha J\left(\tau_1^H, \tau_x, \hat{x}(\tau_1^H, \tau_x)\right) \equiv \pi^H(\tau_1^H, \tau_x),$$

while the supplier in F expects a payoff equal to[18]

(6) $$\pi^F = (1 - \alpha) J\left(\tau_1^H, \tau_x, \hat{x}(\tau_1^H, \tau_x)\right) - \hat{x}(\tau_1^H, \tau_x) \equiv \pi^F(\tau_1^H, \tau_x).$$

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[17] Implicit in our discussion is that $J(\tau_1^H, \tau_x, x) > 0$, so that the Nash bargain payoff beats each party's outside option, and that τ_x and τ_1^H are such that an interior solution to (4) always exists. It is straightforward to show that these features hold in our Benchmark Model for the relevant values of home and foreign policies given our assumptions on $y(x)$.

[18] Note that by (4) and the concavity of $y(x)$, we have $\pi^F = (1 - \alpha)[(1 + \tau_1^H) y(\hat{x}) - \tau_x \hat{x}] - \hat{x} \geq (1 - \alpha) \times [(1 + \tau_1^H)\hat{x} y'(\hat{x}) - \tau_x \hat{x}] - \hat{x} = \hat{x}\{(1 - \alpha)[(1 + \tau_1^H) y'(\hat{x}) - \tau_x] - 1\} = 0$, and so for any home and foreign policies the payoff anticipated by the supplier at the time the partnership with the producer is formed beats his ex ante outside option.

As a result, and recalling that $\tau_x \equiv \tau_x^H + \tau_x^F$, welfare in H inclusive of tax revenue is given by

$$W^H(\tau_1^H, \tau_x^H, \tau_x^F) = CS^H(1 + \tau_1^H) + \pi^H(\tau_1^H, \tau_x)$$

$$+ \tau_1^H[D_1(1 + \tau_1^H) - y(\hat{x}(\tau_1^H, \tau_x))] + \tau_x^H \hat{x}(\tau_1^H, \tau_x),$$

while welfare in F is

$$W^F(\tau_1^H, \tau_x^H, \tau_x^F) = CS^F(1) + \pi^F(\tau_1^H, \tau_x) + \tau_x^F \hat{x}(\tau_1^H, \tau_x).$$

We now seek to characterize the set of trade policy choices that maximize world welfare. Formally, we seek the policies that maximize $W^W \equiv W^H(\tau_1^H, \tau_x^H, \tau_x^F) + W^F(\tau_1^H, \tau_x^H, \tau_x^F)$, where recall that W^H and W^F are defined subject to $\hat{x}(\tau_1^H, \tau_x)$ as determined by (4).[19] But notice that

$$W^W = W^H(\tau_1^H, \tau_x^H, \tau_x^F) + W^F(\tau_1^H, \tau_x^H, \tau_x^F)$$

$$= CS^H(1 + \tau_1^H) + CS^F(1) + (1 + \tau_1^H) y(\hat{x}(\tau_1^H, \tau_x)) - \hat{x}(\tau_1^H, \tau_x)$$

$$+ \tau_1^H[D_1(1 + \tau_1^H) - y(\hat{x}(\tau_1^H, \tau_x))],$$

$$\equiv W^W(\tau_1^H, \tau_x).$$

Hence, while W^H and W^F each depend on the individual values of τ_x^H and τ_x^F, world welfare depends only on τ_x, the sum of τ_x^H and τ_x^F. This implies that the constrained-efficient policies will only pin down the sum of the home and foreign tax on input trade, τ_x, in addition to τ_1^H. The efficient policies τ_1^{HE} and τ_x^E are then determined by the following first-order conditions of the problem above:[20]

$$(7) \qquad \frac{\partial W^W(\tau_1^H, \tau_x)}{\partial \tau_1^H} = \tau_1^H \frac{\partial D_1}{\partial p_1^H} + [y'(\hat{x}) - 1]\frac{\partial \hat{x}(\tau_1^H, \tau_x)}{\partial \tau_1^H} = 0, \text{ and}$$

$$\frac{\partial W^W(\tau_1^H, \tau_x)}{\partial \tau_x} = [y'(\hat{x}) - 1]\frac{\partial \hat{x}(\tau_1^H, \tau_x)}{\partial \tau_x} = 0.$$

The first-order conditions in (7) are instructive. Recalling from (4) that $\partial \hat{x}/\partial \tau_1^H > 0$, it is clear from (7) that the optimal choice of τ_1^H is strictly positive,

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[19] It is the presence of this constraint that leads us to refer to the policies that solve this program as *constrained-efficient* trade policy choices, although we shall show that these policy choices lead to an attainment of the first-best welfare level.

[20] It is easily checked that second-order conditions are satisfied as long as $y''(x) \leq 0$ for all x (see the Appendix).

provided that $[y'(\hat{x}) - 1] > 0$ which by (2) implies that $\hat{x} < x^E$: this suggests that an import tariff or export subsidy on trade in the final good 1 could raise welfare in the world, by increasing $\hat{x}$ toward x^E and thereby helping to ameliorate the hold-up problem at the cost of lost consumer surplus. However, recalling from (4) that $\partial\hat{x}/\partial\tau_x < 0$, it is clear from (7) that the optimal choice of τ_x must ensure that $[y'(\hat{x}) - 1] = 0$, thereby achieving productive efficiency: there is no associated loss in consumer surplus when the tariff on imported inputs τ_x is used to increase $\hat{x}$, and the optimal choice of τ_x therefore solves completely the hold-up problem and achieves productive efficiency. This in turn leaves no reason for government intervention with regard to trade in the final good 1. Hence, the optimal choice of τ_1^H is $\tau_1^{HE} = 0$. On the other hand, the constrained-efficient policies do call for intervention with regards to input trade, as long as holdup problems exist, i.e., $\alpha > 0$. In particular, from equation (4) it follows that the optimal trade tax is an input subsidy in an amount equal to $\tau_x^E \equiv \tau_x^{HE} + \tau_x^{FE} = -\alpha/(1 - \alpha)$. We may thus state:

PROPOSITION 2: *In the Benchmark Model, the constrained-efficient trade policy choices maintain free trade in the final good and subsidize importation of the input so as to solve the hold-up problem and achieve an efficient volume of input trade* $(\hat{x} = x^E)$.

The intuition for Proposition 2 is simple. The hold-up problem between producers in H and suppliers in F results in a level of imported inputs which is inefficiently low. The market failure is an international one in nature, and thus it is natural that trade taxes or subsidies can serve a useful role in alleviating the inefficiency. Furthermore, although trade intervention in the final good could be used to raise the home-country price of the final good and increase the volume of imported inputs (through rent-sharing), this would come at a cost of reduced home-country consumer surplus. A subsidy to imported inputs does not reduce consumer surplus, but it nevertheless succeeds in increasing the volume of imported inputs by increasing the surplus over which the parties negotiate in the ex post (*stage*-3) bargain. As a consequence, a subsidy to imported inputs targets just the distorted margin, and in analogy with the targeting principle (Bhagwati and Ramaswami 1963; Johnson 1965) is hence the optimal method of addressing the problem.

We have thus identified a novel role for trade policy intervention, namely, as a means of addressing the international hold-up problem that arises when international trade involves significant lock-in effects between domestic producers and their foreign suppliers. A natural question is whether the *unilateral* trade policy choices of both the home and foreign governments will lead to overall trade interventions that concord with the efficiency conditions outlined in Proposition 2. We tackle this issue next.

II. Nash Equilibrium Trade Policy

In this section we characterize the unilaterally optimal trade policy choices of the home and foreign governments, and we compare the resulting Nash equilibrium policies to the constrained efficient policies characterized in the previous section. In

particular, we now derive the subgame perfect equilibrium of the Benchmark Model for the case in which *stage* 0 is as follows:

Stage 0: The home government H selects a trade tax τ_1^H on the final good 1, and a trade tax τ_x^H on the imported input x; simultaneously, the foreign government F selects a trade tax τ_x^F on the exported input x.[21]

We start by considering H's incentive to intervene facing a given F policy $\left(\tau_x^F\right)$. We earlier defined the home welfare function $W^H\!\left(\tau_1^H, \tau_x^H, \tau_x^F\right)$. Using this, the definition of τ_x, and the functions $\hat{x}(\tau_1^H, \tau_x)$ and $\pi^H(\tau_1^H, \tau_x)$ defined by (4) and (5), respectively, the optimal choice of τ_1^H and τ_x^H for given τ_x^F must satisfy the first-order conditions:[22]

$$\frac{\partial W^H(\tau_1^H, \tau_x^H, \tau_x^F)}{\partial \tau_1^H} = 0 = \tau_1^H \frac{\partial D_1}{\partial p_1^H} - (1 - \alpha) y(\hat{x})$$

$$+ \left[(\alpha - (1 - \alpha)\tau_1^H) y'(\hat{x}) + (1 - \alpha)\tau_x^H - \alpha \tau_x^F\right] \frac{\partial \hat{x}(\tau_1^H, \tau_x)}{\partial \tau_1^H},$$

and

$$\frac{\partial W^H(\tau_1^H, \tau_x^H, \tau_x^F)}{\partial \tau_x^H} = 0 = (1 - \alpha)\hat{x} + \left[(\alpha - (1 - \alpha)\tau_1^H) y'(\hat{x})\right.$$

$$\left. + (1 - \alpha)\tau_x^H - \alpha \tau_x^F\right] \frac{\partial \hat{x}(\tau_1^H, \tau_x)}{\partial \tau_x^H}.$$

Applying the implicit function theorem (twice) to $\hat{x}(\tau_1^H, \tau_x)$ delivers $\left(\partial\hat{x}/\partial\tau_1^H\right)/\left(\partial\hat{x}/\partial\tau_x^H\right) = -y'(\hat{x})$, which can be used to manipulate the above first-order conditions to obtain the following expressions implicitly defining the home best-response policy pair $\left(\tau_1^{HR}, \tau_x^{HR}\right)$:

$$(8) \quad \tau_1^{HR}\!\left(\tau_x^F\right) = -\frac{(1 - \alpha)\hat{x}\left[\dfrac{y(\hat{x})}{\hat{x}} - y'(\hat{x})\right]}{|\partial D_1/\partial p_1^H|}, \text{ and}$$

$$\tau_x^{HR}\!\left(\tau_x^F\right) = -\frac{\left[\alpha - (1 - \alpha)\tau_1^{HR}\!\left(\tau_x^F\right)\right] y'(\hat{x})}{(1 - \alpha)} - \frac{\hat{x}}{\partial\hat{x}/\partial\tau_x} + \frac{\alpha \tau_x^F}{(1 - \alpha)}.$$

The expressions for the home best-response policies in (8) reflect an interesting logic. Part of the goal of the home government in intervening with τ_1^H and/or τ_x^H, as in the case of the constrained-efficient policies, is to raise $\hat{x}$ toward its efficient level x^E. Nevertheless, the home government does not maximize world welfare, and hence there is an offsetting leakage of bargaining surplus to the foreign supplier that must be taken into account by the home government in setting its best-response policies. This has an immediate and important implication: recalling that the concavity of $y(x)$ implies $[(y(\hat{x})/\hat{x}) - y'(\hat{x})] > 0$, the top line of (8) implies $\tau_1^{HR}(\tau_x^F) < 0$. Evidently, it is not optimal for the home government to deliver the chosen $\hat{x}$ using only τ_x^H, and as we next explain the setting of $\tau_1^H \neq 0$ reflects a new source of international inefficiency associated with the unilateral policy choices of the home country.

The finding that $\tau_1^{HR}(\tau_x^F) < 0$ can be understood as follows. The home government must concern itself with two tasks as it considers its policy choices. First, it must face foreign suppliers with the appropriate *marginal* incentives for investment in the supply of x so as to achieve the desired investment level $\hat{x}$. Second, the home government must also concern itself with extracting *inframarginal* profits from foreign suppliers through the use of its policy instruments. According to (4), the home government can make adjustments in τ_1^H and τ_x^H that will not alter $\hat{x}$ provided that these adjustments satisfy $d\tau_x^H(\tau_1^H)/d\tau_1^H = -(\partial\hat{x}/\partial\tau_1^H)/(\partial\hat{x}/\partial\tau_x^H) = y'(\hat{x})$; with such adjustments, and using (6), the home government can then alter (inframarginal) foreign profits according to

$$(9) \qquad \frac{d\pi^F(\tau_1^H, \tau_x^H(\tau_1^H) + \tau_x^F)}{d\tau_1^H}\Bigg|_{d\hat{x}=0} = (1 - \alpha)\hat{x}\left[\frac{y(\hat{x})}{\hat{x}} - y'(\hat{x})\right],$$

where we have used $\tau_x \equiv \tau_x^H + \tau_x^F$ in writing $\pi^F(\tau_1^H, \tau_x^H(\tau_1^H) + \tau_x^F)$. With $[(y(\hat{x})/\hat{x}) - y'(\hat{x})] > 0$, it follows from (9) that for any given level of $\hat{x}$, additional surplus can be extracted from foreign suppliers while holding $\hat{x}$ fixed by *reducing* τ_1^H and accompanying this with a reduction in τ_x^H which preserves the level of $\hat{x}$. Intuitively, a reduction in τ_1^H matched with a reduction in τ_x^H that preserves $\hat{x}$ will extract surplus from foreign suppliers because τ_1^H must work through the final good production function $y(x)$—which is concave—to induce a given amount of investment from foreign suppliers, and this creates more inframarginal bargaining surplus for foreign suppliers than does the analogous τ_x^H, which works directly (and linearly) through import volume x.

What, then, prevents the home country from lowering τ_1^H and τ_x^H in this fashion indefinitely, until all of the surplus has been extracted from foreign suppliers? To answer this question, we must consider the impact on home-country welfare of these tariff changes, which is given by

$$(10) \qquad \frac{dW^H(\tau_1^H, \tau_x^H(\tau_1^H), \tau_x^F)}{d\tau_1^H}\Bigg|_{d\hat{x}=0} = \tau_1^H\frac{\partial D_1^H}{\partial p_1^H} - (1 - \alpha)\hat{x}\left[\frac{y(\hat{x})}{\hat{x}} - y'(\hat{x})\right].$$

As the first term of equation (10) makes clear, what eventually stops this process of foreign surplus extraction is the growing home-country final good demand distortion associated with $\tau_1^H < 0$.

It is for these reasons that (8) implies $\tau_1^{HR}(\tau_x^F) < 0$: in words, it is unilaterally optimal for the home government to utilize trade policy to *distort downward the home-market price of the final good* (through either an import subsidy or an export tax on the final good) as a means of extracting bargaining surplus from foreign suppliers. Our model therefore identifies a new source of international inefficiency—apart from any inefficiency in input trade volume $\hat{x}$—when the home country sets its tariffs unilaterally.[23]

We next consider F's incentive to intervene. Using our expression for foreign welfare $W^F(\tau_1^H, \tau_x^H, \tau_x^F)$ as well as the definition of τ_x and the functions $\hat{x}(\tau_1^H, \tau_x)$ and $\pi^F(\tau_1^H, \tau_x)$, the best-response choice of τ_x^F for given τ_1^H and τ_x^H must satisfy the first-order condition

$$(11) \quad \frac{\partial W^F(\tau_1^H, \tau_x^H, \tau_x^F)}{\partial \tau_x^F} = 0 = \alpha\hat{x} + [(1 - \alpha)(1 + \tau_1^H)y'(\hat{x}) - 1$$

$$- (1 - \alpha)\tau_x^H + \alpha\tau_x^F)]\frac{\partial\hat{x}(\tau_1^H, \tau_x)}{\partial\tau_x}.$$

Recalling that $\partial\hat{x}/\partial\tau_x < 0$, the first-order condition in (11) together with (4) immediately implies that the foreign best-response tariff (τ_x^{FR}) is given by

$$(12) \quad \tau_x^{FR}(\tau_1^H, \tau_x^H) = -\alpha\frac{\hat{x}}{\partial\hat{x}/\partial\tau_x} > 0,$$

and hence, the foreign country finds it optimal to set an export tax on the intermediate input.

Before providing intuition for this result, it is helpful to consider the Nash policies $(\tau_1^{HN}, \tau_x^{HN}, \tau_x^{FN})$, which are defined by the joint solution to the conditions in (8) and (12). We have already established that $\tau_1^{HR}(\tau_x^F) < 0$ and $\tau_x^{FR}(\tau_1^H, \tau_x^H) > 0$, and so it is immediate that $\tau_1^{HN} < 0$ and $\tau_x^{FN} > 0$. But now, using (4) it is direct to show that the Nash policies also imply

$$(13) \quad y'(\hat{x}^N) = 1 - \frac{\hat{x}^N}{\partial\hat{x}/\partial\tau_x} > 1,$$

where (13) is evaluated at the Nash policies $(\tau_1^{HN}, \tau_x^{HN}, \tau_x^{FN})$ and where we use $\hat{x}^N$ to denote the equilibrium trade volume in intermediate inputs evaluated at Nash policies. It is then clear that the Nash equilibrium involves suboptimal trade in intermediate inputs, $\hat{x}^N < x^E$.

The findings that $\hat{x}^N < x^E$ and $\tau_x^{FN} > 0$ can be understood as follows. First, as we have already observed, there is a tension that arises for H's government between correcting the hold-up problem and capturing surplus from the foreign input supplier, and this tension prevents H from adopting policies that would bring the volume of trade in intermediate inputs up to its optimal level. Why, then, doesn't F's

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[23] To confirm that $\tau_1^{HR}(\tau_x^F)$ is inefficient from the perspective of aggregate world welfare, note that for any τ_x^F, (9) and (10) together imply $\frac{dW^W(\tau_1^H, \tau_x^H(\tau_1^H), \tau_x^F)}{d\tau_1^H}\big|_{d\hat{x}=0} = \tau_1^H\frac{\partial D_1^H}{\partial p_1^H}$, which is strictly positive for $\tau_1^H < 0$ and *any* level of $\hat{x}$.

government offer an export subsidy to increase exports of x up toward their efficient level? The reason is that the level of x is chosen by the foreign supplier to maximize foreign profits, and so there is no gain to the foreign country from manipulating this choice with export-sector intervention. Moreover, foreign suppliers do not bear the full burden of the increase in the marginal cost of production associated with an export tax, because they have less than full bargaining power in their negotiations with final good producers ($\alpha > 0$). Hence, F is able to pass part of the cost of the export tax on to the home country while keeping the entire benefit from it (in the form of tax revenue), making an export tax, rather than an export subsidy, the optimal intervention for the foreign government.

We can thus conclude that, when governments choose their policies noncooperatively, international efficiency is not achieved. In particular, we may state:

PROPOSITION 3: *In the Nash equilibrium of the Benchmark Model*, *F maintains free trade in the final good and taxes the exports of the input*, *while H intervenes in both the final good and input markets*, *resulting in* (*i*) *an inefficiently low volume of input trade* $\left(\hat{x}^N < x^E \right)$, *and* (*ii*) *an inefficiently low local price for the final good in H's market.*

Proposition 3 identifies inefficiencies that arise in the Benchmark Model when governments set their trade policies unilaterally, and, as we will argue shortly, it suggests the potential for trade agreements with novel features in this setting. However, before turning to explore this possibility, we first introduce into the Benchmark Model the possibility that governments possess political economy motivations.

III. The Benchmark Model with Political Economy

We have thus far assumed that each country's government is benevolent and seeks to maximize the aggregate welfare of its residents. Both casual and formal evidence suggest, however, that it is more realistic to formulate a social welfare function that weights asymmetrically the welfare of different groups in society. The political economy literature has stressed the role of special interest groups in generating these biases in policy (Baron 1994; Grossman and Helpman 1996).

In this section, we extend the Benchmark Model to allow for government welfare functions that place a higher weight on producer welfare than on consumer welfare. In line with analogous results reported for example in Grossman and Helpman (1994) and Bagwell and Staiger (2002, Ch. 10), we first show that the introduction of political economy motives can eliminate unrealistic features of the Benchmark Model's policy predictions (e.g., convert import subsidies to import tariffs). We then confirm, however, that the inefficiencies associated with the Nash equilibrium as described in Proposition 3 continue to apply in the presence of political economy concerns on the part of governments. For simplicity, except where it might cause confusion we continue to refer to the politically augmented Benchmark Model as simply the Benchmark Model.

A. *Introducing Political Economy*

To represent political-economy motives, we implicitly assume that producers are in a better position to solve the "collective action" problem and hence can better

coordinate their demands on the government. We also assume that the ownership of productive assets is highly concentrated, so that we can ignore the role of producers as consumers and as receivers of lump-sum tax rebates. In particular, we let:

$$(14)\ \tilde{W}^j\ =\ CS^j\ +\ \gamma^j \pi^j\ +\ \text{Trade Tax Revenue}^j, \text{ with } \gamma^j\ \geq\ 1, \text{ for } j \in \{H, F\},$$

where γ^j represents the weight that the government of country j places on the welfare of its producers, with political-economy motives present in country j if and only if $\gamma^j > 1$. Using (5), (6), and (14), the welfare of the home and foreign governments in the (politically augmented) Benchmark Model can be written as

$$\tilde{W}^H\big(\tau_1^H, \tau_x^H, \tau_x^F\big)\ =\ CS(p_1^H)\ +\ \gamma^H \alpha((1\ +\ \tau_1^H) y(\hat{x})\ -\ \tau_x \hat{x})$$

$$+\ \tau_1^H\big[D_1(p_1^H)\ -\ y(\hat{x})\big]\ +\ \tau_x^H \hat{x}$$

and

$$\tilde{W}^F\big(\tau_1^H, \tau_x^H, \tau_x^F\big)\ =\ CS(1)\ +\ \gamma^F((1\ -\ \alpha)((1\ +\ \tau_1^H) y(\hat{x})\ -\ \tau_x \hat{x}))\ -\ \hat{x})$$

$$+\ \tau_x^F \hat{x},$$

respectively. Manipulating the first-order conditions that define the Nash policies τ_1^{HN}, τ_x^{HN}, and τ_x^{FN} delivers

$$(15)\qquad \tau_1^{HN}\ =\ -\frac{\big(1\ -\ \alpha \gamma^H\big) \hat{x} \left[\dfrac{y(\hat{x})}{\hat{x}}\ -\ y'(\hat{x})\right]}{|\partial D_1 / \partial p_1^H|},$$

$$\tau_x^{HN}\ =\ -\frac{\big[\gamma^H \alpha\ -\ (1\ -\ \gamma^H \alpha)\tau_1^{HN}\big] y'(\hat{x})}{(1\ -\ \gamma^H \alpha)}\ -\ \frac{\hat{x}}{\partial \hat{x} / \partial \tau_x}\ +\ \frac{\gamma^H \alpha \tau_x^{FN}}{(1\ -\ \gamma^H \alpha)},$$

$$\tau_x^{FN}\ =\ -\frac{\big(1\ -\ (1\ -\ \alpha)\gamma^F\big) \hat{x}}{\partial \hat{x} / \partial \tau_x^F},$$

which, when $\gamma^H = 1 = \gamma^F$, naturally reduces to the analogous expressions implied by (8) and (12).

Notice that for low enough γ^H (in particular $\gamma^H < 1/\alpha$), the home government continues to find it optimal in the Nash equilibrium to set a positive export tax (or import subsidy) on the final good to depress the final-good price in the domestic market. Nevertheless, when the weight that the home government places on producer surplus becomes sufficiently high (i.e., $\gamma^H > 1/\alpha$), τ_1^{HN} flips sign according to (15) and becomes positive. In such a case, the home government puts in place a Nash trade policy that leads to an *increase* in the domestic price of the final good (i.e., an import tariff or export subsidy). As we have shown above, these policies tend to transfer surplus from the home country to the foreign country, but a sufficiently politically influenced home government is willing to allow this because consumers bear a disproportionate part of the cost of this rent-dissipation. As in the case of welfare-maximizing governments,

the home input policy τ_x^{HN} continues to be of ambiguous sign when political economy motives are introduced. Finally, the third first-order-condition indicates that for large enough γ^F (in particular $\gamma^F > 1/(1 - \alpha)$), the foreign government no longer sets an export tax in the Nash equilibrium but rather chooses to subsidize exports of intermediate inputs. Intuitively, although a subsidy reduces foreign tariff revenue by an amount which is strictly larger than the amount by which foreign profits increase, a sufficiently politically influenced foreign government weights the latter effect disproportionately more, and thus sets a positive export subsidy in the Nash equilibrium.

B. *Politically Efficient Policies*

In light of the impacts that political economy concerns can have on Nash policies in the Benchmark Model, a natural question is whether the inefficiencies of Nash policies as described in Proposition 3 are robust to the inclusion of political economy considerations. For instance, as we have observed, a sufficiently high weight on home producer surplus (when $\gamma^H > 1/\alpha$) leads the home government to place an import tariff/export subsidy on the final good, resulting in a Nash trade policy that raises the domestic price of the final good: this suggests that the domestic final good price might therefore be *too high* in the Nash equilibrium if political economy motives are sufficiently strong. And similarly, it seems possible that the use of export subsidies by the foreign government (when $\gamma^F > 1/(1 - \alpha)$) could lead to *excessive* trade in intermediate inputs.

In order to asses the nature of the inefficiencies associated with Nash equilibrium trade policies when political economy motives are present, we first need to characterize the efficient policies in the presence of political biases. Defining world aggregate welfare as $\tilde{W}^W = \tilde{W}^H + \tilde{W}^F$, it is straightforward to verify that the efficient policy choices of the two governments (i.e., the policies $\tau_x \equiv \tau_x^H + \tau_x^F$ and τ_1^H that maximize $\tilde{W}^W$, the sum of home and foreign welfare when evaluated in light of the objectives of the governments) must satisfy the following two first-order conditions:[24]

$$(16) \quad \frac{\partial \tilde{W}^W}{\partial \tau_1^H} = 0 = \tau_1^H \frac{\partial D_1}{\partial p_1^H} - \left(1 - (\gamma^H \alpha + \gamma^F (1 - \alpha))\right) \hat{x} \left[\frac{y(\hat{x})}{\hat{x}} - y'(\hat{x})\right],$$

and

$$\frac{\partial \tilde{W}^W}{\partial \tau_x} = 0 = \left(1 - (\gamma^H \alpha + \gamma^F (1 - \alpha))\right) \hat{x} + \left[y'(\hat{x}) - \frac{1 - \alpha \gamma^H}{1 - \alpha}\right] \frac{\partial \hat{x}}{\partial \tau_x}.$$

When political economy motives are absent $(\gamma^H = 1 = \gamma^F)$, these expressions immediately imply that the efficient policies are $\tau_1^{HE} = 0$ and $\tau_x^E \equiv -\alpha/(1 - \alpha)$ so that $y'(\hat{x}) = 1$, as we showed in Section IC. When political economy motives are present $(\gamma^H > 1$ and/or $\gamma^F > 1)$, however, efficiency now requires $\tau_1^H > 0$ and $y'(\hat{x}) < 1$. Intuitively, as long as $\gamma^H > 1$ or $\gamma^F > 1$, governments will value positively the implied redistribution from H's consumers to H's

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[24] Defining the efficiency frontier in this way when political economy motives are present fits well with the "member-driven" nature of the WTO, and it is the approach to evaluating the performance of trade agreements taken by most of the literature, but it is not the only approach. An alternative (pursued for example by Aghion, Antràs, and Helpman 2007 and by Ornelas 2008) is to evaluate the performance of trade agreements on the basis of whether

producers and F's suppliers associated with a (small) positive final good tariff and overall subsidies to input trade that push $\hat{x}$ beyond the level implied by $y'(\hat{x}) = 1$.

How do these politically efficient policies compare with those obtained in the noncooperative equilibrium? Evaluating the partial derivatives of world welfare given in (16) at the Nash policies given in (15) delivers

$$\frac{\partial \tilde{W}^W}{\partial \tau_1^H} = \gamma^F (1 - \alpha) \hat{x} \left[\frac{y(\hat{x})}{\hat{x}} - y'(\hat{x}) \right] > 0, \quad \text{and}$$

$$\frac{\partial \tilde{W}^W}{\partial \tau_x} = - \hat{x} < 0.$$

We can thus conclude that the Nash equilibrium choice of τ_1^H—and hence the local price of the final good in H's market—is *inefficiently low*, in the sense that world welfare could be increased by increasing τ_1^H above the Nash level τ_1^{HN}. Similarly, the Nash level of τ_x is too high, in the sense that world welfare could be increased by reducing τ_x below the level implied by the Nash tariffs τ_x^{HN} and τ_x^{HF}; and therefore given that $\hat{x}$ is increasing in τ_1^H and decreasing in τ_x, we may conclude as well that the input trade volume is also *inefficiently low*. These results confirm that the two inefficiencies associated with the Nash equilibrium as described in Proposition 3 continue to apply in the presence of political economy biases.

IV. The Role and Design of Trade Agreements

Our analysis above identifies the inefficiencies associated with Nash policies that a trade agreement could correct, and thereby provides the starting point for understanding the role of a trade agreement in the presence of offshoring. We now examine this role in more depth to establish two main points. First, we argue that the traditional "market access" focus adopted by the GATT/WTO is unlikely to deliver efficient trade agreements in the presence of offshoring. And second, we establish that the nature of the underlying problem for a trade agreement to solve in the presence of offshoring varies with the preferences of member governments. We argue that this second feature will diminish the ability of the GATT/WTO pillars of reciprocity and non-discrimination to guide governments to efficient trade agreements. After establishing these points, we relate our findings to those of the terms-of-trade theory of trade agreements, and draw conclusions about the broader implications of the rise in offshoring for the role and design of trade agreements.

A. *Beyond Market Access*

Since the creation of GATT in 1947, the central activity of GATT/WTO negotiations has been, by design, the exchange of market access, accomplished through the trading of one tariff concession for another; at their core, virtually all other activities

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or not the agreement guides governments to a point on an efficiency frontier that is defined with regard to a set of preferences that are unrelated to government preferences (e.g., the maximization of real world income).

within the GATT/WTO play a supporting role to this fundamental purpose.[25] The market-access focus of GATT/WTO negotiations is embodied in the choice of tariffs rather than domestic policies as the primary object of bargaining, and it underpins the feature (as codified in the GATT/WTO by the "principal supplier" rule) that an exporting country engages an importing country in tariff negotiations only on those products where the exporting country has a significant supplying interest in gaining improved access to the importing country's markets. In our model, market access negotiations between H and F would focus on H's import tariff on intermediate inputs τ_x^H: the level of H's intervention on trade in the final good τ_1^H would *not* be part of a market access bargain between H and F, because by assumption F does not export the final good 1 to H and as such has no natural interest in access to H's final good market for its (nonexistent) final-good exporters. This is not to say that τ_1^H would be left completely unconstrained by a market access bargain between H and F which resulted in an agreement by H to lower τ_x^H. On the contrary, there are GATT/WTO rules that are meant to address the possibility that H might later make adjustments in other policies $\left(\text{e.g., } \tau_1^H\right)$ that would have *adverse trade effects* for F and thereby undercut the market access implications of its bargain with H; but beyond this, the level of τ_1^H would not be restricted in a market access negotiation between H and F.[26]

Suppose, then, that trade negotiators maintain their focus on market access negotiations in the presence of offshoring. We wish to evaluate the efficiency properties of this approach to negotiations. Our discussion above suggests two possibilities for a formal representation of such negotiations, depending on what is meant by adverse "trade effects." [27]

One possibility is that H and F negotiate over the levels of τ_x^H and τ_x^F, and then subsequently H may make unilateral adjustments to τ_x^H and τ_1^H so long as these adjustments do not alter the equilibrium import volume $\hat{x}$ from the level implied by the agreed levels of τ_x^H and τ_x^F and the level of τ_1^H that prevailed at the time of the negotiation. This possibility would essentially equate trade effects with equilibrium trade volume effects.

We now establish that such a negotiation could not lead to internationally efficient policies in the presence of offshoring. While this result is valid whether or not political economy forces are present, for simplicity we abstract from political economy issues in what follows: recall that we then have that the efficient policies are $\tau_1^{HE} = 0$ and $\tau_x^E = -\alpha/(1 - \alpha)$. To establish our result, notice from our

[25] An exception to this is the WTO Agreement on Trade-Related Intellectual Property Rights (TRIPS), which is not a market access agreement. In part for this reason, its inclusion in the WTO is somewhat controversial among economists and legal scholars.

[26] The exclusion of τ_1^H from market access negotiations between H and F would extend as well to all of H's "internal" policies, such as domestic consumption and production taxes, that could impact imports of x; none of these policies would be the direct subject of negotiations in a market access bargain between H and F over H's imports of the intermediate good x, and each would in principle be subject to the same constraints as we have described in the text for τ_1^H. We will later comment on how our results can be easily extended to include such policies. Note also that below we do allow F's export policy, τ_x^F, to be part of the bargain, even though negotiations over export policies are not characteristic of GATT/WTO market access bargains either (though bargaining over export policies is a feature of the agriculture negotiations in the ongoing Doha Round of WTO negotiations). But as will become clear, we could abstract from export policies completely without changing any of the discussion that follows, so this feature is inessential.

[27] The two possibilities we consider bracket the definition of trade effects/market access adopted by Bagwell and Staiger (2001a, 2002). We will discuss the relationship between our findings here and those of Bagwell and Staiger in Section IVC.

description just above that equilibrium input trade volume will be pinned down in the negotiation stage, and so it is sufficient to consider the case in which negotiation delivers the efficient input trade volume x^E and show that this cannot result in efficient policy choices once H's subsequent unilateral policy adjustments are factored in. In particular, for this case and supposing that the foreign government has agreed to the tariff level $\bar{\tau}_x^F$, the home government may then choose any combination of τ_1^H and τ_x^H that satisfies $\hat{x}(\tau_1^H, \tau_x^H + \bar{\tau}_x^F) = x^E$, and so the home government policy choices must then satisfy the first-order condition

$$(17) \quad \frac{dW^H\left(\tau_1^H, \tau_x^H(\tau_1^H), \bar{\tau}_x^F\right)}{d\tau_1^H}\Bigg|_{d\hat{x}=0} = \tau_1^H \frac{\partial D_1^H}{\partial p_1^H} - (1-\alpha) x^E \left[\frac{y(x^E)}{x^E} - y'(x^E)\right] = 0.$$

But this implies that the home government would set $\tau_1^H < 0$, and hence would continue to utilize trade policy to distort downward the price of the final good 1 in the home market (through either an import subsidy or an export tax on the final good) as a means of extracting bargaining surplus from foreign suppliers. Hence, a market access negotiation that took this form could not implement internationally efficient policies in the presence of offshoring.

To provide further insight into the shortcomings of a market access focus for negotiations in this setting, it is useful to define the *international price* of the input x, which we denote by p_x^*. In words, p_x^* is the (untaxed) price negotiated in *stage* 3 for the exchange of inputs between the foreign supplier and the home producer. It is easy to see that in the Benchmark Model this price is given by $p_x^* = \pi^F/\hat{x} + (1 + \tau_x^F)$, which can be written as

$$(18) \quad p_x^* = (1-\alpha)(1+\tau_1^H)\frac{y\left(\hat{x}(\tau_1^H, \tau_x)\right)}{\hat{x}(\tau_1^H, \tau_x)} - (1-\alpha)\tau_1^H + \alpha\tau_x^F \equiv p_x^*\left(\tau_1^H, \tau_x^H, \tau_x^F\right),$$

where $\hat{x}(\tau_1^H, \tau_x)$ is defined by (4). Given that the world price of the final good 1 is fixed by our small-country assumption, the international price p_x^* plays the role of the terms of trade between the home and foreign country in the Benchmark Model. But notice that

$$(19) \quad \frac{dp_x^*\left(\tau_1^H, \tau_x^H(\tau_1^H), \bar{\tau}_x^F\right)}{d\tau_1^H}\Bigg|_{d\hat{x}=0} = (1-\alpha)\left[\frac{y(\hat{x})}{\hat{x}} - y'(\hat{x})\right] > 0,$$

and so using (19) we may rewrite (17) in the equivalent form

$$\frac{dW^H\left(\tau_1^H, \tau_x^H(\tau_1^H), \bar{\tau}_x^F\right)}{d\tau_1^H}\Bigg|_{d\hat{x}=0} = \tau_1^H \frac{\partial D_1^H}{\partial p_1^H} - x^E \frac{dp_x^*\left(\tau_1^H, \tau_x^H(\tau_1^H), \bar{\tau}_x^F\right)}{d\tau_1^H}\Bigg|_{d\hat{x}=0} = 0.$$

Evidently, market access negotiations that proceed along the lines of the first possibility described above leave H with the flexibility to maintain input trade volume with adjustments in τ_1^H and τ_x^H while simultaneously manipulating its terms of trade,

and when choosing its unilaterally optimal policy mix, H weighs the income effects of the terms-of-trade improvements against the domestic consumption distortions that are introduced as a by-product. We may therefore conclude that H's incentive to manipulate its terms of trade given the policy flexibility it retains under this approach to negotiations will prevent this approach from achieving internationally efficient policies.

Let us then turn to a second possibility, that subsequent to their negotiation over the levels of τ_x^H and τ_x^F, H may make adjustments to τ_x^H and τ_1^H only so long as these adjustments alter neither $\hat{x}$ nor p_x^* from the levels for these magnitudes implied by the agreed levels of τ_x^H and τ_x^F and the level of τ_1^H that prevailed at the time of their negotiation. This second possibility would incorporate both equilibrium volume and equilibrium price effects in the measure of adverse trade effects.[28] But whereas the first possibility above left H with too much flexibility to allow internationally efficient policies to be implemented with market access negotiations in the presence of offshoring, this second possibility leaves too little flexibility, because as (19) confirms there are no changes that H could make to τ_x^H and τ_1^H that would leave both $\hat{x}$ and p_x^* unaltered, and hence H would be stuck with the (e.g., Nash) level of τ_1^H that prevailed at the time of its market access negotiation with F, and therefore with a final-good tariff set inefficiently low at $\tau_1^{HN} < \tau_1^{HE}$.[29]

According to our Benchmark Model, then, to achieve an efficient outcome in the presence of offshoring a trade agreement must constrain not only τ_x^H and τ_x^F, and therefore τ_x, but it must directly constrain the level of τ_1^H as well. In fact, it is straightforward to extend the Benchmark Model to include various "internal" behind-the-border policies that might impact trade in x, and to show that our central arguments about τ_1^H also extend to this set of H's internal policies: that is, to achieve internationally efficient policies in the presence of offshoring, negotiations must directly constrain *all* of these policies.[30] We will refer to this as *deep integration*, to distinguish it from the "shallow integration" associated with a market access focus as we have described that focus above. In effect, deep integration is required in the presence of offshoring because, as Proposition 3 indicates, the inefficiencies associated with Nash policy choices extend beyond the problem of low trade volumes that an exchange of market access might reasonably address.

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[28] As Bagwell and Staiger (2001a, footnote 18) observe, some support for this more expansive interpretation of trade effects can be found in legal arguments associated with WTO disputes.

[29] Of course, at the beginning of the negotiations H could announce that, conditional on the successful conclusion of negotiations with F over the input tariffs τ_x^H and τ_x^F, it will change the level of its final good tariff from τ_1^{HN} to τ_1^{HE}; and if this announcement were factored in to the trade effects/market access constraint, the negotiation between H and F might then achieve efficiency in this fashion. But this would amount to including τ_1^H in the negotiations by another name.

[30] As a simple example, if a unit of the numeraire good can be produced in H with 1 unit of labor, and if the final good 1 production function is extended to include labor as an input as well, so that good 1 is produced according to the function $q(L,x) = 2[L^{1/2}y(x)^{1/2}]$, and finally if H has at its disposal a tax/subsidy policy τ_L^H that can be imposed on labor employed in the production of good 1, then it is straightforward to show that the labor tax τ_L^H will be set inefficiently high in the Nash equilibrium, and that aside from this one difference all of the qualitative statements we have made with regard to τ_1^H will apply to τ_L^H as well. Analogous statements would also apply to a consumption tax policy applied to good 1, provided that H were assumed to be large in world markets for good 1 so that H's producer prices for good 1 were impacted by this policy. See Antràs and Staiger (2012) for further elaboration on this point.

We summarize this discussion with:

PROPOSITION 4: *In the presence of offshoring, an efficient trade agreement must achieve deep integration, requiring governments to agree to constraints on policies that extend beyond market access commitments.*

Finally, it bears emphasis that, as we indicated earlier, the finding summarized in Proposition 4 applies whether or not governments face political economy pressures.

B. *Beyond the Terms of Trade*

We next establish that the specific nature of the underlying problem for a trade agreement to solve in the presence of offshoring varies with the preferences of member governments, and that in particular the problem is limited to terms-of-trade manipulation only if political economy forces are absent from government objectives. We then consider what this means for the ability of the GATT/WTO pillars of reciprocity and non-discrimination to deliver efficient bargaining outcomes.

To provide an interpretation of the underlying problem that a trade agreement can solve in this setting, it is useful to express the conditions for efficient policies in terms of the local and international prices that these policies induce. We have already in (18) defined the international input price p_x^* and observed that this price represents the terms of trade between H and F. We now record the derivatives of p_x^* with respect to the foreign and each of the domestic tariffs:

$$(20) \quad \frac{\partial p_x^*}{\partial \tau_x^F} = -\frac{(1-\alpha)}{\hat{x} y''(\hat{x})} \left[\frac{y(\hat{x})}{\hat{x}} - y'(\hat{x}) \right] + \alpha,$$

$$\frac{\partial p_x^*}{\partial \tau_1^H} = (1-\alpha) \left[\frac{y(\hat{x})}{\hat{x}} - y'(\hat{x}) \right] + \frac{(1-\alpha)}{\hat{x} y''(\hat{x})} \left(\left[\frac{y(\hat{x})}{\hat{x}} - y'(\hat{x}) \right] + \hat{x} y''(\hat{x}) \right),$$

$$\frac{\partial p_x^*}{\partial \tau_x^H} = -\frac{(1-\alpha)}{\hat{x} y''(\hat{x})} \left(\left[\frac{y(\hat{x})}{\hat{x}} - y'(\hat{x}) \right] + \hat{x} y''(\hat{x}) \right).$$

The top line of (20) indicates that an increase in the foreign export tax τ_x^F increases p_x^*, and hence improves F's terms of trade. According to the next two lines of (20), the impact of home policies on the terms of trade depends on the sign of $\left([(y(\hat{x})/\hat{x}) - y'(\hat{x})] + \hat{x} y''(\hat{x}) \right)$: if this expression is negative, then $\partial p_x^*/\partial \tau_x^H < 0$ and $\partial p_x^*/\partial \tau_1^H > 0$; if this expression is positive, then $\partial p_x^*/\partial \tau_x^H > 0$ and $\partial p_x^*/\partial \tau_1^H$ may be of either sign. In general, this expression can be positive or negative, depending on the curvature properties of y. In what follows we assume only that $\left([(y(\hat{x})/\hat{x}) - y'(\hat{x})] + \hat{x} y''(\hat{x}) \right) \neq 0$ when evaluated at the relevant $\hat{x}$, so that $\partial p_x^*/\partial \tau_x^H \neq 0$ and there exists an adjustment in τ_x^H that could offset any impact of a change in τ_1^H on p_x^*.[31]

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[31] For example, when y takes the form of the power function $y(x) = x^\eta/\eta$ as in our parameterized example in Appendix A, it is straightforward to show that $\left([(y(\hat{x})/\hat{x}) - y'(\hat{x})] + \hat{x} y''(\hat{x}) \right) > 0$ for $\hat{x} > 0$. An example where this expression is negative for an interval of positive $\hat{x}$ is $y(x) = \theta \log(1 + x)$.

Next, we define the home-country price of the input x by

$$p_x^H = p_x^* + \tau_x^H = (1 - \alpha)(1 + \tau_1^H)\frac{y(\hat{x}(\tau_1^H, \tau_x))}{\hat{x}(\tau_1^H, \tau_x)} + \alpha\tau_x \equiv p_x^H(\tau_1^H, \tau_x).$$

Similarly, we define the foreign-country price of the input x by

$$p_x^F = p_x^* - \tau_x^F = (1 - \alpha)(1 + \tau_1^H)\frac{y(\hat{x}(\tau_1^H, \tau_x))}{\hat{x}(\tau_1^H, \tau_x)} - (1 - \alpha)\tau_x \equiv p_x^F(\tau_1^H, \tau_x).$$

Finally, notice that $p_x^H - p_x^F = \tau_x$, and recall that $p_1^H = 1 + \tau_1^H$. This implies that we may express $\hat{x}$ equivalently as a function of local home and foreign prices: $\hat{x}(\tau_1^H, \tau_x) = \bar{x}(p_1^H, p_x^H - p_x^F)$. Below, we will continue to make use of the function $\hat{x}(\tau_1^H, \tau_x)$, but it will sometimes be convenient to use the equivalent function $\bar{x}(p_1^H, p_x^H - p_x^F)$.

With these definitions, we are now ready to express home and foreign welfare as functions of local and international prices. In particular, letting $\bar{x}(\cdot)$ denote $\bar{x}(p_1^H, p_x^H - p_x^F)$ for notational ease, we may write the welfare of the home and foreign governments in the (politically augmented) Benchmark Model as

(21) $W^H = CS(p_1^H) + \gamma^H[p_1^H y(\bar{x}(\cdot)) - p_x^H \bar{x}(\cdot)] + (p_1^H - 1)[D(p_1^H) - y(\bar{x}(\cdot))]$

$$+ (p_x^H - p_x^*)\bar{x}(\cdot)$$

$$\equiv \overline{W}^H(p_1^H(\tau_1^H), p_x^H(\tau_1^H, \tau_x), p_x^F(\tau_1^H, \tau_x), p_x^*(\tau_1^H, \tau_x, \tau_x^F)),$$

and

(22) $W^F = CS(1) + \gamma^F[p_x^F - 1]\bar{x}(\cdot) + (p_x^* - p_x^F)\bar{x}(\cdot)$

$$\equiv \overline{W}^F(p_1^H(\tau_1^H), p_x^H(\tau_1^H, \tau_x), p_x^F(\tau_1^H, \tau_x), p_x^*(\tau_1^H, \tau_x, \tau_x^F)).$$

Here, and throughout this section, we use $\overline{W}^j$ to represent the objectives of government j when expressed as a function of prices.

Notice that, with subscripts on the welfare functions denoting partial derivatives, expressions (21) and (22) imply

(23) $\overline{W}_{p_x^*}^H = -\hat{x}$ and $\overline{W}_{p_x^*}^F = \hat{x},$

and so $\overline{W}_{p_x^*}^H + \overline{W}_{p_x^*}^F = 0$. This reflects the fact that the income effect of the terms-of-trade change embodied in the rise of p_x^*—holding local prices fixed—is given simply by the trade volume ($\hat{x}$), and amounts to a pure (inframarginal) transfer of rents from the home country to the foreign country. This property is also reflected in

the fact that the sum of home and foreign welfare is independent of p_x^*. In particular, we may write world welfare as

$$\overline{W}^W = \overline{W}^H + \overline{W}^F$$

$$= CS(p_1^H) + \gamma^H\big[p_1^H y(\bar{x}(\cdot)) - p_x^H \bar{x}(\cdot)\big] + (p_1^H - 1)\big[D(p_1^H) - y(\bar{x}(\cdot))\big]$$

$$+ CS(1) + \gamma^F\big[p_x^F - 1\big]\bar{x}(\cdot) + (p_x^H - 1)\bar{x}(\cdot)$$

$$\equiv \overline{W}^W\big(p_1^H(\tau_1^H), p_x^H(\tau_1^H, \tau_x), p_x^F(\tau_1^H, \tau_x)\big).$$

An implication is that efficiency imposes conditions only on τ_1^H and τ_x, confirming the analogous finding reported in the previous sections.

Using the welfare expressions given in (21) and (22) and the prices defined above, we may now express the conditions that the efficient policies τ_1^{HE} and τ_x^E must satisfy

$$(24) \qquad \overline{W}_{p_x^H}^W \frac{\partial p_x^H}{\partial \tau_x} + \overline{W}_{p_x^F}^W \frac{\partial p_x^F}{\partial \tau_x} = 0,$$

and

$$(25) \qquad \overline{W}_{p_1^H}^W + \overline{W}_{p_x^H}^W \frac{\partial p_x^H}{\partial \tau_1^H} + \overline{W}_{p_x^F}^W \frac{\partial p_x^F}{\partial \tau_1^H} = 0,$$

where in writing (25) we have used the fact that $\partial p_1^H / \partial \tau_1^H = 1$. However, for later comparison it is convenient to rewrite the efficiency condition in (25) by solving the efficiency condition in (24) for $\overline{W}_{p_x^F}^W$, using the resulting expression to eliminate $\overline{W}_{p_x^F}^W$ from the condition in (25), and finally observing that changes in τ_x^H and τ_1^H that hold fixed $p_x^*(\tau_1^H, \tau_x^H, \tau_x^F)$ must hold fixed as well the foreign local price $p_x^F(\tau_1^H, \tau_x) = p_x^* - \tau_x^F$ (given that τ_x^F is unchanged), and hence are defined by

$$\frac{d\tau_x^H}{d\tau_1^H}\bigg|_{dp_x^*=0} = \frac{-\partial p_x^F / \partial \tau_1^H}{\partial p_x^F / \partial \tau_x}.$$

With these steps we may rewrite the efficiency condition in (25) in the equivalent form:

$$(26) \qquad \overline{W}_{p_1^H}^W + \overline{W}_{p_x^H}^W \left(\frac{\partial p_x^H}{\partial \tau_1^H} + \frac{\partial p_x^H}{\partial \tau_x} \frac{d\tau_x^H}{d\tau_1^H}\bigg|_{dp_x^*=0}\right) = 0,$$

where we have also used $d\tau_x / d\tau_x^H = 1$.

Together (24) and (26) describe efficient policies. The condition in (24) says that at efficient policies, a small change in τ_x must have no first-order impact on world welfare. The condition in (26) states that small changes in τ_1^H and τ_x^H that hold fixed p_x^*, and hence p_x^F, must have no first-order impact on world welfare either.

We previously offered, in Proposition 3, a characterization of the Nash inefficiencies that arise when governments maximize national income, and we established in Section IIIB that this broad characterization extends to politically motivated governments as well. We now ask whether the inefficiency of Nash policies can be attributed solely to terms-of-trade manipulation in the (politically augmented) Benchmark Model. To this end, we follow Bagwell and Staiger (1999) and define *politically optimal* tariffs as those tariffs that would hypothetically be chosen by governments unilaterally if they did not value the pure international rent/cost-shifting associated with the terms-of-trade movements induced by their unilateral tariff choices. Specifically, we suppose that the home government acts as if $\overline{W}^H_{p_x^*} \equiv 0$ when choosing its politically optimal tariffs, while the foreign government acts as if $\overline{W}^F_{p_x^*} \equiv 0$ when choosing its politically optimal tariff. We therefore define politically optimal tariffs, which we denote by τ_1^{HPO}, τ_x^{HPO}, and τ_x^{FPO}, as those tariffs that satisfy the three conditions

$$(27) \qquad \overline{W}^H_{p_1^H} + \overline{W}^H_{p_x^H}\frac{\partial p_x^H}{\partial \tau_1^H} + \overline{W}^H_{p_x^F}\frac{\partial p_x^F}{\partial \tau_1^H} = 0,$$

$$\overline{W}^H_{p_x^H}\frac{\partial p_x^H}{\partial \tau_x} + \overline{W}^H_{p_x^F}\frac{\partial p_x^F}{\partial \tau_x} = 0, \text{ and}$$

$$\overline{W}^F_{p_x^H}\frac{\partial p_x^H}{\partial \tau_x} + \overline{W}^F_{p_x^F}\frac{\partial p_x^F}{\partial \tau_x} = 0.$$

Having defined politically optimal tariffs, we may next ask whether politically optimal tariffs are efficient, and in this way determine whether the Nash inefficiencies identified above can be given a terms-of-trade interpretation, according to which the fundamental problem faced by governments in designing their trade agreement is to find a way to eliminate terms-of-trade manipulation and thereby escape from a terms-of-trade driven Prisoners' Dilemma.

To assess the efficiency properties of politically optimal tariffs, we add together the middle and bottom expressions in (27) to derive a first implication of politically optimal policies:

$$(28) \qquad \overline{W}^W_{p_x^H}\frac{\partial p_x^H}{\partial \tau_x} + \overline{W}^W_{p_x^F}\frac{\partial p_x^F}{\partial \tau_x} = 0.$$

And we solve the middle expression in (27) for $\overline{W}^H_{p_x^F}$ and use the resulting expression to eliminate $\overline{W}^H_{p_x^F}$ from the top expression in (27) to derive a second implication of politically optimal policies:

$$(29) \qquad \overline{W}^H_{p_1^H} + \overline{W}^H_{p_x^H}\left(\frac{\partial p_x^H}{\partial \tau_1^H} + \frac{\partial p_x^H}{\partial \tau_x}\frac{d\tau_x^H}{d\tau_1^H}\bigg|_{dp_x^*=0}\right) = 0.$$

It is direct from (28) that the condition for efficiency in (24) is satisfied at politically optimal tariffs. However, at politically optimal policies it can be confirmed that

$$(30) \quad \overline{W}_{p_1^H}^F \; + \; \overline{W}_{p_x^H}^F \left(\frac{\partial p_x^H}{\partial \tau_1^H} \; + \; \frac{\partial p_x^H}{\partial \tau_x} \frac{d\tau_x^H}{d\tau_1^H} \bigg|_{dp_x^*=0} \right) = \; \frac{(\gamma^F - 1)\hat{x}}{2} \left[\frac{y(\hat{x})}{\hat{x}} \; - \; y'(\hat{x}) \right].$$

If the foreign government maximizes national income ($\gamma^F = 1$), the expression on the right-hand side of (30) reduces to zero, and (29) and (30) then imply that politically optimal tariffs satisfy the condition for efficiency in (26). However, in the presence of foreign political economy forces ($\gamma^F > 1$), the expression on the right-hand side of (30) is strictly positive, and (29) and (30) then imply that politically optimal tariffs violate the condition for efficiency in (26).

Evidently, when $\gamma^F > 1$ politically optimal tariffs are not efficient and the Nash inefficiencies identified above cannot be given a terms-of-trade interpretation. Rather, as (29) and (30) indicate, beginning from politically optimal policies, a small increase in τ_1^H coupled with a change in τ_x^H that leaves p_x^* unchanged (and hence with τ_x^F fixed also leaves p_x^F unchanged) will lead to a second-order loss for Home (according to (29)) but results in a first-order gain for Foreign (according to (30)), and τ_x^H and τ_x^F can then be adjusted holding τ_x fixed so as to compensate Home for the second-order loss and still leave Foreign with a first-order gain from this maneuver.

It is instructive to consider further the nature of the additional Pareto gains that a trade agreement can generate in this setting beyond eliminating international rent/cost-shifting motives and thereby providing governments with an avenue of escape from a terms-of-trade driven Prisoners' Dilemma. To this end, notice from the first line of (22) that the changes in τ_1^H and τ_x^H described above—which leave p_x^* and p_x^F unchanged—impact Foreign welfare only by changing $\bar{x}$. Therefore, using $p_x^* - p_x^F = \tau_x^F$ and (22), we may write the resulting impact on Foreign welfare as

$$dW^F \; = \; \gamma^F \big[p_x^F \; - \; 1 \big] d\bar{x} \; + \; \tau_x^F d\bar{x}.$$

When $\gamma^F = 1$, the expression above simplifies to $dW^F = \gamma^F [p_x^* - 1] d\bar{x}$ and it is direct to establish that at the political optimum τ_x^F is set so that $p_x^* = 1$. Hence, when $\gamma^F = 1$, Foreign is not affected to the first order by a change in $\bar{x}$. In this case, as we have observed, the political optimum is efficient. But when $\gamma^F > 1$, it can be verified that at the political optimum Foreign offers an export subsidy to its input producers ($\tau_x^F < 0$) and raises the price they receive above their unit cost ($p_x^F > 1$). Consequently, beginning from the political optimum and for $\gamma^F > 1$, a small increase in $\bar{x}$ induced by changes in τ_1^H and τ_x^H which leave p_x^* and p_x^F unchanged will increase Foreign's valuation of the surplus directed to Foreign input producers ($\gamma^F [p_x^F - 1] d\bar{x} > 0$), which is good for Foreign; but it will also raise the budgetary cost of Foreign's export promotion program ($\tau_x^F d\bar{x} < 0$), which is bad for Foreign. Foreign will then benefit from a slight increase in $\bar{x}$ when the first effect dominates the second; and when instead the second effect dominates the first, Foreign will benefit from a slight reduction in $\bar{x}$. Either way, with Home unaffected to the first order

by these policy adjustments, an efficiency improvement over the political optimum can be generated.[32]

Evidently, then, the home country's policies can help provide a more efficient means of redistributing income toward input suppliers in the foreign country than is possible with the foreign country's own policies alone; and when the foreign government values this redistribution, the need for additional international policy coordination beyond that required to eliminate terms-of-trade manipulation is then implied.[33] We summarize this discussion with:

PROPOSITION 5: *In the presence of offshoring, an efficient trade agreement must serve two roles: it must provide governments with an avenue of escape from a terms-of-trade driven Prisoners' Dilemma; and when the foreign government objectives include political economy considerations, it must coordinate the setting of policies across countries so as to reduce the deadweight loss associated with export promotion programs for traded intermediate inputs.*

Notice that, as is reflected in Proposition 5, it is the foreign political economy forces that prevent the politically optimal policies from being efficient. More generally, however, in the presence of symmetric home-supplier/foreign-producer relationships (which for example could be introduced into the Benchmark Model with the addition of a mirror-image second sector with the roles of Home and Foreign reversed), political economy forces in either country will interfere with the efficiency properties of the political optimum.[34]

Why is it important to characterize the purpose of a trade agreement? Identifying the underlying problem(s) that a trade agreement can solve is useful in part because it may suggest some simple institutional design features that could be helpful to governments in their efforts to solve the problem(s). In this regard, reciprocity and non-discrimination (the latter as embodied in the most-favored-nation (MFN) clause) are viewed as pillars of the GATT/WTO architecture, and Bagwell and Staiger (1999, 2002) have shown in a wide range of settings that a reciprocity rule (and, in a many country competing-exporter setting, reciprocity in combination with

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[32] To see which direction of change in $\hat{x}$ is implied by the changes in τ_1^H and τ_x^H described in the text, we may use (4) and

(18) to derive that $\dfrac{\partial \hat{x}(\tau_1^H, \tau_x)}{\partial \tau_1^H} + \dfrac{\partial \hat{x}(\tau_1^H, \tau_x)}{\partial \tau_x} \dfrac{d\tau_x^H}{d\tau_1^H}\bigg|_{dp_x^*=0} = \dfrac{\left[\frac{y(\hat{x})}{\hat{x}} - y'(\hat{x})\right]\hat{x}}{p_1^H\left(\left[\frac{y(\hat{x})}{\hat{x}} - y'(\hat{x})\right] + \hat{x}y''\right)}$, and so the sign of the change in $\hat{x}$ implied

by these tariff changes is the same as the sign of $\left(\left[\frac{y(\hat{x})}{\hat{x}} - y'(\hat{x})\right] + \hat{x}y''(\hat{x})\right)$. As indicated in footnote 31, when y takes

the form of the power function $y(x) = x^\eta/\eta$ as in our parameterized example in Appendix A, $\left(\left[\frac{y(\hat{x})}{\hat{x}} - y'(\hat{x})\right] + \hat{x}y''(\hat{x})\right)$

> 0 for $\hat{x} > 0$, and so in this case the described tariff adjustments imply an increase in $\hat{x}$. For the other example mentioned in footnote 31, where $y(x) = \theta \log(1 + x)$, it can be shown for a range of model parameters that $\left(\left[\frac{y(\hat{x})}{\hat{x}} - y'(\hat{x})\right] + \hat{x}y''(\hat{x})\right) < 0$ when evaluated at the political optimum, and hence for this case the described tariff adjustments imply a decrease in $\hat{x}$.

[33] It might be conjectured that this finding hinges on the foreign country being small in the world market for the final good, so that it is unable to use its final good tariff to alter final good prices in the home-country market by itself. But, as we show in the online Appendix, allowing the foreign country to be large in the world market for the final good does not alter our basic finding.

[34] In addition, as we establish in the online Appendix and describe further there, political economy forces in either country will interfere with the efficiency properties of the political optimum when the model is extended to allow the foreign country to be large in the world market for the final good.

MFN) can help guide countries to politically optimal policies as we have defined those policies above. And it can be confirmed that the properties of reciprocity that accomplish this operate as well in the model that we have developed here.[35] But as we have just shown and as Proposition 5 reflects, when governments have political economy motives, politically optimal tariffs are not efficient in the presence of offshoring. And so, in this setting, reciprocity's ability to guide governments to politically optimal policies will not deliver efficient outcomes (except in the case where governments are national income maximizers). Proposition 5 therefore implies that the traditional pillars of the GATT/WTO architecture cannot be counted on to deliver efficient bargaining outcomes in the presence of offshoring. Notice, too, that according to Proposition 5, the problem that a trade agreement must address *varies* with the political preferences of member governments. This carries a further implication: when offshoring is present, simple and general rules that can help governments negotiate to efficient policy choices may simply be unavailable.

Finally, it is worth emphasizing that the statements in Propositions 3, 4, and 5 continue to be true even when the hold-up inefficiencies under free trade in the Benchmark Model disappear. More specifically (and abstracting from political economy forces though analogous statements apply in their presence), recall that when $\alpha \to 0$, foreign suppliers have full bargaining power and the level of investment under free trade is at its efficient level $\left(\text{i.e., } \hat{x} \to x^E\right)$, thereby implying that the second-best policies call for no trade intervention $(\tau_1^{HE} = 0, \tau_x^E \to 0)$. Nevertheless, as the expressions in (8) and (13) make clear, $\hat{\tau}_1^{HN} < 0$ and $y'(\hat{x}^N) > 1$ even when $\alpha \to 0$, and thus Nash policies continue to exhibit the same two inefficiencies in that case. This indicates that the key feature of the Benchmark Model which is responsible for our central results is not the hold-up inefficiencies associated with lock-in effects, but rather the bilateral determination of prices resulting from these lock-in effects (this point is further emphasized in Antràs and Staiger 2012).[36]

C. *Institutional Responses to the Rise of Offshoring*

In the previous sections we have suggested that traditional GATT/WTO concepts and rules—such as market access, reciprocity and MFN/non-discrimination—are not particularly well suited to help governments solve their trade-related problems in the presence of offshoring. These conclusions are at odds with the implications of the terms-of-trade theory of trade agreements. In this section we relate our findings to those of the terms-of-trade theory, and draw inferences about the broader implications of the rise in offshoring for the changing nature of the role and design of trade agreements.

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[35] In particular, following Bagwell and Staiger (1999, 2001b) we define tariff changes that conform to reciprocity as those that bring about equal changes in the volume of each country's imports and exports when valued at existing world prices. Using this definition, accounting for trade in the numeraire good 0 and the final good 1 as well as the input x, and proceeding along the lines of Bagwell and Staiger (2001b, footnote 19), it is straightforward to establish that tariff changes that conform to reciprocity (and that do not eliminate trade in the input x) must leave the international price p_x^*—and hence the terms of trade—unchanged. This is the key property of reciprocity that Bagwell and Staiger (1999, 2002) show can help to guide governments toward the political optimum.

[36] As can also be confirmed from (8), at the other extreme when $\alpha \to 1$ and the home final good producer has all of the bargaining power, the home government need not concern itself with extracting surplus from foreign input suppliers and hence $\hat{\tau}_1^{HN} \to 0$.

We begin with Proposition 4, which states that governments must agree to constraints on policies that extend beyond market access commitments if they are to achieve efficient policy outcomes in the presence of offshoring, a finding that as we have indicated holds whether or not governments face political economy pressures. This implication contrasts sharply with the implications of the terms-of-trade theory. As Bagwell and Staiger (2001a) have demonstrated, according to the terms-of-trade theory, and whether or not governments face political economy pressures, the inefficiency associated with Nash policy choices can be characterized simply as a problem of insufficient market access. That is, the level of market access offered by each government in the Nash equilibrium is inefficiently low, but the mix of policies that each government uses to deliver this level of market access is efficient. And as Bagwell and Staiger explain, the negotiation of a trade agreement that focuses on market access commitments along the lines that we have described above is sufficient to allow governments to achieve internationally efficient policies. Hence, the terms-of-trade theory provides strong support for the market-access focus of the GATT/WTO.

Importantly, the settings considered by Bagwell and Staiger (2001a) all share the property that international prices are determined by market-clearing, leading to a natural definition of market access as the volume of imports a country would accept at a particular international price (i.e., a point on the country's import demand curve). As Bagwell and Staiger emphasize, policy adjustments by one country that do not alter market access defined in this way do not alter equilibrium international prices or trade volumes, and hence cannot effect the country's trading partners.[37] It is because of this feature that a country acting unilaterally can be expected to make internationally efficient policy choices when it is held to its market-access commitments. But as our Benchmark Model confirms, this feature does not hold in the presence of offshoring, because international prices are determined by bilateral bargaining, not by a market clearing condition.[38] And as we have established above, in this setting a market access commitment cannot both protect exporting governments from harm and provide importing governments with the policy flexibility they would need to make efficient unilateral adjustments to their policy mix. Viewed from the perspective of the terms-of-trade theory, the findings reported in Proposition 4 can then be interpreted as suggesting that the rise in offshoring and its implication for international price determination is likely to erode the effectiveness of the market-access focus of the GATT/WTO.

[37] It is now also possible to see that the two alternative formalizations of market access commitments that we consider in Section IVA bracket the formalization adopted by Bagwell and Staiger (2001a), because under their formalization, the volume of imports a country would accept at a particular international price is fixed by a market access commitment, and this has the implication of fixing equilibrium volume and international price, while under our first possibility the volume of imports (at any international price) is fixed but this does not imply that the equilibrium international price is fixed, and under our second possibility the equilibrium volume and international price are fixed directly.

[38] Our model of offshoring differs from models representative of the terms-of-trade theory in two ways: first, it emphasizes input trade; and second, the international price of the traded input is determined by bilateral bargaining. We establish in the online Appendix, however, that a model of input trade in which the international price of the traded input is determined by a market clearing condition does not exhibit the novel properties that our offshoring model exhibits, which is why we can attribute these properties to the novel manner in which international prices are determined in our model (see also Antràs and Staiger 2012).

Next we turn to Proposition 5 which states that, beyond providing governments with an avenue of escape from a terms-of-trade driven Prisoners' Dilemma, an efficient trade agreement must also address a separate "political externality" that arises in the presence of offshoring.[39] In effect, as we have described, in the presence of offshoring a trading partner's policies can help provide a more efficient means of redistributing income toward specific groups in a country than is possible with that country's own policies alone, giving rise in turn to the need for additional international policy coordination beyond that required to eliminate terms-of-trade manipulation.

The identification of a political externality is also in stark contrast to the predictions of the terms-of-trade theory, where as established by Bagwell and Staiger (1999, 2002) the presence of political economy motives has no impact on the nature of the problem that a trade agreement must solve, which remains the elimination of terms-of-trade manipulation. This feature is important because, as Bagwell and Staiger establish, it implies that politically optimal policies, as we have defined above, are internationally efficient; and that the GATT/WTO pillars of reciprocity and MFN/non-discrimination, in guiding governments toward politically optimal policies, can then be interpreted as simple rules that, under a broad range of possible political economy motives, work to eliminate international cost-shifting and help governments achieve efficient policies. In this way, the terms-of-trade theory provides strong support for the basic pillars of the GATT/WTO approach to trade liberalization. The findings we report in Proposition 5 cast doubt on the appropriateness of these pillars in a world of pervasive offshoring: our contrasting results can again be traced to the implications of offshoring for the way in which international prices are determined, and they suggest that the rise in offshoring and its implication for international price determination is likely to diminish the ability of the GATT/WTO pillars of reciprocity and non-discrimination to guide governments to efficient trade agreements.

Taken together, these results indicate that if the WTO is to remain an effective institution, its tradition of market access negotiations guided by a few simple and broadly-applied rules will need to give way to a deeper form of integration that considers a wider set of policy instruments and delivers more individualized agreements that can better reflect member-specific idiosyncratic needs. In this sense, our findings suggest that the rise of offshoring will present the WTO with a profound institutional challenge.

V. Sensitivity

In this section, we consider the generality of our central findings to various alternative modeling assumptions. For simplicity, we return to the setting of Section II in which governments do not possess political economy motives. Our main conclusion is that, in each of the extensions that we consider, the role of a trade agreement continues to be to correct both the inefficiently low input trade volume and the inefficiency in the home-market final good price that arise under Nash policies, implying

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[39] We note that this externality bears a resemblance to that described in Ethier (2004). As Ethier (p. 305) puts it, "Political externalities," by my definition, arise when policymakers in one country believe that their political status (whatever that might be specified to mean) is directly sensitive, to some degree, to actions by policymakers in another country." See also Bagwell and Staiger (2002, chapter 2) for a further discussion of these ideas.

that our central findings embodied in Propositions 3 through 5 then continue to hold. To save space, we relegate most of the mathematical details to the online Appendix.

A. *Secondary Market*

In the Benchmark Model we have assumed that the lack of an ex post contractual agreement leaves both parties with no time to attempt to transact with alternative producers, and thus the outside options in the bargaining are equal to 0. We have explored the robustness of our results to the case in which there exists a secondary market for inputs but there are still gains from trade in the primary market because of the imperfect customization inherent in resorting to a secondary market (which reduces the surplus created by a final-good-producer and supplier pair).[40] In the online Appendix, we show that as long as the primitive bargaining power of final-good producers versus suppliers is identical in the primary and secondary market, the introduction of the secondary market has no effect on the equilibrium expressions (and thus the results) obtained in our Benchmark Model. We also show that when the relative bargaining power of suppliers is different in the primary and secondary markets, then the tariff choices would be different from those obtained in our Benchmark Model, but the main conclusions from our analysis would remain unaltered.

In describing the Benchmark Model, we have emphasized the role of customization in creating the lock-in effect at the heart of the bilateral determination of prices and the holdup problem. As shown in the online Appendix, a simple variant of this extension of the model can be used to show that the same lock-in effect could be generated by (ex post) search frictions even in the absence of any customization.

B. *Ex Ante Lump-Sum Transfers*

Our Benchmark Model rules out ex ante lump-sum transfers between home producers and foreign suppliers. Although this seems a plausible assumption in our international framework where the promises associated with these transfers may be hard to enforce, it is important to study the robustness of our results to this assumption. For that purpose, we have considered a modification of *stage* 1 of our Benchmark Model in which lump-sum transfers are allowed and these are determined by a bargaining process captured by the generalized Nash bargaining solution with weights β and $(1 - \beta)$ for the home producer and foreign supplier, respectively, where $\beta \in (0, 1)$. In that case, the equilibrium level of $\hat{x}$ will be identical to that in the Benchmark Model, since foreign suppliers choose $\hat{x}$ to maximize ex post payoffs (thus ignoring ex ante payments), but the Nash equilibrium trade policies will be affected by this different distribution of overall surplus. The particular expressions describing these policies can be found in the online Appendix. The important conclusion for our purposes, however, is that the implied volume of input trade continues to be inefficiently low and that the Home government continues to distort the final good market (by lowering p_1^H) with the aim

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[40] Beyond determining outside options, the secondary market plays no role in the model and is only used by a negligible measure of producers in equilibrium.

of extracting bargaining surplus from foreign suppliers. Hence, trade agreements serve the same role in this extension as in our Benchmark Model.

C. *Vertical Integration*

Up to now we have not taken a stance as to whether the home producer and foreign supplier are vertically related or not. According to the transaction-cost approach to the boundaries of the firm (c.f., Coase 1937; Williamson 1985), vertical integration would arise precisely when the hold-up inefficiencies that we have modeled above become large relative to the larger "governance" costs of running an integrated organization. Under that view, the novel role for trade agreements in the presence of offshoring that we have identified might disappear if all production decisions are taken by a vertically-integrating final good producer and no bargaining over prices occurs. In practice, however, offshore outsourcing is quantitatively important in the data.

More relevantly, the property-rights approach to the theory of the firm (c.f., Grossman and Hart 1986; Hart and Moore 1990) has persuasively argued that firm boundaries are better understood as determining the relative bargaining power of producers (via the allocation of residual rights of control inherent in the ownership of productive physical assets) rather than as affecting the space of contracts available to economic agents. Under this interpretation, the role for trade agreements that our Benchmark Model identifies would still apply even to vertically integrated cross-border production relationships. A crude way to capture the essence of the property-rights theory of the firm in terms of the Benchmark Model is to think about firm boundaries as a discrete choice among different feasible values of the parameter α in our model, with final-good producers retaining a relatively high bargaining power (high α) under vertical integration. With this interpretation, our finding in the Benchmark Model that the role of a trade agreement is not sensitive to the particular value of $\alpha \in (0,1)$ then suggests as well that the presence or absence of vertical integration would not alter the fundamental role of a trade agreement.[41] While one could study how the integration decision (i.e., the optimal choice of α) interacts with trade policy in our framework, such analysis is beyond the scope of this paper.[42]

D. *Multiple Foreign Countries and Search Costs*

In the Benchmark Model, we have restricted our analysis to situations in which home producers can only search for suppliers in *F*. It is straightforward to show that at least some of our results could be overturned when this restriction is relaxed. To see this, consider the case in which there is a second "foreign" country, denoted by *S* for "South," with an additional unit measure of potential suppliers identical to those in *F*.

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[41] This is not to say that the presence or absence of vertically integrated home producers and foreign suppliers would be irrelevant for the nature of trade agreements. On the contrary, to the extent that international factor ownership associated with vertically integrated multinational firms alters the objective functions of each government, the nature of trade agreements could be very much affected (see Blanchard 2010). Rather, our point is simply that vertical integration does not by itself obviate the novel role for a trade agreement that our Benchmark Model identifies.

[42] Note that vertical integration may be optimal for final-good producers whenever α is sufficiently small, despite the fact that supplier underinvestment will be aggravated by such integration. This is due to the constraints on ex ante transfers in our framework (see Acemoglu, Antrás, and Helpman 2007).

Assume that F and S are identical in every other respect, including preferences, technology, and bargaining strength. Under these circumstances and as long as $\tau_x^F > \tau_x^S$, all home producers will prefer to match with southern suppliers over suppliers in F. As a result, the government in F will have an incentive to reduce its export tax below the southern one. Pushing this argument further, it is straightforward to show then that the optimal foreign and southern export taxes that emerge from this variant of the model are negative (i.e., they are subsidies) and Home ends up capturing all the welfare gains from offshoring.[43] As a result, the mix of policies τ_1^{HN} and τ_x^{HN} will be efficient and the rationale for a trade agreement will have vanished.

This example, however, is special in a number of ways. To begin with, the assumption that F and S are symmetric is not innocuous: if one of the two foreign countries has a comparative advantage in supplying inputs, it can (and will) maintain a positive export tax (analogous to "limit pricing" in the case of Bertrand competition among firms), and the result of our Benchmark Model is then preserved. More importantly, the structure of the example above imposes that home producers find a match with probability one, no matter where they search for suppliers. As emphasized by Grossman and Helpman (2005), an important feature of offshoring relationships is the costly search for suitable partners. The same characteristics that make offshoring relationships contractually difficult (i.e., customization, international enforceability of contracts, etc.) preclude the existence of a frictionless competitive market for inputs or for suppliers. In the online Appendix, we explicitly introduce these search frictions and confirm that the central findings of our Benchmark Model are robust to the introduction of multiple foreign countries where inputs may be sourced.

E. *Ad Valorem Tariffs*

We have assumed throughout that tariffs on final goods and intermediate inputs are specific. It is straightforward to verify that nothing substantive changes if the final good tariffs are expressed in ad valorem terms. The case of ad valorem import tariff on intermediate inputs is more interesting. In particular, in the online Appendix, we show that ad valorem input tariffs introduce a novel channel through which bargaining between the home producer and foreign supplier can be affected. Despite this novel channel, however, we confirm that the role played by an international trade agreement remains the same.

The key new feature associated with ad valorem tariffs is that these instruments affect the *slope* of the bargaining frontier between the home producer and the foreign supplier. A positive ad valorem import tariff or export tax makes this slope steeper, because the producer and supplier are then penalized for shifting surplus toward the foreign supplier through a high price p_x^*. On the other hand, a negative ad valorem tariff (an import or export subsidy) makes the slope of the bargaining frontier flatter, thus encouraging transfers of surplus toward the foreign supplier.[44] This constitutes

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[43] The logic is analogous to that behind the fact that Bertrand competition implies marginal-cost pricing.

[44] We abstract here from the possibility that firms might engage in transfer-pricing-type behavior in order to avoid trade taxes or collect trade subsidies. In our setting, this amounts to assuming that firms do not have other (non-price) means to transfer surplus between them in their bilateral bargain. If they did have such means, then the price they negotiate would be determined completely by the sign of the trade taxes subject only to the ability of governments to regulate such behavior. Even without such means, the firms in our model do respond to government

a novel channel through which ad valorem trade taxes can affect the severity of the international hold-up problem. This channel is not present when a specific tariff is instead utilized, because the slope of the bargaining frontier between producer and supplier is -1 independent of the level of the specific tariffs τ_x^H and τ_x^F.

When solving for the Nash taxes in this setup, however, we confirm the key inefficiencies existing in our Benchmark Model (see the online Appendix for details). Hence, while the mechanisms through which specific and ad valorem tariffs on traded inputs influence the international hold-up problem are distinct, the broad conclusions are similar to those obtained above. Combining this with our earlier observation that the form of the final good tariff is immaterial, we may conclude that the central findings of our Benchmark Model are robust to the form (ad valorem or specific) that tariffs take, despite the different mechanisms that operate in the two environments.[45]

F. *Domestic Suppliers*

Our Benchmark Model assumes that home final good producers never purchase intermediate inputs from local suppliers located at home. One may wonder whether this assumption is important for our results. In the online Appendix, we show that the presence of local suppliers may affect the positive implications of our model for the type and sign of policy instruments that will be used by governments in the Nash equilibrium, but it does not significantly affect the nature of constrained efficient trade policies, and more importantly, it does not affect the substantive results of the Benchmark Model regarding the role of trade agreements. The reason is that distortions (if any) in the provision of domestic inputs at home are optimally targeted through the use of *domestic subsidies* to input producers at home. But constrained efficient policies will naturally include domestic subsidies that are set in a way that eliminates domestic hold-up problems and, hence, this extended model essentially collapses to our Benchmark Model, with the constrained efficient policies of the extended model analogous to those in our Benchmark Model (with the addition of domestic input subsidies at home).[46]

If investments by domestic suppliers at home are independent of those by foreign suppliers (say because final good producers buy only from foreign suppliers or from domestic suppliers, but not from both), then Nash policy choices are also identical to those in our Benchmark Model. As shown in the online Appendix, matters become more complicated when locally-provided inputs are either complements or substitutes with respect to the inputs provided by suppliers in Foreign. In such a case, the

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trade taxes by negotiating different prices, but at least when these firms are taken to be engaged in arms-length transactions this would not be interpreted as transfer pricing in the traditional sense.

[45] It is interesting to observe that the novel channel through which ad valorem tariffs alter the bargaining outcome between home producer and foreign supplier—namely, the slope of the bargaining frontier—also suggests that these policy instruments may have a broader class of applicability with regard to their ability to mitigate international hold-up problems than is the case for specific tariffs. For example, if x were reinterpreted as the unverifiable quality of a fixed unit to be traded, so that tariff policy could not then be conditioned on x, a specific tariff on trade in x would lose its ability to affect the hold-up problem, but an ad valorem tariff could continue to play this role.

[46] We note that the introduction of domestic subsidies along these lines, even though they are efficiency-enhancing, might well run into conflict with the WTO rules on domestic subsidies. But we do not emphasize this point here, because it is a particular example of a more general tension between Pigouvian intervention and WTO subsidy rules that has been pointed out by Bagwell and Staiger (2006).

home government will not fully internalize the effect of domestic subsidies to its suppliers on foreign welfare, and the provision of these subsidies will in general be inefficient. This in turn complicates characterizing the sign of the remaining policy instruments used in the Nash policy game (i.e., the input trade taxes charged by the home and foreign governments as well as the final good trade tax imposed by the home government). Nevertheless, in the online Appendix we show that these policies continue to diverge from the constrained efficient policies, so there is still a role for trade agreements. Furthermore, the home country now has the ability to affect the international price p_x^* through three different policy instruments, and this only reinforces our main conclusions regarding the need to extend trade agreements to a wider set of policies (see also footnote 30).

G. *Two-Sided Investments*

Our modeling of final good production in the Benchmark Model is exceedingly simple. In the online Appendix, we also consider the case in which transforming the supplier's intermediate input into a final good requires an additional relationship-specific investment (or input) on the part of the final good producer, as in the property-rights model of Antràs (2003, 2005) and Antràs and Helpman (2004). It turns out that the analysis is essentially identical to a variant of the model with domestic suppliers described before, where final good producers play the role of these domestic suppliers. In this variant of the model, it is again the case that the constrained efficient policies are identical to those in our Benchmark Model, except for the introduction of a subsidy to the provision of the final good producer's input. The Nash policy choices depart from those in our Benchmark Model, but they do so in an analogous manner to the case with domestic suppliers (see the online Appendix for details).

VI. Conclusion

In this paper, we have initiated the study of trade agreements in the presence of offshoring. Our findings indicate that the rise of offshoring and its implications for international price determination will complicate the task of trade agreements for two reasons. First, the mechanism by which countries shift the costs of intervention on to their trading partners is more complicated in the presence of offshoring and extends to a wider set of policies than is the case when offshoring is not present, and this implies that the agreements themselves must extend beyond market access to a wider set of policies as well—a form of deep integration. And second, the underlying problem that a trade agreement must address in the presence of offshoring varies with the political preferences of member governments, interfering with the ability of governments to rely on reciprocity and non-discrimination to guide their negotiations and shape their agreements.

As a consequence of these findings, we have argued that the growing prevalence of offshoring will make it increasingly difficult for governments to utilize traditional GATT/WTO concepts and rules to help them solve their trade-related problems. Instead, effective trade agreements and the institutions that support them will have to evolve, from a market access focus toward a focus on deep

integration, and from a reliance on simple and broadly-applied rules that guide the member-governments in their negotiations and shape their agreements, toward a collection of more-individualized agreements that can better reflect member-specific idiosyncratic needs.

In this regard, it is interesting to observe that the dual features of deep integration and member-specific agreement characteristics seem to describe fairly well not the central multilateral approach to liberalization embraced by the GATT/WTO, but rather the approach to liberalization embodied in the exploding web of preferential agreements that WTO members have negotiated with each other (outside the WTO and under the GATT Article XXIV exception to non-discrimination) over the past two decades. Indeed, some have argued that the growth of preferential agreements in Asia beginning in the 1990s may have been triggered by the growth in offshoring and "value chains" in that region (see, for example, WTO 2011); and the empirical findings of Orefice and Rocha (2011) suggest the possibility that a causal relationship running from offshoring to preferential agreements may hold more broadly. Our findings would lend some formal support to this possibility, because they suggest that WTO-member governments whose countries experience a dramatic rise in the importance of offshoring might seek out preferential agreements as a way to achieve the deep integration and idiosyncratic bargains that WTO commitments in their current form could not adequately provide.[47]

In a similar vein, the practice of bilateral bargaining over prices may be especially prevalent in the area of service trade, an important and growing segment of the WTO liberalization agenda. It is therefore interesting that, despite its efforts, the WTO's contribution to liberalization of trade in services has to date been negligible (see, for example, Francois and Hoekman 2010). Can the forces we identify here help explain the WTO's relative lack of success in facilitating liberalization in the service sector?

More broadly, an important open question is the impact of offshoring on specific bargaining outcomes within the WTO. We have established here that the rise in offshoring is likely to interfere with the ability of traditional GATT/WTO concepts and rules to deliver efficient bargaining outcomes for member governments. But we have stopped short of providing a full characterization of the bargaining outcomes that theoretically would emerge in a GATT/WTO-like setting when offshoring is present. For this reason, while our Figure 1 presents suggestive evidence that countries have more difficulty liberalizing trade through WTO negotiations in sectors where customized inputs are especially prevalent, that evidence can be no more than suggestive: providing more conclusive evidence of our model's predictions would require working out the impact of offshoring on specific bargaining outcomes within the WTO and confronting those predictions with the data. These and related issues strike us as fertile areas for further research.

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[47] That said, it should be emphasized that this does not diminish the institutional challenge that offshoring poses for the WTO, because the existence of preferential agreements pose their own problems for the effectiveness of the GATT/WTO architecture in helping member governments solve the terms-of-trade Prisoners' Dilemma problem (see, for example, Bagwell and Staiger 2002).

Appendix

In this Appendix we provide a discussion of the second-order conditions of the main tariff setting problems developed in the text.

A. *Constrained Efficient Policy Choices in the Benchmark Model*

It is easily verified that the second order conditions associated with the first-order conditions in (7) are satisfied. Simply note that evaluated at the equilibrium, we have

$$\frac{\partial^2 W^W}{\partial (\tau_1^H)^2} = \frac{\partial D_1}{\partial p_1^H} + y''(\hat{x}) \left(\frac{\partial \hat{x}}{\partial \tau_1^H} \right)^2 < 0$$

$$\frac{\partial^2 W^W}{\partial (\tau_x)^2} = y''(\hat{x}) \left(\frac{\partial \hat{x}}{\partial \tau_x} \right)^2 < 0$$

$$\frac{\partial^2 W^W}{\partial \tau_x \partial \tau_1^H} = y''(\hat{x}) \frac{\partial \hat{x}}{\partial \tau_1^H} \frac{\partial \hat{x}}{\partial \tau_x} > 0,$$

and thus $(\partial^2 W^W / \partial (\tau_1^H)^2)(\partial^2 W^W / \partial (\tau_x)^2) - (\partial^2 W^W / \partial \tau_x \partial \tau_1^H)^2 = (\partial D_1 / \partial p_1^H) \times y''(\hat{x})(\partial \hat{x} / \partial \tau_x)^2 > 0.$

B. *Nash Equilibrium Policy Choices in the Benchmark Model*

We now consider the second-order conditions of the Nash equilibrium. Using equation (4) which characterizes the equilibrium choice of $\hat{x}$, that is $(1 - \alpha)(1 + \tau_1^H) y'(\hat{x}) = 1 + (1 - \alpha) \tau_x$, we can simplify the first-order conditions to obtain:

$$\frac{\partial W^H}{\partial \tau_1^H} = 0 = \tau_1^H \frac{\partial D_1}{\partial p_1^H} - (1 - \alpha) y(\hat{x}) + [y'(\hat{x}) - 1 - \tau_x^F] \frac{\partial \hat{x}}{\partial \tau_1^H},$$

$$\frac{\partial W^H}{\partial \tau_x^H} = 0 = (1 - \alpha) \hat{x} + [y'(\hat{x}) - 1 - \tau_x^F] \frac{\partial \hat{x}}{\partial \tau_x^H}, \quad \text{and}$$

$$\frac{\partial W^F}{\partial \tau_x^F} = 0 = \alpha \hat{x} + \tau_x^F \frac{\partial \hat{x}}{\partial \tau_x^F}.$$

Consider first the second-order condition for the choice of τ_x^F, i.e., $\partial^2 W^H / \partial (\tau_x^F)^2 < 0$. Differentiating the last expression above with respect to τ_x^F, we have

(A1)
$$\frac{\partial^2 W^F}{\partial (\tau_x^F)^2} = (1 + \alpha) \frac{\partial \hat{x}}{\partial \tau_x^F} + \tau_x^F \frac{\partial^2 \hat{x}}{\partial (\tau_x^F)^2}.$$

But using the implicit function theorem on (4), we have

(A2)
$$\frac{\partial \hat{x}}{\partial \tau_x^F} = \frac{1}{(1 + \tau_1^H) y''(\hat{x})},$$

which implies

(A3)
$$\frac{\partial^2 \hat{x}}{\partial (\tau_x^F)^2} = -\frac{1}{(1 + \tau_1^H)(y''(\hat{x}))^2} y'''(\hat{x}) \frac{\partial \hat{x}}{\partial \tau_x^F}.$$

Using these expressions as well as $\tau_x^F = -\alpha \hat{x}/(\partial \hat{x}/\partial \tau_x^F)$, we can write (A1) as

$$\frac{\partial^2 W^F}{\partial (\tau_x^F)^2} = \frac{\partial \hat{x}}{\partial \tau_x^F} \left(1 + \alpha + \alpha \frac{\hat{x} y'''(\hat{x})}{y''(\hat{x})} \right),$$

which is negative only if $1 + \alpha + \alpha \hat{x} y'''(\hat{x})/y''(\hat{x}) > 0$. As an example, assume that $y(x) = x^\eta/\eta$, with $\eta \in (0, 1)$. In this case, we have $y''(x) = (\eta - 1) x^{\eta-2}$ and $y'''(x) = (\eta - 2)(\eta - 1) x^{\eta-3}$, and hence $1 + \alpha + \alpha \hat{x} y'''(\hat{x})/y''(\hat{x}) = 1 - \alpha + \alpha \eta$, which is indeed positive.

The fact that in the Nash equilibrium we have $\tau_1^H \neq 0$ implies that the second-order conditions for the choice of τ_1^H and τ_x^H are more cumbersome to characterize, as they will now also involve properties of the demand function. Throughout the paper, we simply assume that they are satisfied without providing the exact conditions needed. But here we develop a particular case of our model where the second order conditions for the choice of τ_1^H and τ_x^H are easy to characterize. In particular, we make the simplifying assumption that demand for the final good is linear, with $\partial D_1/\partial p_1^H = -\lambda$ where λ is a positive parameter. With this demand assumption, using our assumption just above that $y(x) = x^\eta/\eta$, and imposing $\partial W^H/\partial \tau_x^H = 0$ to eliminate τ_x^F, it can be confirmed that

$$\frac{\partial^2 W^H}{\partial (\tau_1^H)^2} = -\lambda - \frac{\hat{x}^\eta}{(1 + \tau_1^H)^2 (1 - \eta)},$$

$$\frac{\partial^2 W^H}{\partial (\tau_x^H)^2} = -\frac{[1 - (1 - \alpha)(1 + \tau_1^H)(1 - \eta)] \hat{x}^{2-\eta}}{(1 + \tau_1^H)^2 (1 - \eta)}, \quad \text{and}$$

$$\frac{\partial^2 W^H}{\partial \tau_1^H \partial \tau_x^H} = \frac{\hat{x}}{(1 + \tau_1^H)^2 (1 - \eta)}.$$

Recall that $\tau_1^H > -1$ is required for $p_1^H > 0$ and that this is implied by the first-order conditions provided that Home demand for final good 1 is sufficiently price sensitive for p_1^H close to zero (see footnote 22). For our linear demand case this imposes a restriction that λ not be too small, which we assume is met. From the expressions

above, we then have that $\partial^2 W^H / \partial(\tau_1^H)^2 < 0$ and $\partial^2 W^H / \partial(\tau_x^H)^2 < 0$, and so the second-order conditions for τ_1^H and τ_x^H are satisfied provided that

$$\frac{\partial^2 W^H}{\partial(\tau_1^H)^2} \frac{\partial^2 W^H}{\partial(\tau_x^H)^2} > \left(\frac{\partial^2 W^H}{\partial \tau_1^H \partial \tau_x^H} \right)^2.$$

Using the expressions above, this inequality can be written as

$$(A4) \qquad \lambda > \frac{(1 - \alpha)\hat{x}^\eta}{(1 + \tau_1^H)[1 - (1 - \alpha)(1 + \tau_1^H)(1 - \eta)]}.$$

Finally, note that in our parametric example, equations (8) and (13) imply

$$\tau_1^H = -\frac{(1 - \alpha)}{\lambda} \frac{1 - \eta}{\eta} \hat{x}^\eta$$

$$\hat{x}^{\eta-1}\left(\eta + \frac{(1 - \alpha)}{\lambda} \frac{(1 - \eta)^2}{\eta} \hat{x}^\eta \right) = 1,$$

and thus for sufficiently high λ, the right-hand side of (A4) will converge to

$$\frac{(1 - \alpha)\eta^{\eta/(1-\eta)}}{1 - (1 - \alpha)(1 - \eta)},$$

and thus inequality (A4)—and hence the second-order conditions for the choice of τ_1^H and τ_x^H—is necessarily satisfied for λ sufficiently large (i.e., home demand for the final good sufficiently price-sensitive).

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