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A HOLD-UP INTERPRETATION.

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ABSTRACT

A central institution of US trade policy is Fast-Track Authority (FT), by which Congress commits not to amend a trade agreement that is presented to it for ratification, but to subject the agreement to an up-or-down vote.

We offer a new interpretation of FT based on a hold-up problem. If the US government negotiates a trade agreement with the government of a smaller economy, as the negotiations proceed, businesses in the partner economy, anticipating the opening of the US market to their goods, may make sunk investments to take advantage of the US market, such as quality upgrades to meet the expectations of the demanding US consumer. As a result, when the time comes for ratification of the agreement, the partner economy will be locked in to the US market in a way it was not previously. At this point, if Congress is able to amend the agreement, the partner country has less bargaining power than it did ex ante, and so Congress can make changes that are adverse to the partner. As a result, if the US wants to convince such a partner country to negotiate a trade deal, it must first commit not to amend the agreement ex post. In this situation, FT is Pareto-improving.

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1 Introduction

A central institution of US trade policy is the practice by which Congress from time to time commits in advance not to amend a trade agreement that is presented to it for ratification, but to subject the agreement to an up-or-down vote. This institution, which delegates a portion of Congress' authority to the executive branch, has been called *Fast-Track Authority* (FT) in the past, and is often now referred to as *Trade-Promotion Authority.*

Fast Track has at times been intensely controversial, and recent debates over it have borne this out. The most recent bill to enact Fast-Track Authority (H.R. 3830, named the "Bipartisan Congressional Trade Priorities Act of 2014," introduced to the House of Representatives on January 9, 2014) was opposed strenuously by such groups as the AFL-CIO, which called it 'bad for democracy and bad for America' (www.aflcio.org). The argument that FT is incompatible with democracy is not new, as Koh (1992) and Tucker and Wallach (2008) discuss at length.

A natural question is why Congress would ever be interested in delegating any of its authority in this way. There have been a number of interpretations suggested, but we offer in this paper a new interpretation of FT based on a hold-up problem. In brief, if the US government negotiates a trade agreement with the government of a smaller economy, then as the negotiations proceed, businesses in the partner economy, anticipating the opening of the US market to their goods, may make investments to prepare to take advantage of the US market – quality upgrades to meet the expectations of the demanding US consumer, changes in packaging and adjustments to US regulations, searching for and negotiating with US partner firms to develop marketing channels, and so on. A portion of these investments are likely to be sunk and specific to the US market. As a result, when the time comes for ratification of the final agreement, the partner economy will be locked in to the US market in a way it was not previously. At this point, if Congress is able to amend the agreement, the partner country has less bargaining power than it did *ex ante*, and so Congress can make changes that are adverse to the partner but beneficial to the US. Given the *ex post* diminution of the partner country's bargaining power due to the sunk investments, it may well acquiesce in these changes, thereby accepting an agreement that makes it worse off than if it had never negotiated with the US at all. As a result, if the US wants to convince such a partner country to negotiate a trade deal, it must commit *first* not to amend the agreement *ex post* – the purpose of Fast-Track Authority.[1]

This interpretation joins a number of others that have been suggested by other authors. Lohmann and O'Halloran (1994) suggest that FT is used to avoid a 'log-rolling' problem, in which Congress would otherwise be stuck in a bad equilibrium whereby each member votes for trade protection for other members' constituent industries in return for protection for its own. Delegation to the President is seen as a way of reaching a Pareto-superior outcome of more open trade. Conconi *et al.* (2012) suggest that FT can be a way export interests in Congress can pry trade policy influence away from protectionists in Congress and hand it to a less-protectionist executive. Celik *et al.* (2015) suggest that FT may be a way to get out of an inefficient congressional bargaining equilibrium in which each member tries to secure the maximum possible protection rents for her own constituents and to cobble together a bare protectionist majority coalition to achieve it. Amador and Bagwell (2018) suggest that Congress may delegate trade policy authority if the executive branch has superior information, for example about the foreign partner's ability to commit not to invoke hidden forms of protection.[2] Our hold-up interpretation is different than these other interpretations since it explains why the partner country government would need FT for negotiations even to begin with.[3]

This insistence is emphasized by Hermann von Bertrab, who was the chief negotiator

[1]It can be objected that Congress could always pass a repeal of its FT power immediately before the ratification is due, thus undoing the commitment. This is technically true, if the President could be persuaded to sign such a bill, but such a move would be extremely costly to Congress as a matter of reputation. We assume, in effect, that the reputational damage would be sufficient deterrent.

[2]Their main question is why Congress has in the past often used a tariff floor as the form of delegation, such as was often the case under the Reciprocal Trade Agreements Act of 1934.

[3]In the base case specification of Conconi *et al.* (2012), the partner government always prefers to negotiate with the US under FT, since it places US bargaining authority in the hands of the president, who is less protectionist than the congressional governing coalition that will form without FT. Nevertheless, the lack of FT is not a reason by itself for the partner government to make FT a pre-condition for negotiations. One could, however, add to that model a sunk cost of bargaining and establish some conditions under which the partner would insist on FT before negotiations begin. This would be a theory complementary to our model.

for the Mexican government on the North American Free Trade Agreement (NAFTA), in his memoir of the negotiation process (Bertrab, 1997). His interpretation of Fast Track is that it "grew out of a perceived need to negotiate with other countries in good faith," and that "Foreign countries would otherwise hesitate even to begin the process of negotiations." (p. 1) His account makes it clear that Congressional passage of Fast Track was viewed by Mexican officials as an irreplaceable precondition for negotiations even to begin.

More broadly, the view that partner countries need FT in order to have the 'confidence' required to negotiate a trade agreement with the US is expressed frequently by observers of the history and politics of FT. For example, a report on the merits of FT renewal prepared for the House Ways and Means Committee in 2007 explains: "trade promotion authority gives U.S. trading partners confidence that an agreement agreed to by the United States will not be reopened during the implementing process (Committee on Finance, United States Senate, 2007, p. 34)." Similarly, from a Senate report: "A foreign country may be reluctant to conclude negotiations with the United States faced with uncertainty as to whether and when a trade agreement will come up for approval by Congress. Likewise, a country may be reluctant to make concessions, knowing that it may have to renegotiate following Congress' initial consideration of the agreement (p. 36)." In both cases, the emphasis is on convincing the foreign government to participate, using FT as a commitment. Koh (1992, p. 148) explains that "it bolstered the Executive Branch's negotiating credibility with the United States allies, which had suffered serious damage during the Kennedy Round, by reassuring trading partners that negotiated trade agreements would undergo swift and nonintrusive legislative consideration." As one pundit put it, "Many in Congress view Fast Track as a hammer to drive reluctant nations to the negotiating table because what's agreed to between the dealmakers cannot be changed by those picky partisans in Congress (Guebert, 2014)."[4]

One major innovation of the current paper is to introduce such strategic considerations

[4]This is also in line with then-White House Chief of Staff Erskine Bowles (1997) arguing that Fast Track would give the president "the credibility to negotiate tough trade deals because other nations know agreements will not be reopened provision-by-provision by Congress," and Bagwell (1997) arguing that without Fast Track the president's "ability to negotiate valuable trade agreements with foreign trading partners would be compromised."

into a model in which the policy variables are not tariffs but rather rules of origin (ROO). This is realistic in the context of free trade agreements, since WTO rules require internal tariffs in a free-trade agreement to be set equal to zero, but ROO's can be set as part of the agreement in a restrictive manner that reduces or eliminates the benefits of tariff reductions. In general, an ROO is an agreed-upon rule for which products can be considered to have originated in the countries that are parties to a free-trade agreement, and therefore are eligible to be shipped from one member country to another tariff-free. ROO's take several forms, but the form we focus on for tractability is a rule that specifies a minimum content requirement; for example, within the context of NAFTA, a rule that specifies what fraction of the costs of a given product must be accounted for by North-American produced inputs or North-American labor. ROO's are an appropriate focus for studying the negotiation of free-trade agreements, since they are in practice a focus of much (perhaps most) of the contentious issues. For a recent example, US negotiators have indicated tightening ROO's as a key priority in the proposed re-negotiation of NAFTA.[5] Intense lobbying over ROO's was highlighted by critics of the Trans-Pacific Partnership (TPP),[6] and ROO's for textiles and shoes were the main point of contention for EU negotiations over free trade with Vietnam.[7]

The analysis of optimal (and equilibrium) ROO's is qualitatively quite different from the corresponding analysis of tariffs. It turns out that optimal ROO's quite often take the form of a corner solution, and when ROO's serve a protectionist function there are cases in which an increase in protectionism can worsen rather than improve the terms of trade of the country using it. These are starkly different from results obtained with tariffs. We allow for ROO's to be set differently for different industries, so both the level and the inter-industry pattern of ROO's are endogenous. We show conditions such that in equilibrium the *ex ante* optimal level of ROO's from the US point of view are not optimal *ex post*, after the partner

[5] Ana Swanson, "Trump Team Readies for Nafta Fight Over Making Goods in America," *New York Times*, September 22, 2017.

[6] Mike Masnick, "Revealed Emails Show How Industry Lobbyists Basically Wrote The TPP," TechDirt.com, June 8, 2015.

[7] Danny Hakim and Tuan Nguyen, "To Lower Tariffs, Vietnam Pushes for Easing Trade Rules," *New York Times*, December 13, 2013.

country's firms have sunk their investments. *Ex post*, Congress would want to tighten those ROO's, extracting more rents from the partner country. This is the source of the hold-up problem that emerges, and is a major departure from the earlier FT papers, all of which focus on tariffs.

Historical background. Useful concise histories of Fast Track can be found in Smith (2006), Tucker and Wallach (2008), and Fergusson (2015). Fast-Track Authority grew out of the Reciprocal Trade Agreements Act of 1934, which gave congressional approval in advance to trade agreements that satisfied a number of listed criteria. The pre-approval was limited to tariffs. This act was re-approved in various forms over the following decades, finally in the form of the Trade Expansion Act (TEA) of 1962.

The US employed an idiosyncratic system for determining 'fair market value' for purposes of setting anti-dumping duties, called the 'American Selling Price' (ASP). As part of its negotiations in the Kennedy Round of the GATT, the Johnson administration agreed to a major overhaul of the ASP. The tariff part of the Kennedy Round entered into US law automatically under the TEA, but the reform of the ASP was rejected in a Senate vote. Since it was an agreement on a non-tariff measure, it was beyond the bounds of the TEA (Tucker and Wallach, 2008, pp. 45-46).

In 1973, Richard Nixon cited the ASP debacle as a precedent that must not be repeated, and called for trade negotiation authority to encompass all aspects of a trade agreement. This led to the Trade Act of 1974, which created Fast-Track Authority in its modern form. It required Congress to be notified of negotiations in advance, and to be briefed on the progress of negotiations along the way, while at the end within a 90-day window Congress was required to give the *entire* agreement an up-or-down vote with no amendments, not merely the portions that dealt with tariffs *per se* (Tucker and Wallach, 2008, pp. 55-56). It was controversial from the start; Representative James Burke declared in an apoplectic floor speech: "How… Congress a few weeks [after the Tonkin Gulf incident] can even contemplate abdicating authority in the foreign trade area is beyond my comprehension" (p. 63).

Fast Track thus resulted from one case in which Congress delivered a major humiliation to a President by refusing to honor part of a trade agreement, and was seen as a significant delegation of congressional power. The authority was renewed a number of times subsequently, lapsing from 1984 to 2002, and then again from 2007 to 2015 (renewed most recently as part of Public Law No: 114-26) (see Fergusson, 2015). Almost all major trade agreements into which the US has entered have been negotiated under FT to some degree; the only agreements negotiated without FT at all are the Canada-US Auto Pact of 1965 (Tucker and Wallach, 2008, pp. 43-45) and the free-trade agreement with Jordan (Okun-Kozlowicki and Horwitz, 2013, p. 4).[8] However, the Trans Pacific Partnership (TPP) was negotiated without FT, under anticipation that FT would be passed by the time of the ratification process (Okun-Kozlowicki and Horwitz, 2013, p. 7). (That turned out to be correct, but it was a moot point because the executive branch eventually withdrew from the agreement.) We will return in the conclusion to the small number of anomalous cases of agreements signed without FT.

Prior work. In formalizing our interpretation of Fast-Track Authority, we draw on a wide range of prior work. The idea that firms wishing to export to a given destination must make sunk investments to do so has been explored in many ways. Verhoogen (2008) shows that Mexican firms that begin to export to the US typically upgrade their quality of goods intended for the US market. Hallak and Sivadasan (2013) show how the need to upgrade quality for a high-income export market helps fit firm-level data on trade flows. Handley (2012) and Handley and Limão (2015) show that sunk costs to export to a specific destination can help explain the response of trade flows to uncertainty about trade policy. For example, they show that a significant portion of the trade response observed when Portugal joined the European Economic Community (EEC) can be explained by the elimination of uncertainty about EEC tariffs against Portugal.[9]

[8] The free-trade agreement with South Korea was ratified under FT in 2010, even though by then the statute had expired, because the administration had submitted the first version of the agreement to Congress before the deadline in 2007 (Schott, 2010).

[9] Sunk investments and hold-up in trade are important for different reasons in the industrial-organization literature. Ornelas and Turner (2008; 2011) show how import tariffs can affect organizational form decisions by firms that need specialized inputs in a setting with incomplete contracting. For example, a tariff reduction can induce a downstream firm to integrate vertically with its foreign supplier, magnifying the effect of trade

The effects of sunk costs or anticipatory investment on equilibrium policy have been studied from a number of angles. Staiger and Tabellini (1989) study time consistency of optimal policy when private resource allocation decisions are made in anticipation of policy. McLaren (1997) shows how anticipatory investment can cause a small country to suffer from a hold-up problem in liberalizing trade with a larger one, and McLaren (2002) shows how similar considerations can lead to the world dividing up into inefficient, exclusionary trade blocks rather than multilateral free trade. Maggi and Rodríguez-Clare (2007) show how similar considerations can motivate a trade agreement as a commitment device to hedge against the influence of domestic political interest groups. Chisik (2003) shows how sunk investments in an export sector can result in gradualism in bilateral trade liberalization as a way of softening incentive-compatibility constraints worsened by the hold-up problem. Chisik (2012) shows that in the presence of periodic trade wars or disputes between trade partners export-sector firms can be deterred from making sunk investments in product quality.

We also make use of tools from the literature on the effects of ROO's. Grossman (1981) studies domestic content rules, whose properties are almost identical to ROO's, while Krishna and Krueger (1995) study a simple model of ROO's, showing how equilibrium is changed qualitatively when the ROO is strict enough that firms have no incentive to comply with it. Falvey and Reed (2002) study a model of optimal tariff preferences and ROO's for a country that imports a final good and does not produce the input required for it. Ju and Krishna (2005) show that the comparative statics of equilibrium with respect to ROO's in a free-trade agreement have important non-monotonicities when the compliance constraint becomes binding. Duttagupta and Panagariya (2007) show how ROO's can make a free-trade agreement politically feasible (possibly at the same time making it inefficient). Overviews are provided by Falvey and Reed (1998) and Krishna (2006). Empirically, Anson *et al.* (2005) use a qualitative measure of restrictiveness of ROO's to show that more restrictive ROO's in NAFTA tend to reduce Mexican exports to the US, *ceteris paribus.* Conconi *et al.* (2018), also focussing on NAFTA, show that inputs with more ROO's attached to them

liberalization on trade flows.

tend to have lower imports into Mexico from the rest of the world, *ceteris paribus*.

We contribute to the theoretical literature on ROO's an analysis of the *optimal profile of ROO's across industries* in a model with many industries, each of which draws inputs from many industries, which is quite different from what emerges in a model with one final good and one tradeable input.[10] One highlight is the finding that equilibrium ROO policy treats different industries very differently even if the industries are symmetric. Another is to show that the effect of ROO's can be qualitatively different in the presence of strong backward and forward linkages compared to weak ones.

Anticipatory sunk costs in exporting: Examples. Our model is based on the assumption that at least a portion of the investment that firms need to make to take advantage of an export opportunity are sunk and time-sensitive, so that firms see a need to invest in anticipation of a new trade agreement rather than waiting until it is completed. Examples of this sort of investment are abundant.

For example, in 1988, before the Canada-US Free-Trade Agreement (CUFTA) was ratified, Dupont Canada increased its capital spending plans by 50% in anticipation of the agreement, particularly in modernizing and expanding capacity in synthetic fibers, plastics, and films largely for export to the US. To quote a news article immediately after ratification:[11]

> As a result of new capacity already put in place this year in anticipation of the free-trade agreement, Du Pont Canada expects to increase its exports by 40 per cent next year to $335-million, with 90 per cent going to the United States.
>
> It was a gamble, [Dupont CEO] Mr. Newall admitted. "Imagine how we would have felt had it [CUFTA] not gone forward."

In the mid-1980's, anticipating that a CUFTA or something similar was 'inevitable,' the leadership of John Labatt Ltd., the largest Canadian brewery, began to invest in a US

[10] In this regard, we do something for ROO's analogous to what Costinot *et al.* (2015) do for tariffs.

[11] "Trade accord prompts Du Pont Canada spending spree," by Patricia Lush, *The Globe and Mail*, Saturday, December 3, 1988.

distribution network, acquiring 16 US companies to do so.[12] On a smaller scale, Vineland Estate Wines Ltd. of Ontario launched a major marketing push in the US in early 1988 in anticipation of the agreement, holding numerous wine tastings in New York, Boston, and Philadelphia with a goal of exporting a quarter of its output to the US in the first year of the agreement; and Canadian consultant firms such as Samson Belair and Fasken Martineau Walker were doing brisk business advising firms on how to adapt to the new environment the agreement would create if ratified.[13] Of course, all such consultant fees are sunk investments.

Portugal's negotiations to join the European Economic Community (EEC) in the 1980's provide additional examples. In 1983, Samsung announced plans to build a factory for color televisions in Portugal "because of its location, reasonable labour costs and forthcoming EEC membership," even though the accession negotiations would continue for years afterward.[14] Similarly, in the early 1980's, the Portuguese textile industry saw a huge boom in investment and modernization in anticipation of the likely accession. One example is the Arco company, which purchased 380 state-of-the-art looms and 30,000 new spindles to gear up for export. "Much of the new investment has been made with the specific intention of getting the industry ready for the EEC," reported a journalist covering the industry.[15]

Similar examples can be found in the negotiation and ratification period for NAFTA. In March 1993, Cone Mills announced a plan for an $80-100 million denim plant in Mexico "in anticipation of the North American Free Trade Agreement" even though its ratification was by no means guaranteed.[16] Stevens (1998) finds evidence of a big upswing in US direct investment in Mexico in the years before NAFTA, which he interprets as anticipatory to the agreement.

In the case of the TPP, the Vietnamese textile producer Vinatex announced a plan in

[12] "The Canadians Look South," by D'Arcy Jenish, *Maclean's*, September 19, 1988, p. 39.

[13] "Winning the Trade Battle," by D'Arcy Jenish, *Maclean's*, September 19, 1988, p. 32 and p. 33, respectively.

[14] "South Korean Television Venture in Portugal," by Diana Smith, *Financial Times*, March 31, 1982, p. 6.

[15] "Heavy Investment in Modern Machinery," by Anthony Moreton, *Financial Times*, September 14, 1983, Section VI, p. VI.

[16] "Cone Mills Expanding to Mexico Labor Leaders Criticize Deal," by Susan Harte,. *Atlanta Journal and Constitution*, March 30, 1993, Section E, p. 1.

2014 to invest in 57 capital projects to increase its ability to source and weave cotton fibers in anticipation of expanded export opportunities due to the agreement, which was still being negotiated.[17]

More examples can be found in Freund and McLaren (1999, pp. 22-24). Of course we do not claim that *all* investments for exporting are of this character, but we can state with confidence that sunk anticipatory investments are common and quite important in practice.

To summarize: This paper offers three pieces of value-added. (1) We present an interpretation of FT that is more consistent with observed behavior and statements of decision makers than alternatives that have been studied in the past.

(2) We present tools for analyzing ROO's as the strategic variable instead of tariffs. These tools are likely to be widely useful beyond the analysis of FT because they are the key choice variables in free-trade agreements. Indeed, as of this writing they are the topic of major announcements regarding negotiations on NAFTA revisions (Bown (2018)).

(3) We do this in the context of a model with backward and forward linkages, which can have a profound effect on the way the hold-up problem works and even change its direction (unlike simpler hold-up models such as McLaren (1997)). As we discuss in the final section, this may help us understand some of the unusual cases in which FT does not seem to have been necessary.

In the following section we lay out the model, including consumption, production, bargaining, and how ROO's work. The following three sections show how the model works under FT: Section 3 derives equilibrium conditions under FT including the form of optimal ROO policy; Section 4 shows how to calculate welfare; and Section 5 derives the full equilibrium under FT. Section 6 analyzes the equilibrium without FT. Section 7 then analyzes the choice of whether or not to use FT in the case of weak backward and forward linkages, while Section 8 discusses the case with strong linkages. The last section summarizes our results and concludes.

[17] "Vinatex seeks more funds to take advantage of TPP," *South Asian Government News*, March 1, 2014.

2 Model

2.1 Overview.

In order to have a discussion of a free-trade agreement with ROO's, we need to have at least two member countries plus at least one non-member country. Accordingly, our model includes the US, a partner country that we will call Mexico (M), and a non-member country (N). Further, in order to allow for US policy on ROO's to pose a potential hold-up threat, it must be the case that Mexican manufacturers produce using both North-American-produced inputs, which for concreteness we assume are produced in Mexico, and non-member produced imported inputs. In order for the ROO to have a possibility of being satisfied in non-trivial cases, it must be possible for Mexican manufacturers to raise their domestic content, which implies that it is possible to substitute Mexican-produced inputs at least partially for non-member produced inputs. We allow this by specifying a Cobb-Douglas production function for Mexican manufactures that takes as arguments a composite of non-member-produced inputs, Mexican-produced inputs, and labor.

We model Mexican manufactures as produced in a monopolistically-competitive sector, which allows for the number of varieties produced to adjust to policy as an important endogenous outcome. To avoid an artificial separation between producers of industrial inputs and producers of final goods, we adopt the convenience of assuming that all manufactured goods are both final goods and inputs, just as in Krugman and Venables (1995) or Eaton and Kortum (2002). This creates a situation in which backward and forward linkages are important: An increase in demand for Mexican products can increase the range of Mexican inputs produced, lowering marginal costs for all Mexican firms. The strength of these backward and forward linkages will be an important factor in the analysis.

Some stylized simplifications in our model should be pointed out. First, we are not interested in the details of either the US or non-member economy, so these essentially both become single-product endowment economies, the US producing a numeraire consumption good, and the non-member country producing a composite input. Second, we are not interested in conflict of interest between members of Congress or between Congress and the President, since those issues have been carved out in great detail in the other FT papers reviewed above and are not important to the hold-up problem that is our focus.[18] Therefore, we implicitly assume that each congressional district has the same economic features, so that all members of Congress have the same preferences over policy, and so does the executive branch.

The inter-governmental bargaining structure is very simple. There are two periods. If Mexico agrees to negotiate, in period 1 the US executive branch makes a take-it-or-leave-it offer, which the government of Mexico either accepts or rejects. At the same time, each Mexican firm decides whether or not to undertake a sunk investment in quality upgrade, which is essential to export to the US market. In period 2, if FT has been enacted, the US Congress either accepts or rejects the agreement that was struck in period 1 between the two governments, and production and consumption occur, whether there is an agreement or not. If FT has not been enacted, then Congress may amend it; if the amendments are accepted by the Mexican government, the amended agreement goes into force, otherwise there is no agreement.

[Insert Timeline Figure here]

2.2 Consumption.

Each individual has an identical utility function given by

$$u = \left(\frac{x_0}{\alpha}\right)^{\alpha} \left(\frac{Q}{1-\alpha}\right)^{1-\alpha}, \; 0 < \alpha < 1, \tag{1}$$

where x_0 is a homogenous numeraire good, Q is a composite good and α represents the constant share of income that is spent on x_0. Let Y and P denote total spending and the aggregate price of the composite good, respectively. Solving the consumer's utility maximization problem yields

$$x_0 = \alpha Y \text{ and } Q = \frac{(1-\alpha)\, Y}{P}. \tag{2}$$

[18]See also Celik *et al.* (2013) for legislative trade policy-making when there is conflict of interest between members of Congress.

The composite good Q is represented by the analogue of the Cobb-Douglas utility function for a continuum of goods

$$\ln Q = \int_{j=0}^{1} \ln Q_j dj,$$

where Q_j represents consumption of a composite good made up of varieties of products produced by industry $j \in [0,1]$. If the set of products available in industry j is $\Omega_j \subset \Re$, then aggregate consumption in industry j is

$$Q_j = \left(\int_{i \in \Omega_j} q_j(i)^\rho di \right)^{\frac{1}{\rho}}, \ 0 < \rho < 1,$$

which is a CES function of the consumption of different varieties of $q_j(i)$. The elasticity of substitution between varieties is given by $\frac{1}{1-\rho}$. The range of i will be endogenously determined in equilibrium.

We can derive consumer demand for a variety i in industry j, $q_j(i)$, from the minimization problem given by

$$\min_{q_j(i)} \int_{i \in \Omega_j} p_j(i) q_j(i) di \text{ s.t. } Q_j = \left(\int_{i \in \Omega_j} q_j(i)^\rho di \right)^{\frac{1}{\rho}},$$

which yields

$$q_j(i) = \left(\frac{p_j(i)}{P_j} \right)^{\frac{1}{\rho - 1}} Q_j, \tag{3}$$

where $P_j = \left(\int_{i \in \Omega_j} p_j(i)^{\frac{\rho}{\rho-1}} di \right)^{\frac{\rho-1}{\rho}}$ represents the aggregate price of composite industry j good, Q_j.

Next, we can find the demand function for a composite industry good j, Q_j, in a similar fashion as

$$\min_{Q_j} \int_{j=0}^{1} P_j Q_j dj \text{ s.t. } \ln Q = \int_{j=0}^{1} \ln Q_j dj,$$

which yields

$$Q_j = \frac{PQ}{P_j}, \tag{4}$$

where the price of the composite good is given by $P = e^{\int_{j=0}^{1} \ln P_j dj}$. In addition, using equations (2), (3), and (4), we obtain

$$q_j(i) = \left(\frac{p_j(i)}{P_j^{\rho}}\right)^{\frac{1}{\rho-1}} (1-\alpha)\, Y. \tag{5}$$

2.3 Production.

The numeraire good is produced in the US with labor alone such that one unit of labor produces one unit of output. On the other hand, each Mexican differentiated-product manufacturing firm i produces output $q_j(i)$ following the production function

$$q_j(i) = \left(\frac{x_j(i)}{\beta}\right)^{\beta} \left(\frac{l_j(i)}{1-\beta}\right)^{1-\beta}, \; 0 < \beta < 1,$$

where $x_j(i)$ and $l_j(i)$ are respectively the amount of composite manufactured input and labor used by firm i in industry j, and β is the output elasticity of the composite input. Accordingly, the marginal cost function for a typical Mexican firm in industry j that is not constrained by a rule of origin is given by

$$c = P_I^{\beta} w^{*1-\beta}, \tag{6}$$

where P_I is the cost of composite manufactured inputs and w^* is the wage in Mexico. (The case of a constrained firm will be discussed later.) The total cost of producing $q_j(i)$ units of output is then given as

$$C_j(i) = P_I^{\beta} w^{*1-\beta} \left(q_j(i) + F\right),$$

where the cost function involves $P_I^{\beta} w^{*1-\beta}$ (marginal cost) and $P_I^{\beta} w^{*1-\beta} F$ (fixed overhead cost).[19]

In order to export to the US, a Mexican firm must incur an additional fixed cost, $P_I^{\beta} w^{*1-\beta} S$, which we interpret as a quality upgrade. Importantly, the quality upgrade cost is sunk; a firm must incur this cost in period 1 in order to be ready to export in period 2.

[19]For analytical convenience, we model the fixed cost as denominated in units of output.

The fixed cost of production is not sunk, however; a firm that has not invested in the quality upgrade can shut down in period 2, thereby avoiding all costs.

The assumption that a quality upgrade is necessary for export is well-founded empirically. Verhoogen (2008) shows that among Mexican firms, exporting to the US is correlated with upgrades in quality as indicated by ISO 9000 compliance and purchase of more expensive inputs. Iacovone and Javorcik (2012) follow individual products produced by Mexican manufacturing firms, and find that firms that begin to export to the US tend to upgrade quality as measured by a rise in unit value relative to the same product produced by other firms, and the upgrade takes place one year *before* the beginning of exporting. Future changes in US tariffs against Mexico are used as instruments to establish that the quality upgrades are caused by anticipated export opportunities rather than the reverse.

2.4 Cost of composite input.

The price index for the composite input produced by industry j is

$$P_j = \left(\int_{i \in \Omega_j} p_j(i)^{\frac{\rho}{\rho-1}} di \right)^{\frac{\rho-1}{\rho}},$$

where $p_j(i)$ is the price charged by firm i in industry j. Given the symmetry of each variety, for a purchaser of inputs from industry j in Mexico we have

$$P_j = n_j^{\frac{\rho-1}{\rho}} p_j, \tag{7}$$

where p_j is the price of any given variety in industry j and n_j is the number of varieties produced.

The price of the overall composite Mexico-produced input is

$$P_M = e^{\int_0^1 \ln P_j dj}.$$

In the event that all industries price the same way, this will collapse to $P_M = P_j$ for any $j \in [0, 1]$. This will be combined with the inputs produced abroad to make up the overall composite input price.

The composite input is produced from the Mexican-produced composite and an input from the non-member country through a Cobb-Douglas production function with a weight of η on the Mexican composite,[20] so that the unit cost is

$$P_I(P_M, P_N) = P_M^{\eta} P_N^{1-\eta},\ 0 < \eta < 1, \tag{8}$$

where P_M is the price of composite Mexican input, and P_N is the price of the non-member country input, which we take as fixed. The value $\beta\eta$ shows how much of a Mexican firm's cost is made up of purchases from other Mexican firms, and can be interpreted as a measure of backward and forward linkages: The extent to which a new Mexican firm generates demand for the output of other Mexican firms, and the extent to which it provides inputs that will be useful to other Mexican firms. We will impose the following parameter restriction throughout

$$\beta < \rho. \tag{9}$$

This is the parameter region of interest because, as shown later in Proposition 8, it is where the US government would want a positive tariff (and it also guarantees stability of the equilibrium).[21]

2.5 Pricing and output per firm.

In this section, we will analyze each firm's profit maximization problem. The profits of a firm that produces variety i in sector j are

$$\begin{aligned}\pi_i &= p_j(i)q_j(i) - P_I^{\beta} w^{*1-\beta} \left(q_j(i) + F\right) \\ &= q_j(i) \left(p_j(i) - P_I^{\beta} w^{*1-\beta}\right) - P_I^{\beta} w^{*1-\beta} F.\end{aligned}$$

Since for each product both the consumer demand (from (5)) and the intermediate-input demand have constant elasticity equal to $1/(1-\rho)$, maximizing this expression with respect

[20]More precisely, for each Mexican firm i in industry j the production function of the overall composite input $x_j(i)$ is $x_j(i) = x_{jM}^{\eta}(i) x_{jN}^{1-\eta}(i) / \left(\eta^{\eta}(1-\eta)^{1-\eta}\right)$, where x_{jM} is the composite Mexican input and x_{jN} is the composite non-member-produced input.

[21]Condition (9) is well-known in the economic geography literature as the 'no black hole' condition, for example, condition 4.45 on p. 59 of Fujita *et al.* (1999).

to $p_j(i)$ gives a constant markup of $\frac{1}{\rho}$, or

$$p_j(i) = \frac{P_I^{\beta} w^{*1-\beta}}{\rho}, \tag{10}$$

which implies the total variable profit is $(1-\rho)$ times the total revenue.

In equilibrium, each firm will receive zero profits on all sales together, but we can say more than this: Each firm must make zero profits on its domestic sales, and, on the equilibrium path, must also make zero profits on its exports. This is because in each industry there will be a subset of firms that choose to serve only the domestic market; they must be indifferent between entering and not entering, and those that incur the sunk cost to export will be indifferent between doing so and not doing so. Plugging the value of $p_j(i)$ into the profit function and using the zero-profit condition, we can calculate the quantity of variety i produced for the domestic market in Mexico as

$$q_j(i) = \frac{\rho}{1-\rho} F.$$

2.6 Equilibrium marginal costs.

Marginal costs for a Mexican manufacturer are a function of the endogenous Mexican wage and input prices as well as the variety of inputs available. Since a range of those inputs are produced by those same Mexican manufacturers, Mexican marginal cost is defined by a recursive relationship. Using equations (6), (7), (8) and $P_M = P_j$ for any $j \in [0,1]$ in equilibrium, we obtain

$$\begin{aligned} c &= P_I^{\beta} w^{*1-\beta} \\ &= P_M^{\beta\eta} P_N^{\beta(1-\eta)} w^{*1-\beta} \\ &= \left(p_j n_j^{\frac{\rho-1}{\rho}} \right)^{\beta\eta} P_N^{\beta(1-\eta)} w^{*1-\beta}, \end{aligned}$$

where, as before, p_j is the price of a typical variety. Solving for p_j and using once again the fact that the equilibrium mark-up of each variety's price over marginal cost is equal to $1/\rho$, we derive

$$c = \left(\frac{n^{\frac{\rho-1}{\rho}}}{\rho} \right)^{\frac{\beta\eta}{1-\beta\eta}} \left(P_N^{\beta(1-\eta)} (w^*)^{1-\beta} \right)^{\frac{1}{1-\beta\eta}}. \tag{11}$$

Ceteris paribus, marginal costs for any Mexican firm are lower the more of them there are, since that expands the variety of inputs available. On the other hand, marginal costs are higher, the more expensive are the inputs from the non-member country and the higher is the Mexican wage. The latter has an amplified effect as indicated by the exponent $\frac{1}{1-\beta\eta}$ because any factor that raises marginal costs for any one firm by 1%, holding domestic input prices constant, will cause that firm to raise its price by 1%; but this will happen to all firms at the same time, so that every domestic input price will rise. Consequently, marginal costs will rise by more than 1%. The multiplier $\frac{1}{1-\beta\eta}$ is increasing in the strength of linkages, and is closely related to what Bartelme and Gorodnichenko (2015) call the 'average output multiplier,' which they measure for a wide range of countries. They show that it is strongly correlated with a country's level of development, a fact that will be useful to keep in mind in interpreting results later and to which we will return in the Conclusion.

To put this magnification effect into sharper relief, note that a 1% rise in the wage will directly increase any one firm's marginal cost by $(1-\beta)\% < 1\%$, but the magnification effect results in a larger increase, taking a limit of unity as $\eta \to 1$. Indeed, if η is close enough to 1 and β is close enough to ρ, the marginal cost will be proportional to $\frac{w^*}{n}$.

It should be noted that equilibrium in a model of this sort is generically inefficient despite the fact that in simple Dixit-Stiglitz models of monopolistic competition the number of firms is typically efficient in equilibrium. This is so since the backward and forward linkages in this model create a positive externality from entry; it lowers marginal cost for all firms, as can be seen from equation (11). Nevertheless, in making its entry decision, a firm does not take into account this productivity benefit it confers on all other firms. This is the core market failure behind the multiple equilibria in Krugman and Venables (1995), for example. Later, we will see (Proposition 3) that if the linkages are strong enough, a policy that forces Mexican manufacturers to buy more domestic inputs can even raise Mexican welfare, because it helps to correct this market failure.

2.7 Trade policy: Tariffs and Rules of Origin.

There is an *ad-valorem* tariff of τ on all imports into the US, and a corresponding tariff of τ^* on imports into Mexico. We take these Most-Favored-Nation (MFN) tariffs as exogenous (having been determined by prior multilateral negotiations, for example). They are accompanied by ROO, which we specify here.

In practice, rules of origin can take several forms. One important category is the *change-of-classification* form, which requires that items imported by a member country reside in a different classification of the tariff schedule from the exported finished good in order for that finished good to be eligible for duty-free treatment. A second important category is the *value-content* form, which requires that the share of value produced in the member country be at least as high as a minimum stated share. Various other types of ROO impose particular technical criteria. Krishna (2006) and Falvey and Reed (1998) explain these types in detail, and Conconi *et al.* (2018) provides a detailed example of a change-of-classification ROO in NAFTA. For most purposes of economic analysis, the difference is not important. Conconi *et al.* (2018) point out that NAFTA has both types of ROO, with the first type most common, but in other trade agreements the value-content type is rather more common. Here, for analytical convenience, we will model all ROO's as taking the value-content form.

Under a free-trade agreement between the US and Mexico, then, if a rule of origin is imposed on an industry j, then there is a fraction, say θ_j, such that a Mexican good is not eligible for duty-free entry into the US unless at least θ_j of the costs of producing it are North-American in origin. This is a requirement that the firm's spending on labor and Mexican-made inputs for producing the export must be at least θ_j times the total costs incurred in producing the export. If the ROO is satisfied, the product can then be sold in the US without tariff, but the manufacturer also has the option of ignoring the ROO and paying the tariff instead. Accordingly, we will denote the former as ROO^S and the latter as ROO^{NS}, where the superscripts S and NS stand for 'satisfy' and 'not satisfy', respectively.

Three assumptions should be clarified here, which make the analysis much simpler than it would be in their absence. First, we assume that a firm can satisfy the ROO by ensuring a high domestic content share on its exports alone; production for the Mexican market need not enter into the calculation. Second, we assume that production for the US market under an ROO does not require setting up a separate plant and incurring the fixed production cost F again. These two assumptions together might be called a 'velvet rope' assumption: A firm can separate out, within one production facility, production for export from production for domestic sale, keeping track of paperwork recording input and labor use so that it can document that the ROO is satisfied on the former without imposing it on the latter.

Third, we assume that for the purposes of the ROO an input produced by a Mexican firm with Mexican labor counts as Mexican cost for production of a good for sale in the US, even if that input itself does not satisfy the ROO. For example, Levent's Sunshine Toaster Company in Monterrey, Mexico, which wants to sell toasters in the US market, can satisfy its ROO partly by buying Mexican-produced heating coils, even if those heating coils themselves do not satisfy an ROO.

3 The Case of Fast-Track Authority.

We first analyze equilibrium, taking policy as given, under the assumption that Congress has voted Fast-Track Authority. What that implies is that the President is able to commit credibly to a trade policy in period 1, subject only to the constraint that it will be welfare-worsening for neither country. This means, in particular, that Mexican firms will observe the announced trade policy when they make their decisions as to whether to enter or not and also whether to invest in quality upgrading for the US market or not. This analysis will occupy this and the subsequent two sections; we will turn to the case without Fast-Track Authority in Section 6.

3.1 The Cost of an ROO.

If a Mexican firm is allowed to minimize costs taking prices as given without constraints, it will produce with a share of North American costs equal to $1 - \beta(1 - \eta)$, since $1 - \beta$ is the share of Mexican labor in costs and $\beta\eta$ is the share of Mexican-produced inputs in costs.

Suppose that the firm's industry is faced with an ROO that requires firms to maintain a North American share of costs at least equal to θ in order to export to the US without paying a tariff. Then if $\theta \leq 1-\beta(1-\eta)$, the firm satisfies the ROO even with unconstrained cost minimization, and so if it chooses to export, it will export duty-free to the US, and the ROO will make no difference.

Now, suppose that $1-\beta(1-\eta) < \theta$. Now, the firm cannot satisfy the ROO without incurring some additional cost to raise the North American share of its costs. Note that if the firm chooses to satisfy the ROO, it will do so in the lowest-cost manner possible. This will require that it maintain the right mix of local labor and locally-produced inputs to keep their marginal rate of substitution equal to the relative price. Given the production functions, this can be achieved by increasing the labor and local inputs per unit of output by the same proportion.

Suppose that a firm initially not facing an ROO is producing one unit of output, but then to satisfy the ROO increases labor input and Mexican-produced inputs per unit of output by the factor $\kappa > 1$. This on its own increases output by $\kappa^{(1-\beta(1-\eta))}$. To reduce output back down to one unit, it then multiplies its rest-of-world input used by a factor $\kappa^{\frac{-(1-\beta(1-\eta))}{\beta(1-\eta)}} < 1$. Write the unit demand for Mexican composite input, rest-of-world input, and labor in the unconstrained cost minimization respectively as x_M, x_N, and l. Then the North American cost share following the adjustment in inputs is

$$\frac{\kappa P_M x_M + \kappa w^* l}{\kappa P_M x_M + \kappa^{\frac{-(1-\beta(1-\eta))}{\beta(1-\eta)}} P_N x_N + \kappa w^* l} = \frac{1-\beta(1-\eta)}{1-\beta(1-\eta)+\beta(1-\eta)\kappa^{\frac{-1}{\beta(1-\eta)}}}.$$

Setting this equal to θ and solving for κ yields

$$\kappa^{\frac{-1}{\beta(1-\eta)}} = \frac{(1-\theta)(1-\beta(1-\eta))}{\theta\beta(1-\eta)}.$$

If we denote the unconstrained minimized unit cost as c and the minimized unit cost subject to the ROO as c^{ROO^S}, then substituting the expression for κ into unit costs yields[22]

[22] The derivation follows from noting that $c^{ROO^S} = \kappa P_M x_M + \kappa^{\frac{-(1-\beta(1-\eta))}{\beta(1-\eta)}} P_N x_N + \kappa w^* l = \left[\beta\eta\kappa + \beta(1-\eta)\kappa^{\frac{-(1-\beta(1-\eta))}{\beta(1-\eta)}} + (1-\beta)\kappa\right] c$.

$$CCR(\beta,\eta,\theta) \equiv \frac{c^{ROO^S}}{c} = \left(\frac{1-\beta(1-\eta)}{\theta}\right)^{1-\beta(1-\eta)} \left(\frac{\beta(1-\eta)}{1-\theta}\right)^{\beta(1-\eta)}, \tag{12}$$

where $CCR(\beta,\eta,\theta)$ is the compliance cost ratio. This takes a value of 1 at $\theta = 1-\beta(1-\eta)$ and increases as θ increases above that value, becoming unbounded as θ approaches unity.

3.2 Comparison between satisfying and not satisfying an ROO

Now, for a Mexican firm that intends to export its product to the US we consider the decision of whether or not to satisfy its industry's ROO. The export profit of a firm j that chooses to satisfy the ROO (ROO^S option) is given by[23]

$$\pi_j^{ROO^S}(i) = \left(p_j(i) - c^{ROO^S}\right) q_j(i) - c^{ROO^S} S,$$

where $p_j(i)$ represents the FOB price for the firm, $q_j(i)$ is the quantity exported, and $c^{ROO^S}S$ is the fixed cost of exporting (recall that S is denominated in units of output). Note that the same logic that was used to derive (10) will apply, so the exporters will price with a fixed markup of $\frac{1}{\rho}$ over marginal cost. Now, suppose that θ is set at a level such that it is optimal for firms to comply with the ROO. Then using equation (5) and the constant markup of $1/\rho$, we can rewrite profits as

$$\left(\frac{1-\rho}{\rho}\right) c^{ROO^S} \left(\frac{\frac{c^{ROO^S}}{\rho}}{P_j^{\rho}}\right)^{\frac{1}{\rho-1}} (1-\alpha)\, Y - c^{ROO^S} S,$$

so in equilibrium

$$\left(\frac{c^{ROO^S}}{\rho P_j}\right)^{\frac{\rho}{\rho-1}} (1-\rho)(1-\alpha)\, Y = c^{ROO^S} S.$$

Similarly, we can also write the export profit of a firm j that ignores the ROO and pays the MFN tariff (ROO^{NS} option) as

$$\pi_j^{ROO^{NS}}(i) = (p_j(i) - c)\, q_j(i) - cS.$$

Following steps parallel to those above, if θ is set so that it is optimal for firms to ignore the ROO, minimize costs, and pay the tariff, profits become[24]

[23] Recall that exporters still make zero profit on their domestic sales.

$$\left(\frac{1-\rho}{\rho}\right) c \left(\frac{\frac{(1+\tau)c}{\rho}}{P_j^\rho}\right)^{\frac{1}{\rho-1}} (1-\alpha) Y - cS$$

so in equilibrium

$$\left(\frac{c}{\rho P_j}\right)^{\frac{\rho}{\rho-1}} (1+\tau)^{\frac{1}{\rho-1}} (1-\rho)(1-\alpha) Y = cS.$$

If θ is set so that in equilibrium firms in this industry are indifferent between the ROO^S and ROO^{NS} options, both conditions must hold at the same time, implying

$$\left(\frac{c^{ROO^S}}{c}\right)^{\frac{\rho}{\rho-1}} \left(\frac{1}{1+\tau}\right)^{\frac{1}{\rho-1}} = \frac{c^{ROO^S}}{c}, \text{ or}$$

$$CCR(\beta, \eta, \theta) = 1 + \tau.$$

Therefore, any industry whose θ parameter is set so that $CCR(\beta, \eta, \theta) < 1 + \tau$ will comply with the ROO, whereas the ones with $CCR(\beta, \eta, \theta) > 1 + \tau$ will pay the tariff. If we define $\bar{\theta}$ as the value of θ such that $CCR(\beta, \eta, \theta) = 1 + \tau$ and $\underline{\theta} \equiv 1 - \beta(1 - \eta)$ then the following holds.[25]

Proposition 1 *If $\theta_j \leq \underline{\theta}$, then all exporting firms in industry j will source inputs to minimize cost; the ROO will not bind; and they will export to the US without paying tariff. If $\underline{\theta} < \theta_j \leq \bar{\theta}$, then all exporting firms in industry j will source inputs to satisfy the ROO exactly for their export operation; the ROO binds; and they will export to the US without paying tariff. If $\theta_j > \bar{\theta}$, then all exporting firms in industry j will source inputs to minimize cost, ignoring the ROO; and they will export to the US and pay the MFN tariff.*[26]

This summarizes the firm's decision on whether or not to comply with an ROO: It will ignore a very low or very high ROO, but comply with an intermediate ROO, raising its costs as it does so, but avoiding the tariff.

[24] Note that when calculating a Mexican firm's profit, the price $p_j(i)$ represents the price the Mexican firm receives. On the other hand, the quantity, $q_j(i)$ is a function of the price the U.S. consumers pay. Under ROO^{NS} option, the U.S. consumers pay $(1+\tau)p_j(i)$.

[25] This may seem like more work than is necessary; since the tariff is isomorphic from the firm's point of view to an increase in marginal cost, surely it is automatic that it will pay the tariff unless the increase in marginal cost due to the ROO exceeds $1+\tau$? The reason this is insufficient logic is that the ROO raises the cost of both the variable and the fixed cost, while the tariff applies only to the variable cost.

[26] Note that $\theta_j = \bar{\theta}$ is a knife-edge case in which exporting firms in industry j are indifferent between satisfying the ROO and ignoring it. We break the tie by assuming that they will satisfy the ROO.

Some readers may wonder if non-compliance with ROO's is of more than theoretical interest, but in fact it is extremely common. In 2002, 45% of US imports from Canada failed to comply with ROO's and paid MFN tariffs; the corresponding figure for Mexico is 37%. Compliance rates also varied greatly across industries; in the same year 95% of textile and apparel imports from Canada were in compliance, compared with 14% for jewelry (Kunimoto and Sawchuk, 2005, p. 14). Anson *et al.* (2005) study patterns in non-compliance in intra-NAFTA trade. Hakobyan (2015) studies non-compliance with ROO's for developing-country tariff preferences in US imports.

In contrast to Proposition 1, in some models, once the restrictiveness of an ROO is increased past the point at which firms no longer prefer to comply, the equilibrium switches to a mixed outcome in which some firms comply and some do not. This occurs because the locally-produced input used for that particular final good drops in price just enough that the firms are indifferent between complying with the ROO and paying the tariff. Examples include Grossman (1981) and Ju and Krishna (2005), both models in which one final good is produced with one input that is used only for that one final good. However, that cannot happen in a general equilibrium model in which the ROO applies to one industry out of a large number, each of which is small in the broad market for manufactured inputs, such as ours.

3.3 National incomes as function of trade policy.

First, we analyze the equilibrium under a free trade agreement. Let R denote the number of industries hit with an ROO who choose not to comply with it. Each firm in each of these industries will choose to pay the tariff τ when exporting to the US. Let national income in the US, which in this model amounts to GDP plus any tariff revenue, be denoted by Y, and let national income in Mexico be denoted Y^*.

Of course, an industry not subject to an ROO or subject to an ROO and complying with it generates no tariff revenue. On the other hand, for an industry j facing an ROO but not complying, US consumer spending on the industry is $(1-\alpha)Y$, but only $\frac{(1-\alpha)Y}{1+\tau}$ of that spending reaches the Mexican producers. Consequently, the tariff revenue generated by each non-compliant ROO industry is equal to $\frac{\tau(1-\alpha)Y}{1+\tau}$ and so total tariff revenue is given by multiplying this value by R. Hence, national income can be written as

$$Y = L + R\frac{\tau(1-\alpha)Y}{1+\tau},$$

where L is US GDP (the wage, equal to unity, times the labor supply) plus tariff revenue. Simplifying, this yields

$$Y = \left(\frac{1+\tau}{1+(1-R(1-\alpha))\,\tau}\right)L. \tag{13}$$

Note that this is always greater than the GDP, L, unless the tariff is equal to zero or $R = 0$, so that no Mexican industry pays the tariff. (The case in which where is no trade agreement in force can be represented conveniently by setting $R = 1$, so that all Mexican imports to the US are subject to tariff.)

Mexican income can be derived in a similar way. First we note that

$$Y^* = w^*L^* + \Pi^* + TR^*,$$

where w^* is the Mexican wage, L^* is the supply of labor in Mexico, Π^* is aggregate profits in Mexico, and TR^* is tariff revenue in Mexico. In equilibrium, $\Pi^* = 0$, but to analyze the case without FT we will need to be able to compute income off of the equilibrium path, so that the trade policy expected by entrepreneurs is different from what is finally implemented, and in that case we can have non-zero profits. By an argument parallel to that used to derive (13), we can write

$$Y^* = \left(\frac{1+d\tau^*}{1+(1-\alpha)d\tau^*}\right)(w^*L^* + \Pi^*)\,, \tag{14}$$

where τ^* is the Mexican tariff and d is a dummy variable for MFN tariff that takes a value of 1 if there is no free trade agreement in force, so that all US imports are subject to the tariff τ^*, and 0 if a free trade agreement is in force, so that US imports enter the country duty-free. Once again, note that because of tariff revenue, Mexican income strictly exceeds Mexican GDP, $w^*L^* + \Pi^*$, unless the Mexican tariff has a value of zero or there is a free trade agreement in force.

3.4 A key proposition on optimal ROO policy.

Some basic comparative statics regarding the effects of ROO's can now be derived.

Proposition 2 *Suppose that FT is in effect, so that both n and the number of Mexican firms that export will adjust to any announced choice of policy to make profits in Mexican manufacturing zero, i.e., $\Pi^* = 0$.*[27] *Suppose that the rules of origin $\{\theta_j\}$ for $j \in [0,1]$ have been set so that a fraction R of the industries have $\theta_j > \bar{\theta}$ (and thus ignore the ROO and pay the tariff); a fraction $(1-\gamma)(1-R)$ have $\theta_j \leq \underline{\theta}$ (and thus for them the ROO is not binding); and a fraction $\gamma(1-R)$ have $\underline{\theta} < \theta_j \leq \bar{\theta}$ (and thus comply with the ROO). Denote the average value of θ_j for the complying industries by θ. Now consider changing the ROO schedule so that θ changes but not R or γ. Then*

$$\frac{\partial w^*}{\partial \theta} > 0, \frac{\partial n}{\partial \theta} > 0, \text{ and } \frac{\partial P_N X_N}{\partial \theta} < 0,$$

where X_N is the total imports of composite non-member inputs.

Proof. See appendix.

If complying firms are made to increase their purchases of Mexican inputs and labor, that increases the demand for Mexican labor, raising the Mexican wage; raises the demand for Mexican inputs, increasing the number of inputs produced; and lowers the import of non-member inputs. Now, note that the tightening of ROO's increases w^*, which tends to raise the marginal cost of Mexican manufacturers, while it also raises n, which, recalling (11), tends to have the opposite effect. The net effect on Mexican costs is ambiguous, and depends on the following condition.

Proposition 3 *Denoting by c the marginal cost of a Mexican firm for the domestic market (and thus the marginal cost for exports in the case of an exporting firm that is not constrained by an ROO),*

$$\frac{\partial c}{\partial \theta} > 0 \text{ iff}$$

[27] When FT is not in effect, the number of exporters cannot adjust following an amendment by the U.S. Congress. In that case, the number of firms in Mexico, n, will adjust to guarantee zero profit only for firms serving the domestic market, not for exporters. We will comment on this case without FT in Section 6.1.

$$\beta\eta < \frac{\rho\,(1-\beta)}{1-\rho}. \tag{15}$$

This condition is ensured by (9).

Proof. See appendix.

The stronger are backward and forward linkages, or in other words the bigger is $\beta\eta$, the more likely it is that the effect of the ROO on the number of Mexican firms dominates for marginal costs. It is immediate as well that if (15) holds, the number of varieties of each industry exported to the US is also decreasing in θ.[28] This all brings us to a very important conclusion on policy.

Proposition 4 *If (15) is satisfied, it is never optimal from the point of view of US welfare for a positive mass of industries to have ROO's with $\underline{\theta} < \theta \leq \bar{\theta}$.*

The point is that if condition (15) is satisfied, when θ is in the middle range, it raises the cost of producing Mexico's exports to the US, raising their prices to US consumers and lowering the variety of products available to US consumers, but does not generate any tariff revenue. From here on, we will assume condition (15) holds unless otherwise stated, and therefore, without loss of generality, we can assume that for each j, θ_j is either above $\bar{\theta}$ (it makes no difference how far above) or below $\underline{\theta}$ (it makes no difference how far below). For brevity, henceforth we will call the former the case of an 'ROO,' and the latter the case of 'no ROO.'[29]

It is worth underlining the inefficiency of equilibrium implied by Proposition 3. Note that for any firm complying with its ROO, the marginal cost will be equal to c times $CCR(\beta, \eta, \theta)$, and from (12) the elasticity of $CCR(\beta, \eta, \theta)$ with respect to θ is equal to 0 if $\theta = \underline{\theta}$. This together with Proposition 3 imply that if backward and forward linkages were strong enough

[28] Consider an industry i in which firms comply with the ROO. US spending on this industry is equal to $(1-\alpha)Y$, and variable profits will equal $(1-\rho)\,(1-\alpha)Y$. From (13), this is unchanged by a change in θ. For zero profits to hold, the aggregate sunk cost $\tilde{n}_i c^{ROO^S} S$ incurred in industry i, where $\tilde{n}_i$ is the number of firms in the industry that upgrade their quality for export, must be equal to total variable profit. Since an increase in θ raises c^{ROO^S}, it must lower $\tilde{n}_i$. The argument for other industries is parallel.

[29] It is obvious that the trivial case $\theta_j = \underline{\theta}$ is also under ROO.

that condition (15) was not satisfied, then *Mexican firms' costs would be reduced if they were all forced to deviate from cost-minimizing behavior by an ROO that makes them buy more Mexican inputs than they would choose on their own* – including (at least for small increases of θ above $\underline{\theta}$) the firms that are complying with the ROO. The reason is that it spurs additional firm creation, which is possible without any additional resources because the additional firms raise the productivity of all Mexican firms. Given condition (9), that extreme case will not occur in the part of the parameter space that concerns us, but the inefficiency that is highlighted by the extreme case – too few Mexican firms in equilibrium – will still always be present in a less extreme form.

Beyond our model, there are cases in which binding ROO's could be optimal from the point of view of the US. Falvey and Reed (2002) study a model in which an ROO imposed by an importing country can lower exporters' marginal costs, for example, by lowering the price of inputs from third countries. In our model, this could happen if Mexico had a strong effect on factor prices in non-member countries, so that a shift in input demand away from non-member countries lowers the price of inputs purchased from those countries. In addition, if the US produced inputs that compete with Mexican imports, the ROO could confer a terms-of-trade benefit to the US by increased within-NAFTA demand for those inputs. This mechanism is at play in Duttagupta and Panagariya (2007). In addition, if firms were heterogenous in their compliance costs it is likely that any equilibrium would have a mix of compliant and non-compliant firms in each industry. In our model, the simple structure of optimal ROO's that emerges makes the potential use of ROO's as protectionist devices clear in a stark manner. GATT Article XXIV is generally read to require that a free-trade agreement specify no tariffs at all on trade between members. In our model, however, ROO's effectively function as a way of selectively turning off tariff preferences for a subset of industries that is consistent with the letter if not the spirit of Article XXIV, and so our ROO's fit into the category termed 'hidden protection' in Krishna and Krueger (1995). This does seem to be an important function of ROO's in practice, as indicated by the percentage of intra-NAFTA trade that is subject to tariffs as discussed in Section 3.2.

3.5 Equilibrium wage in Mexico.

We consider market-clearing conditions for the US numeraire good. Recall that under our assumptions this is produced only in the US, but it is consumed everywhere. Its supply is of course equal to the US labor supply, L, which, since it is the numeraire good, is both the quantity produced and the value sold. Domestic US consumer spending on the numeraire good is αY. Mexican consumer spending on the numeraire good is αY^*, of which $\frac{\alpha Y^*}{1+d\tau^*}$ is the value received by US producers (recall that d is the dummy for MFN tariff, as in Section 3.3).

To arrive at the demand from the non-member country we need a slightly roundabout argument. Suppose that in the aggregate, a quantity X_N of input is imported to Mexico from the non-member country at the constant world price of P_N. Then Mexico will have a trade deficit with the non-member country amounting to $P_N X_N$. Since each country's trade must be balanced overall in equilibrium, Mexico must run a trade surplus with the US exactly equal to this amount, and since US trade must also be balanced overall, the US runs an equal-sized trade surplus with the non-member country. Therefore, US sales of its numeraire good to the non-member country must be equal in equilibrium to $P_N X_N$.

As a result, market clearing for the numeraire good can be written as

$$L = \alpha Y + \frac{\alpha Y^*}{1 + d\tau^*} + P_N X_N. \tag{16}$$

Since cost minimization by Mexican firms implies that labor's share of total production costs is equal to $1 - \beta$ and non-member inputs' share is equal to $\beta(1 - \eta)$, and in the aggregate, labor's share of costs must be equal to $w^* L^*$, the condition can be rewritten as

$$L = \alpha Y + \frac{\alpha Y^*}{1 + d\tau^*} + \frac{\beta(1 - \eta)}{1 - \beta} w^* L^*.$$

Using (13) and (14), we obtain

$$w^* = \left[\frac{(1 - \beta)(1 - \alpha)(1 + (1 - \alpha)d\tau^*)}{\alpha(1 - \beta) + \beta(1 - \eta)(1 + (1 - \alpha)d\tau^*)} \right] Z(R) \frac{L}{L^*}, \tag{17}$$

where

$$Z(R) \equiv \frac{1 + (1 - R)\tau}{1 + (1 - R(1 - \alpha))\tau}. \tag{18}$$

Note that the Mexican wage w^* is decreasing in α and L^*/L, since these parameters respectively shift relative demand toward US-made goods, away from Mexican-produced goods, and increase the relative supply of Mexican labor. For our discussion, there are two relevant policy variables, R and d (since we are taking the existing tariff rates as given, but governments in the course of negotiation can choose the coverage of ROO's and whether or not to walk away from the free-trade agreement). Therefore, we can use (17) to define the equilibrium Mexican wage as a function of these two variables, $w^*(R, d)$. It is easy to verify that this function is decreasing in R and increasing in d. An increase in R causes a wider range of Mexican industries to be subject to US tariffs, which switches US consumer demand away from Mexican-produced goods. Switching d from 0 to 1 amounts to tearing up the free-trade agreement, which causes the Mexican tariff to be in force on all imports from the US. This pushes down the relative price of the numeraire good relative to Mexican products, raising the Mexican wage w^* relative to the US wage, and providing Mexico with a terms-of-trade benefit.

Proposition 5 *The Mexican wage in terms of the numeraire, w^*, is decreasing in the number R of industries hit by rules of origin and is also decreased if Mexico eliminates its tariff (switching d from 1 to 0).*

3.6 Equilibrium number of firms.

Consider first the equilibrium number of domestic firms in Mexico. In order to find this, we need to add up the total domestic Mexican demand for a typical industry j. This consists of (a) Mexican final consumer demand; (b) demand by Mexican firms for inputs to produce output for export; and (c) inputs required for (a) and (b) plus inputs to produce inputs. Domestic consumer demand is equal to $(1-\alpha)Y^*$. Total revenues from exports, and therefore total costs for export production, amount to $(1-\alpha)Y$ for a no-ROO industry and $\frac{(1-\alpha)}{(1+\tau)}Y$ for an ROO industry. Given that there are $(1-R)$ of the former and R of the latter industries, export revenues are equal to $(1-\alpha)\left(\frac{1+(1-R)\tau}{1+\tau}\right)Y$, and a fraction $\beta\eta$ of that amount goes to domestically-produced inputs to produce those exports. We can therefore write parts (a) and

(b) above as $Y^{a+b} \equiv (1-\alpha)\left(Y^* + \beta\eta\left(\frac{1+(1-R)\tau}{1+\tau}\right)Y\right)$. If we denote revenue from production of intermediates, part (c) above, by Y^c, then domestic revenue for all Mexican firms together is $Y^{a+b}+Y^c$, and since all Mexican firms produce with a cost share of domestic intermediates equal to $\beta\eta$, we have $Y^c = \beta\eta(Y^{a+b}+Y^c)$, so $Y^c = \left(\frac{\beta\eta}{1-\beta\eta}\right)Y^{a+b}$, and the domestic revenue of all Mexican firms is equal to $Y^{a+b}/(1-\beta\eta)$. Total revenues times $(1-\rho)$ yields variable profit (recall Section 2.5), so equating variable profit with fixed costs implies

$$nFc(n, w^*) = (1-\rho)\frac{1-\alpha}{1-\beta\eta}\left[Y^* + \beta\eta\left(\frac{1+(1-R)\tau}{1+\tau}\right)Y\right], \text{ so}$$

$$n = \frac{(1-\alpha)(1-\rho)}{(1-\beta\eta)Fc(n, w^*)}\left[Y^*(w^*, d) + \left(\frac{1+(1-R)\tau}{1+\tau}\right)\beta\eta Y\right].$$

In other words, n is proportional to the domestic demand for Mexican products and inversely proportional to the fixed cost $Fc(n, w^*)$.[30] Using (13), (14), and (17), this can be rewritten as

$$n = \left[\frac{(1-\beta)(1-\alpha)(1+d\tau^*) + \beta\eta(1+(1-\alpha)d\tau^*)}{\alpha(1-\beta) + \beta(1-\eta)(1+(1-\alpha)d\tau^*)}\right]\frac{(1-\alpha)(1-\rho)}{Fc(n, w^*)}Z(R)L. \tag{19}$$

From (11), the right-hand side of (19) is increasing in n, taking a limit of 0 as $n \to 0$. Further, the elasticity of the right-hand side with respect to n is equal to

$$\left(\frac{1-\rho}{\rho}\right)\left(\frac{\beta\eta}{1-\beta\eta}\right).$$

The value of this elasticity must be less than 1 for the stability of the equilibrium, which requires

$$\beta\eta < \rho. \tag{20}$$

Clearly, condition (9) guarantees this, so (20) will be redundant.

We can now identify the main comparative statics results with respect to a change in the ROO policy. It will be useful to focus on elasticities, and we denote by $\xi_{y,x}$ the elasticity of

[30] It is tempting to see the Mexican economy as a version of a Krugman (1980) economy, with one monopolistically-competitive sector that produces with labor as the only non-produced input, so that the constant markup implies a constant size for each firm, in turn implying a constant number of firms pinned down by the size of the Mexican labor force. This is not how the model works, for two reasons. First, some of the n Mexican firms choose to export, which requires additional labor, and the number of firms that do so is endogenous. Second, all of these firms use imported inputs, and a rise in w^* induces substitution away from Mexican labor toward imported inputs, reducing the labor required by each firm.

variable y with respect to the variable x. Nothing in the big square brackets of (19) depends on R either directly or indirectly, so in computing the elasticity $\xi_{n,R}$ of n with respect to R under FT, we need only to focus on the fraction at the end of the expression. Given (11), this amounts to

$$\xi_{n,R} = \xi_{Z,R} - \left(\frac{\rho-1}{\rho}\right)\left(\frac{\beta\eta}{1-\beta\eta}\right)\xi_{n,R} - \left(\frac{1-\beta}{1-\beta\eta}\right)\xi_{w^*,R},$$

Using $\xi_{w^*,R} = \xi_{Z,R}$ (see equation (17)) and solving this, we have the elasticity of the number of firms in Mexico with respect to the extent of the rules of origin

$$\xi_{n,R} = \frac{\beta\rho(1-\eta)}{\rho-\beta\eta}\xi_{Z,R} < 0, \tag{21}$$

since (9) is assumed and using (18)

$$\xi_{Z,R} = -\frac{\alpha\tau(1+\tau)R}{[1+(1-R(1-\alpha))\tau][1+(1-R)\tau]} < 0. \tag{22}$$

Therefore, if R is increased, the number of firms in Mexico goes down. The exception is if $\beta = 0$ or $\eta = 1$, the two cases in which there are no imported inputs used. In both of these cases, units costs are proportional to w^* (see (11)), which is proportional to the demand shifter $Z(R)$ (see (17)), so when R is increased costs fall in proportion with demand, and the number of firms is unchanged.[31] Otherwise, the fall in n resulting from an increase in R will tend to raise marginal costs for Mexican firms (recall (11) again), while at the same time, from (17), the increase in R lowers the Mexican wage w^*, which tends to *lower* Mexican marginal costs. The net effect on marginal costs in Mexico is ambiguous, and given by

$$\xi_{c,R} = \left(\frac{\rho-1}{\rho}\right)\left(\frac{\beta\eta}{1-\beta\eta}\right)\xi_{n,R} + \left(\frac{1-\beta}{1-\beta\eta}\right)\xi_{w^*,R},$$

which, given (21) and $\xi_{w^*,R} = \xi_{Z,R}$, yields

$$\xi_{c,R} = \left(\frac{\rho(1-\beta(1-\eta))-\beta\eta}{\rho-\beta\eta}\right)\xi_{Z,R}. \tag{23}$$

[31] The neutrality of n to R when $\beta = 0$ or $\eta = 1$ can also be seen from (19). When unit costs are proportional to w^*, the demand shifter $Z(R)$ cancels out and n does not depend on R anymore.

Given (20) and $\xi_{Z,R} < 0$ as shown in (22), this means that an increase in R lowers c, and therefore the price of each good produced in Mexico, as long as the numerator is positive. This will be true if η is small enough; specifically,

$$\xi_{c,R} < 0 \Leftrightarrow \eta < \left(\frac{\rho}{1-\rho}\right)\left(\frac{1-\beta}{\beta}\right). \tag{24}$$

Note that this is the same condition given in (15), and just as before it is guaranteed to hold by (9).

We turn now to the number of firms in each Mexican industry that choose to export to the US. For a given industry j, US consumer spending on the industry's products together is equal to $(1-\alpha)Y$. If industry j is not subject to an ROO (no-ROO industry), this is also the amount Mexican producers obtain whereas if it is subject to an ROO, only $\frac{(1-\alpha)Y}{1+\tau}$ of that spending reaches Mexican producers. Each firm produces $\frac{\rho}{1-\rho}S$ units of exported output. In order for the total industry export revenues to be equal to the value of consumer spending on the products received by Mexican producers, we must have

$$\tilde{n}_j^{NR} p_j \left(\frac{\rho}{1-\rho}\right) S = (1-\alpha)Y, \text{ if } j \text{ is a no-ROO industry}$$

$$\tilde{n}_j^{R} p_j \left(\frac{\rho}{1-\rho}\right) S = \frac{(1-\alpha)Y}{1+\tau}, \text{ if } j \text{ is an ROO industry,}$$

where $\tilde{n}_j^{NR}$ and $\tilde{n}_j^{R}$ denote the number of j-industry firms that choose to export in a no-ROO and ROO industry, respectively. This yields the equilibrium number of exporters for a typical no-ROO industry

$$\tilde{n}^{NR} = (1-\alpha)(1-\rho)\frac{Y}{Sc}. \tag{25}$$

For an industry subject to an ROO, since they receive only $1/(1+\tau)$ of the consumer spending, their equilibrium number is reduced accordingly

$$\tilde{n}^{R} = \frac{\tilde{n}^{NR}}{1+\tau}. \tag{26}$$

The total number of exporters $\tilde{n}$ is defined as

$$\tilde{n} = R\tilde{n}^{R} + (1-R)\tilde{n}^{NR}. \tag{27}$$

It is straightforward to derive that if Mexican firms correctly anticipate the ROO policy that will be followed, then a more restrictive ROO policy will result in fewer exporters.

Proposition 6 *The total number of exporting firms in Mexico, $\tilde{n}$, is decreasing in R in equilibrium.*

Proof. See appendix.

4 Welfare.

Welfare in Mexico can be computed from the indirect utility function, derived from (1)

$$U^M = \frac{Y^*}{(1+d\tau^*)^\alpha \left(n^{\frac{\rho-1}{\rho}} p\right)^{1-\alpha}}. \tag{28}$$

Proposition 7 *Under condition (24), a fully anticipated increase in R will lower the Mexican wage, the number of varieties produced in each Mexican industry, and Mexican welfare.*

Proof. See appendix.

The corresponding expression for US welfare requires computation of the consumer price index in the US. Suppose that R industries expect an ROO. The price index for the composite good for each of those industries (see (7)) is $P_j = \left(\tilde{n}^R\right)^{\frac{\rho-1}{\rho}}(1+\tau)p$. The other $1-R$ industries are not subject to an ROO. The price index for each of those industries' composite goods in the US is $P_j = \left(\tilde{n}^{NR}\right)^{\frac{\rho-1}{\rho}} p$.

Consequently, the log of the price in the US of composite imported goods from Mexico is $\ln(P) = \int_0^1 \ln(P_j)dj = (1-R)\ln\left(\left(\tilde{n}^{NR}\right)^{\frac{\rho-1}{\rho}} p\right) + R\ln\left(\left(\tilde{n}^{R}\right)^{\frac{\rho-1}{\rho}}(1+\tau)p\right)$, so (recalling that $\tilde{n}^R = \tilde{n}^{NR}/(1+\tau)$),

$$P = (1+\tau)^{\frac{R}{\rho}} \left(\tilde{n}^{NR}\right)^{\frac{\rho-1}{\rho}} p. \tag{29}$$

Consequently, using (1) and (29), US welfare is given by

$$U^{US} = \frac{Y}{\left((1+\tau)^{\frac{R}{\rho}} \left(\tilde{n}^{NR}\right)^{\frac{\rho-1}{\rho}} p\right)^{1-\alpha}}. \tag{30}$$

Holding fixed the price of each Mexican good, US welfare is reduced by a rise in the tariff or by the number R of industries that pay the tariff (since this increases the consumption distortion), and increases with a rise in the number of varieties exported to the US (recalling that from (25), (26), and (27) the total number of exported varieties is proportional to $\tilde{n}^{NR}$).

We can now clarify the need for condition (9). In the case with no trade agreement at all (equivalent to the case of $R = 1$), a positive tariff τ is desirable for the US if and only if (9) holds:

Proposition 8 *With $R = 1$, the tariff τ that maximizes US welfare is positive if and only if $\beta < \rho$.*

Throughout our analysis, we assume that tariffs are positive, which would be difficult to justify if a unilateral tariff elimination would raise welfare. Proposition 8 shows that condition (9) eliminates this case. The underlying reason is as follows. Increasing the US tariff pushes down the US demand for Mexican products, which puts downward pressure both on the Mexican wage and on the number of Mexican firms. The former effect is desirable for the US, because it improves the US terms of trade, but the latter effect is undesirable because it raises costs for Mexican firms, increasing their prices and *worsening* the US terms of trade. The effect on the number of firms is larger the larger is β,[32] and the effect of reduced product variety on Mexican costs is larger, the smaller is ρ.[33] Condition (9) ensures that the effect on the Mexican wage is the dominant factor from the point of view of US welfare.

[32]Recall from Section 3.6 that the number of Mexican firms is proportional to the demand for Mexican products and inversely proportional to the fixed cost Fc per firm. If $\beta = 0$, the cost is simply proportional to the wage w^*, but the wage is also proportional to the demand for Mexican products, so the net effect on n is zero. If $\beta > 0$, the cost is less sensitive to the wage, and this allows for the number of firms to respond to the tariff.

[33]If ρ is close to 1, products are almost perfect substitutes, and product variety does not much matter. Recall (11).

5 Equilibrium with Fast-Track Authority.

To compute US welfare under a given value of R under FT, combine (30) with (25) and the condition that $c = \rho p$ to obtain

$$U^{US} = \left[(1+\tau)^{\frac{R}{\rho}} \left(\frac{(1-\alpha)(1-\rho)}{S\rho} \right)^{\frac{\rho-1}{\rho}} \right]^{-(1-\alpha)} Y^{\frac{1-\alpha(1-\rho)}{\rho}} p^{-\frac{(1-\alpha)}{\rho}}. \tag{31}$$

US negotiators choose R to maximize US welfare, taking into account the effect of R on all endogenous variables (n, $\tilde{n}^R$, $\tilde{n}^{NR}$, w^*, and p), subject to the constraint that Mexican welfare with the agreement is not less than Mexican welfare without it. This amounts to

$$max_R \left\{ U^{US}(R,0) \right\} \ni U^{MEX}(R,0) \geq U^{MEX}(1,1),$$

where $U^{US}(R,d)$ and $U^{MEX}(R,d)$ denote respectively US and Mexican utility, taking full account of the equilibrium effect of R and d on all endogenous variables. As before, d is a dummy variable that records a value of 1 if no free-trade agreement is in force, so that the tariffs apply to all trade between the US and Mexico; and d records a value of 0 if a free-trade agreement is in force, so that the tariff applies only to ROO sectors exporting to the US from Mexico. Of course, if there is no free-trade agreement in effect, all industries will pay the tariff, which is equivalent to setting $R = 1$, and so the welfare constraint is written as $U^{MEX}(1,1)$. There are two cases: the case in which the constraint on Mexican welfare does not bind, which we may call the 'interior solution,' and the case in which it does bind, which we may call the 'corner solution.'

5.1 Case I: The Interior Solution.

From (31), the elasticity of US welfare with respect to R under FT can be written as

$$\xi^{FT}_{U^{US},R} = -\frac{1-\alpha}{\rho} R \log(1+\tau) + \frac{1-\alpha(1-\rho)}{\rho} \xi_{Y,R} - \frac{1-\alpha}{\rho} \xi_{p,R}. \tag{32}$$

From (13), we have

$$\xi_{Y,R} = \frac{(1-\alpha)\tau R}{1+(1-R(1-\alpha))\tau}. \tag{33}$$

Furthermore, since markups are constant, we have $\xi_{p,R} = \xi_{c,R}$. Combining (32) with (23), (22), and (33), we obtain the following

$$\xi^{FT}_{U^{US},R} = \frac{(1-\alpha)R}{\rho}\left[\frac{\tau}{1+(1-R(1-\alpha))\tau}\left(1-\alpha\left(1-\rho\right)+\frac{\alpha(1+\tau)(\rho[1-\beta(1-\eta)]-\beta\eta)}{[1+(1-R)\tau][\rho-\beta\eta]}\right)-\log\left(1+\tau\right)\right]. \tag{34}$$

The expression in the square brackets is increasing in R. Therefore, if (34) is ever equal to zero, say for some value $R = \hat{R}$, then for all $R < \hat{R}$, it is negative, and for all $R > \hat{R}$, it is positive. Therefore, $\hat{R}$ is a minimum for US welfare rather than a maximum, and the only possible unconstrained optimal values for R are 0 or 1. In addition, if R is bounded above by an incentive constraint, so that it cannot take a value above, say, R^{max}, then the only possible optimal values are 0 and R^{max}. Therefore, we can disregard the interior solution and focus entirely on the corner solution.

5.2 Case II: The Corner Solution.

We can use (34) to clarify which corner solution will be preferred. The relationship between β and ρ is crucial, which makes sense because the higher is β, the more important are intermediate inputs in production, and the lower is ρ, the more important is the *variety* of intermediate inputs in production, so for high β and low ρ the reduction in n caused by expansion of ROO's discourages the US from using them aggressively. Precisely:

Proposition 9 *For sufficiently small $\tau > 0$, US welfare under FT is increasing in R if $\beta < \rho$ and decreasing in R if $\beta > \rho$.*

Proof. See appendix.

Therefore, at least in the small-τ case, if $\beta > \rho$, the optimum will be $R = 0$ and if $\beta < \rho$ – as we assume throughout – it will be the highest R that satisfies the Mexican participation constraint. In the latter case, the negotiations set the value of R so that the Mexican government will be indifferent between tearing up the agreement and ratifying it. In this case, the optimal value of R, say, R^*, will satisfy

$$U^M(R^*, d = 0) = U^M(R = 1, d = 1). \tag{35}$$

Comment. The contrast between optimal ROO policy and the familiar analysis of optimal tariff setting is clearly quite stark. Optimal tariff setting, whether in the sense of maximizing social welfare or some political support function, typically involves an interior solution, satisfying a first-order condition that balances off terms-of-trade benefits and possibly domestic redistribution effects against domestic distortions created by the tariff (for a survey, see McLaren, 2016). However, we have seen here that in the present context, where ROO's are the instrument of protection an interior solution is never optimal. The reason is as follows. Each expansion of the use of ROO's (each increase in R) increases the number of industries in Mexico that pay the tariff, yielding a terms-of-trade benefit to the US. An additional benefit is that the rise in the price of imports for consumers in the newly-ROO-constrained industries shifts some consumer spending toward industries that are already constrained by an ROO. This undoes a portion of the consumer distortion of the tariff (because the tariff inefficiently discourages consumption of imports from those industries). This particular marginal benefit increases with increases in ROO coverage R, because the more ROO-affected industries there are, the more industries have tariff-distorted consumption. As a consequence, an important portion of the marginal benefit from expanding ROO coverage *rises* with expanding ROO coverage. There is no analogous rising marginal benefit to tariff level in an optimal-tariff calculation.

6 The Case without Fast Track.

All of the preceding analysis has been based on the assumption that Fast Track is in force, so that the value of R proposed in the agreement in period 1 is the same as the value that prevails in period 2. Now, consider the case in which FT is not in effect, so it is possible for Congress to alter the agreement in period 2, just before ratification, after businesses have made their decisions in period 1. For our purposes, that means that in period 2, the value of $\tilde{n}_j$, the number of firms in industry j that have made the sunk investment in quality required to export to the US, is taken as given, and cannot respond to changes in R. Rather, $\tilde{n}_j$ responds to the trade policy that was *expected*, as of period 1, to prevail in period 2. The conditions (25), (26), and (27) will still apply, but, for example, $\tilde{n}^{NR}$ will be the number of firms that invest in an industry that was not *expected* to be hit with a protectionist ROO, and the values on the right-hand side are the *anticipated* US GDP and the *anticipated* value of marginal costs, c. We can consequently write all equilibrium variables as functions of realized trade policy and also of the $\tilde{n}$'s. Most variables of interest will need to be conditioned only on the aggregate, $\tilde{n}$, and not on $\tilde{n}^{NR}$ and $\tilde{n}^{R}$ separately.

Under these conditions, we can rewrite the definition of constrained-optimal R, as defined in (35) and denoted R^*, as

$$U^M(R^*, \tilde{n}(R^*), d = 0) = U^M(R = 1, \tilde{n}(R = 1), d = 1), \tag{36}$$

where $\tilde{n}(R)$ is the value of $\tilde{n}$ that results when as of period 1 it was expected that R industries would be hit with ROO's. By Proposition 6, $\tilde{n}(R^*) > \tilde{n}(1)$ as long as $R^* < 1$.

This optimal value of R will not be credible in the absence of an FT if

$$U^M(R^*, \tilde{n}(R^*), d = 0) > U^M(R = 1, \tilde{n}(R^*), d = 1). \tag{37}$$

The left-hand side of (37) is Mexican welfare if the US promises R^*; this promise is believed by all market participants; and the US actually implements R^*. (It is the same as the left-hand side of (35).) The right-hand side of (37) is Mexican welfare if the US promises R^*; this promise is believed by all market participants; and Mexico in the end walks away from the agreement, tearing it up so that both countries' trade policies return to the status-quo ante ($R = 1$ and $d = 1$); but Mexico's export sector is still locked into the investment level ($\tilde{n}(R^*)$) that results from an expectation of R^*. If (37) holds, then R^* is not credible *ex ante* because if it were believed *ex ante* then *ex post* Mexico would be strictly worse off tearing up the agreement rather than abiding by the agreement; therefore, Congress would have some leeway to adjust R *ex post* in a way that would be beneficial to the US and harmful to Mexico at the margin, and the Mexican government would still have an incentive to ratify. Since everyone would understand this, then (37) would imply that no-one would believe the US promise to implement R^*.

Since the left-hand sides of (36) and (37) are the same, for (37) to hold, it is sufficient that

$$U^M(R=1,\tilde{n}(R=1),d=1) > U^M(R=1,\tilde{n}(R^*),d=1). \tag{38}$$

If that is true, and it is further true that the US can improve its welfare *ex post* by changing the value of R in a way that is injurious to Mexico, then (i) Mexico will do just as well under a free-trade agreement with Fast Track as under no talks at all; (ii) Mexico will do strictly worse under a free-trade agreement without Fast Track, because *ex post*, Congress can get Mexico to agree to the agreement with a higher value of R than it could with Fast Track. Therefore, Mexico will never agree to negotiate without Fast Track. We now investigate these conditions, which require us to learn about the comparative statics of period 2. To verify whether or not the US will want to adjust R in period 2, we need to study the comparative statics with respect to R, holding $\tilde{n}$ constant. To verify whether or not (38) holds, we need to study the comparative statics with respect to $\tilde{n}$, holding R constant. We turn to those inquiries now.

6.1 *Ex post* labor market clearing without Fast Track.

Without Fast-Track Authority, each business manager in Mexico will need to conjecture what amendments the US Congress might make to the agreement, and make investments accordingly. If firm i upgrades its product quality in order to be able to export to the US, then its management must start a process of transformation of the productive process in period 1 that will cost it S units of lost output in period 2 This decision is irreversible; if the firm's conjecture turns out in period 2 to be wrong, it will not be able to change it. In order to focus on the hold-up problem that results from this trade-specific sunk investment, we assume that firms can enter or exit Mexican manufacturing in period 2 (unless they have committed themselves to export), responding to new information about the actions of the US Congress.

One technical issue needs to be mentioned before we proceed: In analyzing the Period-2 outcomes without FT, we will assume that, as in the case with FT, it is not optimal for the US to issue a binding ROO with which firms in Mexico will comply. We have been unable to identify a sufficient condition analogous to that in Proposition 4. However, we have performed numerical simulations for a broad range of parameter values and have not found a case in which it does not hold. Details are available on request. Henceforth, we will assume implicitly the non-optimality of binding ROO's in Period 2.

Now on to the analysis of Period-2 equilibrium. A difficulty with the analysis without Fast Track is that although the zero-profit condition must be satisfied in equilibrium, it need not be satisfied off of the equilibrium path. Precisely, if Congress chooses a value of R in period 2 that is different from what was anticipated in period 1, the firms that invested in export capability will generally have non-zero profit. (Firms that do not export will still have zero profit, since we allow them to enter or exit in period 2, and so n is still endogenous.) This means that the logic used to derive (17), which repeatedly involves equating expenditure on an industry's products with that industry's cost, cannot be used, at least not off the equilibrium path. To analyze labor-market clearing in Mexico in this situation for an arbitrary value of R and $\tilde{n}$, we compute the costs for each industry as follows. Let C^{TOT} denote the cost incurred by all manufacturing firms across Mexico. The variable cost incurred for the production of products exported to the US is denoted C^X, and the variable cost of the products sold in Mexico as final consumption goods is denoted C^D. (The variable cost of a given subset of production is simply the marginal cost, c, times the number of units produced.) The variable cost of output sold in Mexico as an intermediate input (whether for production of products for domestic sale or of products for export) is denoted C^I. The cost implied by the fixed costs for all firms is ncF, and the cost implied by all of the quality upgrades for export is given by $\tilde{n}cS$.

These definitions imply the adding-up constraint

$$C^{TOT} = C^D + C^X + C^I + ncF + \tilde{n}cS. \tag{39}$$

Note that regardless of the behavior of Congress, Mexican firms will make zero profits on their domestic sales. (Mexican firms that do not export will make zero profits, and Mexican firms that do export will charge the same prices and incur the same costs on their domestic sales as those that do not, and will therefore also make zero domestic profits on their domestic sales.) This allows us to write

$$C^D + C^I + ncF = (1-\alpha)Y^* + \frac{C^I}{\rho}. \tag{40}$$

The left-hand side is the total cost incurred on domestic sales, including fixed costs, while the right hand side is the revenue of domestic firms on all domestic sales: the sum of Mexican final consumer demand (the first term) and Mexican spending on Mexican-made inputs (the second term). This last point follows since with price a constant mark-up of $\frac{1}{\rho}$ over marginal costs, total expenditure on Mexican inputs is equal to the total variable cost of producing those inputs divided by ρ, or $\frac{C^I}{\rho}$. Substituting the right-hand side of this expression into (39) yields

$$C^{TOT} = (1-\alpha)Y^* + \frac{C^I}{\rho} + C^X + \tilde{n}cS. \tag{41}$$

Now, given the Cobb-Douglas production function, total spending on domestic inputs must be equal to $\beta\eta C^{TOT}$.[34] Again, given that each variety's price is a markup of $\frac{1}{\rho}$ over marginal cost, the variable cost of production of domestic inputs, C^I, must be equal to $\rho\beta\eta C^{TOT}$. Substituting this into (41) and solving for C^{TOT} yields

$$C^{TOT} = \frac{(1-\alpha)Y^* + C^X + \tilde{n}cS}{1-\beta\eta}. \tag{42}$$

Multiplying both sides by the Cobb-Douglas weight on labor in production yields

$$w^*L^* = (1-\beta)\left(\frac{(1-\alpha)Y^* + C^X + \tilde{n}cS}{1-\beta\eta}\right). \tag{43}$$

We can derive C^X from US income and preferences, recalling that for industries under an ROO, the expenditure by US consumers is equal to $1+\tau$ times the revenue received by Mexican firms

$$\frac{C^X}{\rho} = (1-\alpha)Y\left(\frac{R}{1+\tau} + 1 - R\right),$$

[34]Note that this depends on there being no ROO's to which firms actually comply. For the case with FT, Proposition 4 established conditions under which that will be the case. For the case without FT, we assume this is the case based on our numerical simulations.

which can be rewritten as

$$C^X = (1-\alpha)\rho Z(R)L, \tag{44}$$

where $Z(R)$ is as defined in (18).

We also need an expression for aggregate profits in order to calculate Mexican income using (14). These are given by revenue minus cost in the export sector. Variable costs in Mexican manufacturing are equal to C^X; recalling that the producer's price is equal to marginal cost divided by ρ, we conclude that revenues to the Mexican export sector are equal to $\frac{C^X}{\rho}$. Since the sunk cost for the export sector is given by $\tilde{n}cS$, using (44) we conclude that

$$\begin{aligned} \Pi^* &= \frac{1-\rho}{\rho}C^X - \tilde{n}cS \\ &= (1-\alpha)(1-\rho)Z(R)L - \tilde{n}cS. \end{aligned} \tag{45}$$

Substituting in the expression for Y^* from (14) and for C^X and Π^* just derived into (43), we have

$$\left(\tfrac{1-\beta\eta}{1-\beta} - \tfrac{(1-\alpha)(1+d\tau^*)}{(1+(1-\alpha)d\tau^*)}\right) w^*L^* = \begin{cases} \left[1 + \frac{(1-\alpha)(1+d\tau^*)}{1+(1-\alpha)d\tau^*}\frac{1-\rho}{\rho}\right](1-\alpha)\rho Z(R)L \\ + \left(1 - \frac{(1-\alpha)(1+d\tau^*)}{(1+(1-\alpha)d\tau^*)}\right)\tilde{n}cS, \end{cases} \tag{46}$$

which, after some simplification, becomes

$$w^*L^* = \begin{cases} \underbrace{\left(\frac{(1-\alpha)(1-\beta)\left[1+(1-\alpha)d\tau^* - \alpha(1-\rho)\right]}{\alpha(1-\beta)+\beta(1-\eta)(1+(1-\alpha)d\tau^*)}\right)}_{\text{Denote by } G} Z(R)L \\ + \underbrace{\left(\frac{\alpha(1-\beta)}{\alpha(1-\beta)+\beta(1-\eta)(1+(1-\alpha)d\tau^*)}\right)}_{\text{Denote by } H} \tilde{n}cS, \end{cases} \tag{47}$$

This is one of two key equilibrium conditions that are needed to determine the effect of changes in $\tilde{n}$ and R on the endogenous variables. We can think of this as roughly a labor-market clearing condition, with the left hand indicating the value of labor supplied in Mexico and the right hand indicating the value of labor demanded, both from foreign demand for exported Mexican products (and from the induced input demand and Mexican consumer demand from the Mexican income that those exports generate); and the labor demand from the pre-committed sunk cost $\tilde{n}cS$.[35] Notice that for a given R, increasing $\tilde{n}$ so that $\tilde{n}cS$ goes up by one dollar implies that w^*L^* goes up by less than a dollar (since $H < 1$) – and so in that case Mexican *income*, which is given in (14) as the sum of wage income and profits (multiplied by a positive coefficient to take into account any tariff revenue), falls.

We can combine (47) with (45) to obtain a compact expression for Mexican income

$$w^*L^* + \Pi^* = \ [1 + (1-\alpha)d\tau^*] \left(\frac{[(1-\beta)+\beta(1-\eta)(1-\rho)](1-\alpha)Z(R)L - \beta(1-\eta)\tilde{n}c(n,w^*)S}{\alpha(1-\beta)+\beta(1-\eta)(1+(1-\alpha)d\tau^*)} \right). \tag{48}$$

6.2 Determination of n.

Total cost incurred by Mexican firms on their domestic sales (including fixed costs) are given by (40). Using $C^I = \rho\beta\eta C^{TOT}$ and (42), (40) becomes

$$C^D + C^I + ncF = (1-\alpha)Y^* + \frac{\beta\eta(1-\alpha)Y^*}{1-\beta\eta} + \frac{\beta\eta(C^X + \tilde{n}cS)}{1-\beta\eta},$$

where on the right-hand side the first term is output for Mexican consumers, the second term is output used as intermediate inputs for production of consumer goods for Mexican consumers, and the last term is output used as intermediate inputs for production for the export sector (including the fixed cost).

Zero profits from domestic operations imply (recalling that $p = \frac{c}{\rho}$ and $q_j(i) = \frac{\rho}{1-\rho}F$ from Section 2.5)

$$\frac{(1-\alpha)Y^* + \beta\eta(C^X + \tilde{n}cS)}{1-\beta\eta} = \frac{ncF}{1-\rho}. \tag{49}$$

This determines the value of n given the other variables. Using expressions we have for Y^* (namely, (14)) and C^X (namely, (44)), we obtain

$$\frac{(1-\alpha)(1+d\tau^*)}{1+(1-\alpha)d\tau^*}(w^*L^* + \Pi^*) + \beta\eta\left[(1-\alpha)\rho Z(R)L + \tilde{n}cS\right] = \frac{(1-\beta\eta)}{(1-\rho)}ncF.$$

[35] Of course, Mexican consumer demand also feeds into the demand for Mexican labor, which will put w^*L^* and Π^* terms on the right-hand side of the equation. Gathering terms and rearranging allows us to write the condition in the form (47), with only export-driven income terms on the right-hand side.

Further simplifying this expression using (48) yields

$$\frac{nF}{1-\rho} = \begin{cases} \underbrace{\left(\frac{(1-\alpha)\left[(1-\alpha)(1-\rho\beta)(1+d\tau^*)+\rho\beta\eta(1+(1-\alpha)d\tau^*)\right]}{\alpha(1-\beta)+\beta(1-\eta)(1+(1-\alpha)d\tau^*)} \right)}_{\text{Denote by } K} \frac{Z(R)L}{c} \\ -\underbrace{\left(\frac{-\alpha\beta+\beta(1-\eta)(1+(1-\alpha)d\tau^*)}{\alpha(1-\beta)+\beta(1-\eta)(1+(1-\alpha)d\tau^*)} \right)}_{\text{Denote by } M} \tilde{n}S. \end{cases} \tag{50}$$

This is the second equilibrium condition. We can think of it as roughly a zero-profit condition, in that it shows the number of firms that must enter in Mexico in order for the cumulated fixed cost to be equal to the variable profits generated by the domestic demand, from all sources, for Mexican products, including demand induced indirectly by exports and by the pre-committed sunk cost. We can put this equation together with (47) to determine w^* and n as functions of $\tilde{n}$ and R (remembering that c is also a function of w^* and n through (11)).

6.3 Main comparative statics result for the case with no FT.

We now put (47) together with (50) to analyze the effects of a change in $\tilde{n}$ inherited from period 1 and a change in R on period-2 outcomes. The effects differ qualitatively for different parts of the parameter space, and it will be useful to contrast two cases: The case of 'weak linkages,' namely when η is small, so that the Mexican economy cannot improve its productivity much by producing a wide variety of inputs, and the economy acts like a neoclassical trade model; and the case of 'strong linkages,' in which η and β are both on the high end of their feasible range and the increasing-returns-to-scale nature of the Mexican manufacturing sector becomes more important.

The following term will be useful to define for the upcoming analysis.

$$D \equiv \begin{cases} (\rho-\beta\eta)\left[\frac{KZ(R)L}{c} - M\tilde{n}S\right] GZ(R)L + \beta(\rho-\eta)\left[\frac{KZ(R)L}{c} - M\tilde{n}S\right] H\tilde{n}cS \\ -\beta\eta(1-\rho)\left[GZ(R)L + H\tilde{n}cS\right] M\tilde{n}S, \end{cases} \tag{51}$$

where G and H are defined in (47), and K and M are defined in (50).

First, the comparative statics for $\tilde{n}$:

Proposition 10 *In the case without Fast Track, holding R constant, the elasticities of w^* and n with respect to $\tilde{n}$ can be written as follows.*

$$\xi_{w^*,\tilde{n}} = \frac{(\rho - \beta\eta)\left[\frac{KZ(R)L}{c} - M\tilde{n}S\right]H\tilde{n}cS}{D},$$

$$\xi_{n,\tilde{n}} = \frac{-\rho\left((1-\beta\eta)\left[GZ(R)L + H\tilde{n}cS\right]M\tilde{n}S + (1-\beta)\left[\frac{KZ(R)L}{c} - M\tilde{n}S\right]H\tilde{n}cS\right)}{D},$$

and

$$\xi_{c,\tilde{n}} = \frac{\beta\eta(1-\rho)\left[GZ(R)L + H\tilde{n}cS\right]M\tilde{n}S + \rho(1-\beta)\left[\frac{KZ(R)L}{c} - M\tilde{n}S\right]H\tilde{n}cS}{D},$$

where G and H are defined in (47), K and M are defined in (50), and D is defined in (51).

In the 'weak linkages' limiting case with η close to 0, we have that $D > 0$ and

$$\xi_{w^*,\tilde{n}} > 0,\ \xi_{n,\tilde{n}} < 0,\ \text{and}\ \xi_{c,\tilde{n}} > 0.$$

In the 'strong linkages' limiting case with η close to 1 and β close to ρ but still less than ρ, we have that $D < 0$ and

$$\xi_{w^*,\tilde{n}} = 0,\ \xi_{n,\tilde{n}} = 1,\ \text{and}\ \xi_{c,\tilde{n}} = -1.$$

Proof. See appendix.

A rise in $\tilde{n}$ is similar to an exogenous increase in the demand for Mexican inputs to produce the required quality upgrades for export. In the weak-linkages case, this results in an increase in the price of Mexican inputs due to the increased wage: A greater demand for inputs increases the demand for labor, raising its price. In the process, the rise in costs squeezes out non-exporting firms, so n falls. Both the rise in w^* and the drop in n contribute to the rise in c (recall (11)). On the other hand, in the strong-linkages case, the economy is able to respond to this rise in the demand for inputs by generating a wider variety of inputs, which meets the extra demand with *lower* marginal costs. This reflects the strength of the increasing returns to scale in the manufacturing sector due to the backward and forward linkages. Recall the inefficiency in the equilibrium noted in the discussion of Proposition 3 when linkages are strong; given the external economies of scale, the economy can become much more productive if more firms than the equilibrium number enter. Note from (11) that in the limit with strong linkages c is proportional to $\frac{w^*}{n}$, so $\xi_{w^*,\tilde{n}} = 0$ and $\xi_{n,\tilde{n}} = 1$ together imply $\xi_{c,\tilde{n}} = -1$.

Next, we need the effects of a period-2 change in R:

Proposition 11 *In the case without Fast Track, holding $\tilde{n}$ constant, the elasticity of w^* with respect to R can be written as follows.*

$$\xi_{w^*,R} = \frac{\left[(\rho - \beta\eta)\left(\frac{KZ(R)L}{c}\right) - \rho(1-\beta\eta)M\tilde{n}S\right]GZ(R)L - \beta\eta(1-\rho)\left(\frac{KZ(R)L}{c}\right)H\tilde{n}cS}{D}\xi_{z,R},$$

$$\xi_{n,R} = \frac{\rho\beta(1-\eta)\left[GZ(R)L + H\tilde{n}cS\right]\left(\frac{KZ(R)L}{c}\right)}{D}\xi_{z,R},$$

and

$$\xi_{c,R} = \frac{\rho(1-\beta)\left[\left(\frac{KZ(R)L}{c}\right) - M\tilde{n}S\right]GZ(R)L - \beta\eta(1-\rho)\left[GZ(R)L + H\tilde{n}cS\right]\left(\frac{KZ(R)L}{c}\right)}{D}\xi_{z,R},$$

where G and H are defined in (47), K and M are defined in (50),and D is defined in (51).

In the 'weak linkages' limiting case with η close to 0, we have

$$\xi_{w^*,R} < 0,\ \xi_{n,R} < 0,\ \text{and } \xi_{c,R} < 0.$$

In the 'strong linkages' limiting case with η close to 1 and β close to ρ but still less than ρ, we have

$$\xi_{w^*,R} = \xi_{Z,R} < 0,\ \xi_{n,R} = 0,\ \text{and } \xi_{c,R} < 0.$$

Proof. See appendix.

A rise in R diverts some portion of US consumer demand away from Mexican products, indirectly lowering the demand for Mexican labor. This pushes down the Mexican wage. The effect on the number of Mexican firms is more subtle. Other things equal, a drop in the demand for Mexican products will reduce the number of Mexican firms. Other things equal, a drop in marginal costs, c, will *increase* the number of Mexican firms. These two effects can be seen in (49); the left hand side measures the demand for domestic final output and inputs from Mexican firms, which is reduced by an increase in R (since R lowers Y^* and C^X). Other things equal, a drop in that demand lowers n. However, from the right hand side, it is clear that a drop in c will, other things equal, *raise* n. Now, increasing the scope of ROO's pushes down w^*, which lowers c, so we have two opposing forces on the number of firms. Recalling (11), the effect of w^* on c is much larger with strong backward and forward linkages than it is with weak linkages. As η approaches 1, the elasticity of c with respect to w^* approaches unity. What Proposition 11 shows is that when the linkages are weak, the demand effect dominates, and n falls when R rises; with strong linkages the cost effect counteracts it, so that in the limit the effect of R on n vanishes.

7 A Punchline.

We can now assemble all of these pieces into a conclusion about the desirability of FT for cases in which η is not too large. (We will discuss the strong-linkages case in the next section.) Recall that FT is needed in order to coax Mexico to the table *ex ante* if and only if (38) holds. We need to use (28) with (48) and the elasticities in Proposition 10 to figure out whether Mexican welfare is higher or lower due to the higher value of $\tilde{n}$ if Mexico walks away from the agreement *ex post* (recalling that by Proposition 6, $\tilde{n}(R^*) > \tilde{n}(1)$ as long as $R^* < 1$). Indeed, in the small-η case, a higher $\tilde{n}$ implies a lower value of n and a higher value of c, so a lower variety of goods to consume and a higher price for each variety. Further, since $c\tilde{n}$ is higher, (48) shows that Mexican income is lower. Putting all of these effects together, Mexicans have lower income, higher consumer prices, and less product variety due to the productive resources consumed by the higher value of $\tilde{n}$, implying lower welfare, and so (38) is satisfied. *Ex post*, the Mexican threat point is worsened by the *ex ante* expectation of an agreement, so that the US Congress may be able to extract some additional rents from the Mexicans in period 2 without triggering refusal of the agreement.

At the same time, we can use (30) with the elasticities in Proposition 11 to verify that the US will want to increase R *ex post* if it can.[36] Indeed, by increasing R, Congress will increase Y (through increased tariff revenue) and reduce the price of each imported good (through reduction of c), without sacrificing product variety available to Americans (since $\tilde{n}$ is fixed). By the same token, the increase in R will lower Mexican welfare.

Proposition 12 *If $\beta < \rho$ (as in (9)) and τ is not too large, then for small values of η the optimal R, R^*, for the US is strictly positive, and gives Mexico the same welfare as it would have obtained with no agreement. But this value of R cannot be realized in equilibrium without FT, because if $R = R^*$ was expected, ex post the US would wish to increase R beyond that level, and the Mexican government would agree to remain in the agreement. The equilibrium value of R without FT will be strictly greater than R^*, and Mexican utility will be strictly less than with no agreement and no expectation of an agreement.*

Proof. See appendix.

This is the hold-up problem at work. Under these conditions, Mexico would never agree to negotiations in the absence of FT.

8 The Case With Strong Backward and Forward Linkages.

Now, we can address how the model works in the strong linkages case. The behavior of the model is qualitatively different when linkages are strong, in ways that may help understand trade policy in practice.

Proposition 13 *If $\beta < \rho$ (as in (9)) and τ is not too large, then if η is close to 1 and β is close to ρ, the optimal R, R^*, for the US is strictly positive, and gives Mexico the same*

[36] We should underline the different roles of the two propositions. Proposition 11 shows how things change when the US Congress changes R ex post, with $\tilde{n}$ unchanged; this is used to check whether or not the Congress would wish to change R if it is not constrained by FT. Proposition 10 shows how things change with a higher value of $\tilde{n}$, due to the *anticipation* of a lower value of R, holding the actual value of R constant; this is used to check whether or not the Mexican utility constraint will be slack, per (38), so that the US Congress would be *able* to increase R *ex post*.

welfare as it would have obtained with no agreement. But this value of R cannot be realized in equilibrium without FT, because if $R = R^*$ was expected, ex post the Mexican government would be willing to walk away from the agreement unless R was lowered below R^*.

This can be seen very simply from the results in Proposition 10. In the strong-linkages case, the increased $\tilde{n}$ that results from Mexican businesses anticipating the agreement has no effect on Mexican incomes. Since in the limit the elasticity of c with respect to $\tilde{n}$ approaches -1, the $\tilde{n}c$ in (48) is unchanged, and so Mexican income is unchanged. However, the variety of manufactured products n goes up and the price of each one of them goes down (since c falls), so, by (28), Mexican welfare rises with an increase in $\tilde{n}$ for any given trade policy. Consequently, Mexican threat-point welfare goes up, and Mexico will no longer be willing to accept $R = R^*$ in period 2 if it is possible to change it.

The implication of Proposition 13 for FT is that if an agreement is anticipated between the US and Mexico in the presence of strong linkages, the resulting increase in $\tilde{n}$ will *strengthen* Mexico's bargaining power. Therefore, Congress will want Fast Track, but it will not be because of a hold-up problem suffered by Mexico: It will be to avoid being held up by Mexico. Mexico would have no need to insist on Fast Track as a precondition for negotiations.

9 Conclusion.

The mechanism studied here can be summarized as follows, for cases when η is not too large, so that backward and forward linkages are weak.

(i) Under full commitment (which here means under FT), the optimal policy for the US in designing a free-trade agreement with Mexico is to set maximal ROO's on a subset R of industries, to claw back the tariff preference *de facto* that the free trade agreement creates, while setting minimal ROO's on the remaining industries. It is not optimal to distort any industry's actual input use with an ROO.

(ii) There is an optimal level of R from the point of view of US welfare, which is either $R = 0$ or $R = 1$. In the empirically more interesting case where $R = 1$ is preferred, Mexico's participation constraint will be binding, so the optimal choice of R becomes the value, $R^* < 1$, under which Mexico's welfare from the agreement is equal to its status-quo welfare.

(iii) However, it cannot achieve this optimal policy in the absence of commitment (in other words, without FT). The reason is that if Mexican businesses anticipate $R = R^*$, more of them will invest in quality upgrades for the US market than would have done so under the status quo, and so their government's *ex post* bargaining power will be worse. As a result, at the last minute Congress will be able to raise R above R^* somewhat and the Mexican government will still accept the amended agreement.

(iv) Anticipating this, Mexico will refuse to enter negotiations unless FT is in place first.

On the other hand, when backward and forward linkages are large, the hold-up problem is flipped on its head: Mexico's bargaining position is improved *ex post* by the additional industrial development that comes from an anticipated trade agreement, and it is in a position to demand more from the US than it could have demanded *ex ante*. As a result, in this case the US will be the one to insist on FT.

This contrast between the workings of the cases with strong and weak linkages may help explain the anomalous cases of the Canada-US Auto Pact and the TPP, as mentioned in the Introduction. If weak linkages lead to FT because the US can hold up its trade partner, and strong linkages lead to FT because the trade partner can hold up the US, it is conceivable that there is an intermediate level of linkages where there is no hold-up problem in either direction and the optimal agreement is time-consistent (to a close approximation). Recalling (from Section 2.6) that the strength of linkages tends to be highly correlated with a country's level of development, this could explain how these two agreements, both primarily with countries at a similar level of development, could have been negotiated without FT. Conceivably both Canada and Japan (the key negotiating partner in the TPP) are at such an intermediate level of linkages where the hold-up problem cancels out, while Mexico and less developed economies have weaker linkages that create the regular hold-up problem; and perhaps no country has such strong linkages that the reverse hold-up problem arises.[37] (The

[37] Alternatively, it is possible that there are countries with strong linkages to that extreme degree but that the US does not wish to sign trade agreements with them. It can be shown in our model that if β

case of Jordan would need a separate explanation.)

Appendix.

Proof of Proposition 2. It will be convenient to focus on elasticities. In general, we will denote the elasticity of a variable y with respect to a variable x by $\xi_{y,x}$.

If we denote the total quantity of intermediates produced in Mexico by X_M, the total value of intermediates in Mexico is given by $P_M X_M$. This has two parts: (1) the value of intermediates produced in Mexico for final goods, I^F and, (2) the value of intermediates produced in Mexico for production of intermediates, I^I. Hence, $P_M X_M \equiv I^F + I^I$, and we must have $I^I = \beta\eta(I^I + I^F)$. (Note that this uses the fact that rules of origin do not distort input use away from cost minimization in the production of inputs, but only in the production of final goods for export.) Consequently, $I^I = (\beta\eta/(1-\beta\eta))I^F$ and the total value of intermediates is equal to $(1/(1-\beta\eta))I^F$. We compute I^F in four parts. (i) The value of final goods produced and consumed in Mexico amounts to $(1-\alpha)Y^*$, so the value of intermediates used to produce those amounts to $\beta\eta(1-\alpha)Y^*$. (ii) The value of final goods produced in Mexico for export in industries where the ROO is ignored amounts to $(1-\alpha)Y/(1+\tau)$ per industry (there are R of them), and the value of intermediates for this portion of demand amounts to $R\beta\eta(1-\alpha)Y/(1+\tau)$. (iii) The value of final goods produced in Mexico for export in industries where the ROO does not bind amounts to $(1-\alpha)Y$ per industry (there are $(1-\gamma)(1-R)$ of them), and the value of intermediates for this portion of demand amounts to $(1-\gamma)(1-R)\beta\eta(1-\alpha)Y$. (iv) The value of final goods produced in Mexico for export in industries where the ROO *does* bind amount to $(1-\alpha)Y$ per industry (there are $\gamma(1-R)$ of them), and the value of Mexican intermediates plus labor used to produce this portion of demand amounts to $\gamma(1-R)\theta(1-\alpha)Y$. As discussed in

is close enough to ρ and η is close enough to 1, then reductions in τ^* will paradoxically lower US utility. This is because lowering Mexico's tariff will lower Mexican income, thereby lowering n and raising Mexican marginal costs, which increases the price charged to US consumers. As a result, in this case of extremely strong linkages, the US would not want a trade agreement with Mexico. This is another special feature of the model that would likely change if we introduced a sector in the US that produces inputs for Mexican manufactures.

Section 3.1, for these products, the ratio of the value of Mexican-produced inputs to the value of labor plus Mexican-produced inputs will be $\beta\eta/(1-\beta+\beta\eta) = \beta\eta/(1-\beta(1-\eta))$.[38] Therefore, the value of intermediates used to produce this portion of demand amounts to $\gamma(1-R)\left[\theta\beta\eta/(1-\beta(1-\eta))\right](1-\alpha)Y$.[39]

Consequently, the value of inputs produced in Mexico is the sum of (i) through (iv), divided by $(1-\beta\eta)$

$$P_M X_M \equiv I^F + I^I = (1-\alpha)\tfrac{\beta\eta}{1-\beta\eta}\left[Y^* + \left(\tfrac{1+(1-R)\tau}{1+\tau}\right)Y + \gamma(1-R)\left(\tfrac{\theta}{1-\beta(1-\eta)} - 1\right)Y\right]. \tag{52}$$

Next we derive the labor demand. The portion of labor demand that is due to production of inputs in Mexico is equal to $(1-\beta)$ times the expression just derived. The demand due to production of final good for Mexican consumers is $(1-\beta)(1-\alpha)Y^*$, the demand due to production of non-ROO-compliant exports is $R(1-\beta)(1-\alpha)Y/(1+\tau)$, and the demand due to exports for which the ROO is non-binding is $(1-\gamma)(1-R)(1-\beta)(1-\alpha)Y$. The demand for labor due to production of exports that comply with the ROO is $\gamma(1-R)[\theta(1-\beta)/(1-\beta(1-\eta))](1-\alpha)Y$.[40] Putting these pieces together and simplifying, the demand for labor must be

$$w^*L^* = (1-\alpha)\tfrac{1-\beta}{1-\beta\eta}\left[Y^* + \left(\tfrac{1+(1-R)\tau}{1+\tau}\right)Y + \gamma(1-R)\left(\tfrac{\theta}{1-\beta(1-\eta)} - 1\right)Y\right].$$

Using (13), (14), and the fact that $\Pi^* = 0$ in equilibrium, this expression becomes

$$w^* = \left(\tfrac{(1-\beta)(1-\alpha)(1+(1-\alpha)d\tau^*)}{\alpha(1-\beta)+\beta(1-\eta)(1+(1-\alpha)d\tau^*)}\right)\left(\tfrac{A+B(\theta)}{[1-\beta(1-\eta)][1+(1-R(1-\alpha)\tau)]}\right)\tfrac{L}{L^*}, \tag{53}$$

[38] Recall that due to Cobb-Douglas production, to satisfy the ROO, labor and local input would be increased by the same proportion per unit of output.

[39] Mathematically,

$$\tfrac{P_M x_M + w^* l}{P_M x_M + P_N x_N + w^* l} = \theta \text{ and } \tfrac{P_M x_M}{P_M x_M + w^* l} = \tfrac{\beta\eta}{1-\beta(1-\eta)}, \text{ so } \tfrac{P_M x_M}{P_M x_M + P_N x_N + w^* l} = \tfrac{\theta\beta\eta}{1-\beta(1-\eta)}.$$

[40] Since for these exports,

$$\tfrac{P_M x_M + w^* l}{P_M x_M + P_N x_N + w^* l} = \theta \text{ and } \tfrac{P_M x_M}{P_M x_M + P_N x_N + w^* l} = \tfrac{\theta\beta\eta}{1-\beta(1-\eta)}, \text{ so } \tfrac{w^* l}{P_M x_M + P_N x_N + w^* l} = \tfrac{\theta(1-\beta)}{1-\beta(1-\eta)}.$$

where

$$A \equiv (1-\beta(1-\eta))(1+(1-R)\tau - \gamma(1-R)(1+\tau)), \text{ and}$$
$$B(\theta) \equiv \gamma(1-R)(1+\tau)\theta. \tag{54}$$

Since $\theta > 1-\beta(1-\eta)$, it is then immediate that

$$\xi_{w^*,\theta} = \frac{B(\theta)}{A+B(\theta)} > 0, \tag{55}$$

which implies $\frac{\partial w^*}{\partial \theta} > 0$.

The proof will proceed from a derivation of the demand for inputs from non-member economies. The portion of that demand that is due to production of inputs in Mexico is equal to $\beta(1-\eta)$ times the expression given in (52). The demand due to production of final good for Mexican consumers is $\beta(1-\eta)(1-\alpha)Y^*$, the demand due to production of non-ROO-compliant exports is $R\beta(1-\eta)(1-\alpha)Y/(1+\tau)$, and the demand due to exports for which the ROO is non-binding is $(1-\gamma)(1-R)\beta(1-\eta)(1-\alpha)Y$. The demand for imported inputs due to production of exports that comply with the ROO is $\gamma(1-R)(1-\theta)(1-\alpha)Y$, since for those firms the share of costs due to Mexican labor and Mexican-produced inputs will be exactly θ. Putting these pieces together and simplifying, the total demand for non-member-produced inputs must be

$$P_N X_N = \tfrac{1-\alpha}{1-\beta\eta}\left[\beta(1-\eta)\left(Y^* + \left(\tfrac{1+(1-R)\tau}{1+\tau}\right)Y\right) - \gamma(1-R)(1-\beta)\left(\tfrac{\theta}{1-\beta(1-\eta)} - 1\right)Y\right]. \tag{56}$$

Now, substituting (13), (14), and (53) into (56), it is straightforward to confirm that

$$\tfrac{\partial P_N X_N}{\partial \theta} = -\gamma(1-R)\left(\tfrac{\alpha(1-\alpha)(1-\beta)}{1-\beta(1-\eta)}\right)\left(\tfrac{1+\tau}{1+(1-R(1-\alpha))\tau}\right)\left(\tfrac{1}{\alpha(1-\beta)+\beta(1-\eta)(1+(1-\alpha)d\tau^*)}\right) < 0.$$

Turning attention to the number of firms, n, final consumption demand for Mexican products by Mexican consumers ($(1-\alpha)Y^*$) plus the total revenue from sales of inputs within Mexico as derived from (52) yields

$$= \frac{1-\alpha}{1-\beta\eta}\left[Y^* + \beta\eta\left(\frac{1+(1-R)\tau}{1+\tau}\right)Y + \gamma(1-R)\beta\eta\left(\frac{\theta}{1-\beta(1-\eta)} - 1\right)Y\right].$$

This is the total revenue from domestic sales of Mexican firms. Multiplying this revenue by $(1-\rho)$ yields variable profits (using Section 2.5), which must then be equal to the aggregate of fixed costs incurred by Mexican firms in equilibrium, ncF (recall that F is denoted in units of output). Using, (13), (14) and (53) and rearranging this condition gives

$$n = \left(\frac{(1-\beta)(1-\alpha)(1+d\tau^*)+\beta\eta(1+(1-\alpha)d\tau^*)}{\alpha(1-\beta)+\beta(1-\eta)(1+(1-\alpha)d\tau^*)}\right)\left(\frac{(1-\alpha)(1-\rho)}{[1-\beta(1-\eta)][1+(1-R(1-\alpha)\tau)]F}\right)\left(\frac{A+B(\theta)}{c(\theta)}\right)\frac{L}{L^*},$$

where A and $B(\theta)$ are defined in (54).

Note that c has been written as a function of θ because it depends on w^* and n, which are affected by θ. Consequently, we can write $\xi_{n,\theta} = \frac{B(\theta)}{A+B(\theta)} - \xi_{c,\theta}$. Recalling (11), we also know that $\xi_{c,\theta} = -\left(\frac{1-\rho}{\rho}\right)\left(\frac{\beta\eta}{1-\beta\eta}\right)\xi_{n,\theta} + \left(\frac{1-\beta}{1-\beta\eta}\right)\xi_{w^*,\theta}$. Combining these two equations and using the expression in (55)

$$\xi_{n,\theta} = \left(\frac{\rho\beta(1-\eta)}{\rho-\beta\eta}\right)\frac{B(\theta)}{A+B(\theta)} > 0, \tag{57}$$

given that $\rho > \beta\eta$, as assumed in (9). Finally, $\xi_{n,\theta} > 0$, which implies that $\frac{\partial n}{\partial\theta} > 0$. ■

Proof of Proposition 3. Recalling that $\xi_{c,\theta} = -\left(\frac{1-\rho}{\rho}\right)\left(\frac{\beta\eta}{1-\beta\eta}\right)\xi_{n,\theta} + \left(\frac{1-\beta}{1-\beta\eta}\right)\xi_{w^*,\theta}$, using the expressions for $\xi_{w^*,\theta}$ and $\xi_{n,\theta}$ derived at (55) and (57), we obtain

$$\xi_{c,\theta} = \left(\frac{\rho(1-\beta(1-\eta))-\beta\eta}{\rho-\beta\eta}\right)\frac{B(\theta)}{A+B(\theta)}.$$

Since $\rho > \beta\eta$ (due to (9)), $\frac{\partial c}{\partial\theta} > 0$ if and only if

$$\beta\eta < \frac{\rho\,(1-\beta)}{1-\rho},$$

which is guaranteed to hold when $\beta < \rho$. ■

Proof of Proposition 6. We can use equations (13), (25), (26) and (27) to obtain

$$\tilde{n} = \left(\frac{1+(1-R)\tau}{1+(1-R(1-\alpha))\tau}\right)(1-\alpha)(1-\rho)\frac{L}{Sc},$$

$$= (1-\alpha)(1-\rho)\frac{Z(R)L}{Sc}, \text{ by definition of } Z(R) \text{ given in (18).}$$

Then, the elasticity of $\tilde{n}$ with respect R is given by

$$\xi_{\tilde{n},R} = \xi_{Z,R} - \xi_{c,R}.$$

Using equation (23), we obtain

$$\xi_{\tilde{n},R} = \left(\frac{\rho\beta(1-\eta)}{\rho - \beta\eta}\right)\xi_{Z,R} < 0,$$

since (9) is assumed and $\xi_{Z,R} < 0$ as shown in (22). ■

Proof of Proposition 7. Proposition 5 shows that an increase in R will lower the Mexican wage in terms of the numeraire, and under the stated assumptions it will also lower n as can be seen from (21). Using (14), (28) can be written as

$$\left(\frac{(1+d\tau^*)L^*}{1+(1-\alpha)d\tau^*}\right)\frac{w^*}{(1+d\tau^*)^\alpha\left(n^{\frac{\rho-1}{\rho}}\frac{c(n,w^*)}{\rho}\right)^{1-\alpha}}.$$

The first factor in this expression does not depend on n or w^*. Since, from (11), the function $c(n,w^*)$ is decreasing in n and increasing in w^* with an elasticity less than one, the second factor is increasing in both n and w^*. ■

Proof of Proposition 8. In this proof, we will show that assumption (9) is required to justify the US having positive tariffs when there is no agreement. We continue to use the notation $\xi_{y,x}$ to denote the elasticity of the equilibrium value of y with respect to x. Using (13), (11), and (17), we derive

$$\begin{aligned}
\xi_{Y,\tau} &= \left(\frac{\tau}{1+\tau}\right)\frac{R(1-\alpha)}{1+[1-R(1-\alpha)]\tau},\\
\xi_{c,\tau} &= \left(\frac{1-\beta}{1-\beta\eta}\right)\xi_{w^*,\tau} - \left(\frac{1-\rho}{\rho}\right)\left(\frac{\beta\eta}{1-\beta\eta}\right)\xi_{n,\tau}, \text{ and}\\
\xi_{w^*,\tau} &= \xi_{Z,\tau} = -\frac{\tau R\alpha}{(1+[1-R(1-\alpha)]\tau)(1+(1-R)\tau)} < 0.
\end{aligned}$$

Further, (19) implies

$$\xi_{n,\tau} = \frac{\rho(1-\beta\eta)}{\rho-\beta\eta}\left(\xi_{Z,\tau} - \left(\frac{1-\beta}{1-\beta\eta}\right)\xi_{w^*,\tau}\right) = \frac{\rho\beta(1-\eta)}{\rho-\beta\eta}\xi_{Z,\tau} < 0,$$

given (20). Combining these with (30), we can derive

$$\xi_{U^{US},\tau} = \left(\frac{\tau R(1-\alpha)}{\rho[1+(1-R(1-\alpha))\tau]} \right) \Phi(\tau, R),$$

where

$$\Phi(\tau, R) = \frac{1-\alpha(1-\rho)-[1+(1-R(1-\alpha))\tau]}{1+\tau} + \frac{\alpha\left[\rho(1-\beta(1-\eta))-\beta\eta\right]}{(1+(1-R)\tau)(\rho-\beta\eta)}.$$

The elasticity $\xi_{U^{US},\tau}$ has the same sign as $\Phi(\tau, R)$. It is easy to verify that $\frac{\partial\Phi}{\partial\tau} < 0$ and $\Phi\left(\tau = 0\right) > 0$. This means if there is a value of τ, say τ^{opt} that makes $\Phi = 0$, then τ^{opt} is the optimal tariff maximizing the US welfare. In addition, Φ is increasing in R, therefore τ^{opt} is increasing in R. When $R = 1$, we have

$$\tau^{opt}\left(R = 1\right) = \frac{\rho-\beta}{\beta(1-\eta)}.$$

This is positive if and only if $\beta < \rho$, giving the result. ■

Proof of Proposition 9. From (34), the derivative of US welfare with respect to R under FT has the same sign as

$$\Psi\left(\tau, R\right) \equiv \frac{\tau}{1+(1-R(1-\alpha))\tau}\left(1-\alpha(1-\rho)+\frac{\alpha(1+\tau)(\rho(1-\beta(1-\eta))-\beta\eta)}{(1+(1-R)\tau)(\rho-\beta\eta)}\right) - \log(1+\tau),$$

where $\frac{\partial\Psi}{\partial R} > 0$ and $\Psi\left(0, R\right) = 0$. In addition, we have

$$\frac{\partial\Psi}{\partial\tau} = \begin{cases} \left(\frac{1}{1+(1-R(1-\alpha))\tau}\right)^2 \left(1-\alpha(1-\rho)+\frac{\alpha(1+\tau)[\rho(1-\beta(1-\eta))-\beta\eta]}{(1+(1-R)\tau)(\rho-\beta\eta)}\right) \\ +\frac{\tau R\alpha[\rho(1-\beta(1-\eta))-\beta\eta]}{[1+(1-R(1-\alpha))\tau][1+(1-R)\tau]^2(\rho-\beta\eta)} - \frac{1}{1+\tau}. \end{cases}$$

Evaluating this derivative at $\tau = 0$, we obtain

$$\frac{\partial\Psi}{\partial\tau}_{|\tau=0} = \frac{\alpha\rho(\rho-\beta)}{\rho-\beta\eta},$$

which is positive if $\beta < \rho$ and negative if $\beta > \rho$.[41] ■

[41] Furthermore, it is easy to see that $\frac{\partial^2\Psi}{\partial\tau\partial R} > 0$. As a result, given that $\Psi\left(0, R\right) = 0$, the parameter space in which $\frac{\partial\Psi}{\partial\tau}_{|R=0} > 0$ provides a sufficient condition for the U.S. welfare to be increasing in R. Thus, evaluating

Proof of Proposition 10. By equation (47),

$$w^* L^* = GZ(R)L + H\tilde{n}cS, \tag{58}$$

where $G > 0$, and $0 < H < 1$.

Differentiating (58) with respect to $\tilde{n}$, we obtain

$$\begin{aligned}\frac{dw^*}{d\tilde{n}} &= \frac{HcS}{L^*} + \frac{H\tilde{n}S}{L^*}\frac{dc}{d\tilde{n}} \\ &= \frac{HcS}{L^*}\left(1 + \frac{dc}{d\tilde{n}}\frac{\tilde{n}}{c}\right).\end{aligned}$$

We multiply both sides by $\frac{\tilde{n}}{w^*}$ to get

$$\frac{\tilde{n}}{w^*}\frac{dw^*}{d\tilde{n}} = \frac{H\tilde{n}cS}{w^*L^*}\left(1 + \frac{dc}{d\tilde{n}}\frac{\tilde{n}}{c}\right).$$

Writing this expression in elasticity form and using (58), we obtain

$$\xi_{w^*,\tilde{n}} = \frac{H\tilde{n}cS}{GZ(R)L + H\tilde{n}cS}\left(1 + \xi_{c,\tilde{n}}\right).$$

The elasticity of marginal cost with respect to $\tilde{n}$ can be obtained by using (11)

$$\xi_{c,\tilde{n}} = \left(\frac{1-\beta}{1-\beta\eta}\right)\xi_{w^*,\tilde{n}} - \left(\frac{1-\rho}{\rho}\right)\left(\frac{\beta\eta}{1-\beta\eta}\right)\xi_{n,\tilde{n}}. \tag{59}$$

Using (59) and isolating $\xi_{w^*,\tilde{n}}$ yields

$$\xi_{w^*,\tilde{n}} = \frac{(1-\beta\eta)H\tilde{n}cS}{(1-\beta\eta)GZ(R)L + \beta(1-\eta)H\tilde{n}cS}\left(1 - \frac{\beta\eta\,(1-\rho)}{(1-\beta\eta)\,\rho}\xi_{n,\tilde{n}}\right). \tag{60}$$

Similarly, from (50)

$$n = \left(\frac{1-\rho}{F}\right)\left(\frac{KZ(R)L}{c} - M\tilde{n}S\right), \tag{61}$$

$\frac{\partial\Psi}{\partial\tau}$ at $R = 0$, we have

$$\frac{\partial\Psi}{\partial\tau}_{|R=0} = \left(\frac{1}{1+\tau}\right)^2\left(1 - \alpha(1-\rho) + \frac{\alpha\left[\rho(1-\beta(1-\eta)) - \beta\eta\right]}{(\rho-\beta\eta)}\right) - \frac{1}{1+\tau},$$

which implies that

$$\frac{\partial\Psi}{\partial\tau}_{|R=0} > 0 \text{ if } \tau < \frac{\alpha\rho(\rho-\beta)}{\rho-\beta\eta}.$$

where $K > 0$, and $M \begin{cases} \geqslant 0 \text{ for } \eta \leq \frac{(1-\alpha)(1+d\tau^*)}{1+(1-\alpha)d\tau^*}, \\ < 0 \text{ for } \eta > \frac{(1-\alpha)(1+d\tau^*)}{1+(1-\alpha)d\tau^*}. \end{cases}$

Differentiating (61) with respect to $\tilde{n}$, we obtain

$$\frac{dn}{d\tilde{n}} = -\frac{1-\rho}{F}\left(\frac{KZ(R)L}{c^2}\frac{dc}{d\tilde{n}} + MS\right).$$

We multiply both sides by $\frac{\tilde{n}}{n}$ to get

$$\frac{\tilde{n}}{n}\frac{dn}{d\tilde{n}} = -\frac{1-\rho}{F}\frac{1}{n}\left(\frac{KZ(R)L}{c}\frac{\tilde{n}}{c}\frac{dc}{d\tilde{n}} + M\tilde{n}S\right)$$

Writing this expression in elasticity form and using (61), we obtain

$$\xi_{n,\tilde{n}} = -\frac{1}{\frac{KZ(R)L}{c} - M\tilde{n}S}\left(\frac{KZ(R)L}{c}\xi_{c,\tilde{n}} + M\tilde{n}S\right).$$

Using (59) and isolating $\xi_{n,\tilde{n}}$ yields

$$\xi_{n,\tilde{n}} = -\frac{\rho}{(\rho-\beta\eta)\frac{KZ(R)L}{c} - \rho(1-\beta\eta)M\tilde{n}S}\left[(1-\beta)\frac{KZ(R)L}{c}\xi_{w^*,\tilde{n}} + (1-\beta\eta)M\tilde{n}S\right]. \quad (62)$$

Solving (60) and (62) gives us $\xi_{w^*,\tilde{n}}$ and $\xi_{n,\tilde{n}}$ provided in the proposition. Then, one can use these together with (59) to obtain $\xi_{c,\tilde{n}}$ given in the proposition.

To see the limiting results, first it is easy to check that the limit of D (where D is defined in (51)) as $\eta \to 0$ is positive. The limit of D as $\eta \to 1$ and $\beta \to \rho$ is

$$\frac{-\rho(1-\rho)(1-\alpha)^2(1+d\tau^*)Z(R)L\tilde{n}S}{\alpha} < 0. \quad (63)$$

For η close to 0, the numerator of $\xi_{w^*\tilde{n}}$ is positive (using (61), since $n > 0$) and the numerator of $\xi_{n,\tilde{n}}$ is negative (using (58) and (61), since $n > 0$ and $w^*L^* > 0$, as well as $M > 0$ when η close to 0). As $\eta \to 1$ and $\beta \to \rho$, the numerator of $\xi_{w^*\tilde{n}}$ approaches 0 and the numerator of $\xi_{n,\tilde{n}}$ converges to (63). ■

Proof of Proposition 11. Differentiating (58) with respect to R, we obtain

$$\frac{dw^*}{dR} = \frac{GZ(R)L}{L^*}\frac{1}{Z(R)}\frac{dZ(R)}{dR} + \frac{H\tilde{n}cS}{L^*}\frac{1}{c}\frac{dc}{dR}.$$

We multiply both sides by $\frac{R}{w^*}$ to get

$$\frac{R}{w^*}\frac{dw^*}{dR}=\frac{GZ(R)L}{w^*L^*}\frac{R}{Z(R)}\frac{dZ(R)}{dR}+\frac{H\tilde{n}cS}{w^*L^*}\frac{R}{c}\frac{dc}{dR}.$$

Writing this expression in elasticity form and using (58), we obtain

$$\xi_{w^*,R}=\frac{GZ(R)L}{GZ(R)L+H\tilde{n}cS}\xi_{Z,R}+\frac{H\tilde{n}cS}{GZ(R)L+H\tilde{n}cS}\xi_{c,R}.$$

The elasticity of marginal cost with respect to R can be obtained by using (11)

$$\xi_{c,R}=\left(\frac{1-\beta}{1-\beta\eta}\right)\xi_{w^*,R}-\left(\frac{1-\rho}{\rho}\right)\left(\frac{\beta\eta}{1-\beta\eta}\right)\xi_{n,R}. \tag{64}$$

Using (64) and isolating $\xi_{w^*,R}$ yields

$$\xi_{w^*,R}=\frac{(1-\beta\eta)\left[GZ(R)L\xi_{Z,R}-H\tilde{n}cS\left(\frac{1-\rho}{\rho}\right)\left(\frac{\beta\eta}{1-\beta\eta}\right)\xi_{n,R}\right]}{(1-\beta\eta)GZ(R)L+\beta(1-\eta)H\tilde{n}cS}. \tag{65}$$

Similarly, differentiating (61) with respect to R, we obtain

$$\frac{dn}{dR}=\left(\frac{1-\rho}{F}\right)\frac{KZ(R)L}{c}\left(\frac{1}{Z(R)}\frac{dZ(R)}{dR}-\frac{1}{c}\frac{dc}{dR}\right)$$

We multiply both sides by $\frac{R}{n}$ to get

$$\frac{R}{n}\frac{dn}{dR}=\left(\frac{1-\rho}{F}\right)\frac{KZ(R)L}{c}\frac{1}{n}\left(\frac{R}{Z(R)}\frac{dZ(R)}{dR}-\frac{R}{c}\frac{dc}{dR}\right).$$

Writing this expression in elasticity form and using (61), we obtain

$$\xi_{n,R}=\frac{\frac{KZ(R)L}{c}}{\frac{KZ(R)L}{c}-M\tilde{n}S}\left(\xi_{Z,R}-\xi_{c,R}\right)$$

Using (64) and isolating $\xi_{n,R}$ yields

$$\xi_{n,R}=\frac{\rho\frac{KZ(R)L}{c}\left[(1-\beta\eta)\,\xi_{Z,R}-(1-\beta)\,\xi_{w^*,R}\right]}{(\rho-\beta\eta)\left(\frac{KZ(R)L}{c}\right)-\rho(1-\beta\eta)M\tilde{n}S}. \tag{66}$$

Solving (65) and (66) gives us $\xi_{w^*,R}$ and $\xi_{n,R}$ provided in the proposition. Then, one can use these together with (64) to obtain $\xi_{c,R}$ given in the proposition.

To see the limiting results as $\eta\to 0$, note that in the limit the numerators of the expressions for both $\xi_{w^*,R}$ and $\xi_{n,R}$ are positive (using (58), since $w^*L^*>0$ and using (61), since

$n > 0$), as is the denominator (as noted in the proof of the previous proposition; recall that the denominators are the same). Since $\xi_{Z,R} < 0$, the result is straightforward. It is easy to confirm that the limit of the numerator of $\xi_{w^*,R}$ as $\eta \to 1$ and $\beta \to \rho$ is the same as the limit of D, (63), while the limit of the numerator of $\xi_{n,R}$ is 0. ■

Proof of Proposition 12. Under the given conditions, from Proposition 9 the optimal R for the US will be positive, and will equate Mexico's utility under the agreement with Mexico's utility without an agreement. Call this value R^*. If all participants expect R^* in period 1 but the US is able to change it in period 2, we will verify that the US will indeed want to increase it.

The US welfare without FT requires a slight change in the computation of the consumer price index in the US. Suppose that $\bar{R}$ industries expect an ROO *ex ante*, and *ex post*, a total of $R = \bar{R} + \epsilon$ industries are subject to an ROO. The ϵ term is, if positive, the number of industries that are surprised by an ROO *ex post*, and if negative, the number of industries that expected an ROO but were pleasantly surprised to be exempted from the ROO *ex post*. Under FT, $\epsilon = 0$ by assumption, but without FT we must have $\epsilon = 0$ in equilibrium. Each variety in an industry j without a rule of origin sells for a price of p in the US, while each variety sold under a rule of origin will sell for a price $(1 + \tau)p$. Assume that $\epsilon \geq 0$ for concreteness; the case of $\epsilon < 0$ is analogous and produces the same equation. We can divide the industries into three groups. The first group consists of $(1 - \bar{R} - \epsilon)$ industries that were expecting to be exempt from ROO and were not surprised. The price index for each of those industries' composite goods in the US (see (7)) is $P_j = \left(\tilde{n}^{NR}\right)^{\frac{\rho-1}{\rho}} p$. The second group consists of ϵ industries that were not expecting an ROO but had one imposed on them anyway. The price index for each of those composite goods is $P_j = \left(\tilde{n}^{NR}\right)^{\frac{\rho-1}{\rho}} (1 + \tau)p$. The third group consists of $\bar{R}$ industries that expected and received an ROO. The price index for the composite good for each of those industries is $P_j = \left(\tilde{n}^{R}\right)^{\frac{\rho-1}{\rho}} (1 + \tau)p$. Consequently, the log of the price in the US of composite imported goods from Mexico is $\ln(P) = \int_0^1 \ln(P_j)dj = (1-\bar{R}-\epsilon)\ln\left(\left(\tilde{n}^{NR}\right)^{\frac{\rho-1}{\rho}} p\right) + \epsilon\ln\left(\left(\tilde{n}^{NR}\right)^{\frac{\rho-1}{\rho}} (1 + \tau)p\right) + \bar{R}\ln\left(\left(\tilde{n}^{R}\right)^{\frac{\rho-1}{\rho}} (1 + \tau)p\right)$, so (recalling that $\tilde{n}^R = \tilde{n}^{NR}/(1+\tau)$)

$$P = (1+\tau)^{\frac{\bar{R}}{\rho}+\epsilon} \left(\tilde{n}^{NR}\right)^{\frac{\rho-1}{\rho}} p.$$

Therefore, we can write the US welfare without FT as

$$U^{US} = \frac{Y}{\left((1+\tau)^{\frac{\bar{R}}{\rho}+\epsilon} \left(\tilde{n}^{NR}\right)^{\frac{\rho-1}{\rho}} p\right)^{1-\alpha}}. \tag{67}$$

The elasticity of US welfare with respect to R in period 2 without FT, $\xi^{NFT}_{U^{US},R}$, can be found from (67), remembering that in period 2 $\tilde{n}$ (and thus $\tilde{n}^{NR}$) is fixed and we change R by changing ϵ while holding $\bar{R}$ constant.[42] This elasticity can be written as

$$\xi^{NFT}_{U^{US},R_{|\bar{R}\text{ constant}}} = \xi_{Y,R} - (1-\alpha)R\log(1+\tau) - (1-\alpha)\xi_{c,R},$$

recalling that the price of each product is equal to $\frac{c}{\rho}$. $\xi_{c,R}$ is provided in proposition 11. Also, $\xi_{Z,R}$ and $\xi_{Y,R}$ take the same value when FT holds as when FT does not hold, and are given by (22) and (33), respectively. As a result, in the limit as $\eta \to 0$, $\xi^{NFT}_{U^{US},R}$ can be written as

$$\xi^{NFT}_{U^{US},R_{|\bar{R}\text{ constant}}} = R(1-\alpha)\Omega(\tau, R, c),$$

where

$$\Omega\left(\tau, R, c\right) \equiv \frac{\tau}{1+(1-R(1-\alpha))\tau}\left(1 + \frac{\alpha(1+\tau)}{1+(1-R)\tau}\frac{(1-\beta)GZ(R)L}{GZ(R)L+\beta H\tilde{n}cS}\right) - \log(1+\tau).$$

Note that $\Omega\left(0, R, c\right) = 0$. In addition, taking the derivative of $\Omega\left(\tau, R, c\right)$ with respect to τ and evaluating at $\tau = 0$, we obtain

$$\frac{\partial\Omega(R,\tau,c)}{\partial\tau}_{|\tau=0} = \frac{\alpha\left(1-\beta\right)GL}{GL+\beta H\tilde{n}cS} > 0,$$

where $Z(R) = 1$ when $\tau = 0$. Therefore, for a range of values for τ including $\tau = 0$, $\xi^{NFT}_{U^{US},R_{|\bar{R}\text{ constant}}} > 0$, implying that US welfare increases with R.

This shows that in the indicated part of the parameter space the US will wish to increase R in period 2 if that is possible. Now, to confirm that it will be possible, we need only

[42]This means the derivative of P with respect to R, holding $\bar{R}$ constant, is equal to the derivative of P with respect to ϵ, holding all else constant.

to check that (38) holds, which amounts to checking that the higher level of $\tilde{n}$ that obtains because of Mexico's prior expectation of an agreement results in lower utility if the agreement is nullified compared to the case in which there had never been an agreement. We can use the results from Proposition 10 to check this. First, from the expression for $\xi_{c,\tilde{n}}$, it is easy to confirm that as $\eta \to 0$, $\xi_{c,\tilde{n}} > 0$, so as $\tilde{n}$ goes up $c\tilde{n}$ also goes up. Therefore, from (48), we can see that Y^* is decreasing in $\tilde{n}$ (recall (14)). From (28), seeing that an increase in $\tilde{n}$ reduces Y^* and n but increases p (since it increases c) ensures that Mexican utility is reduced by an increase in $\tilde{n}$, and so (38) is satisfied.

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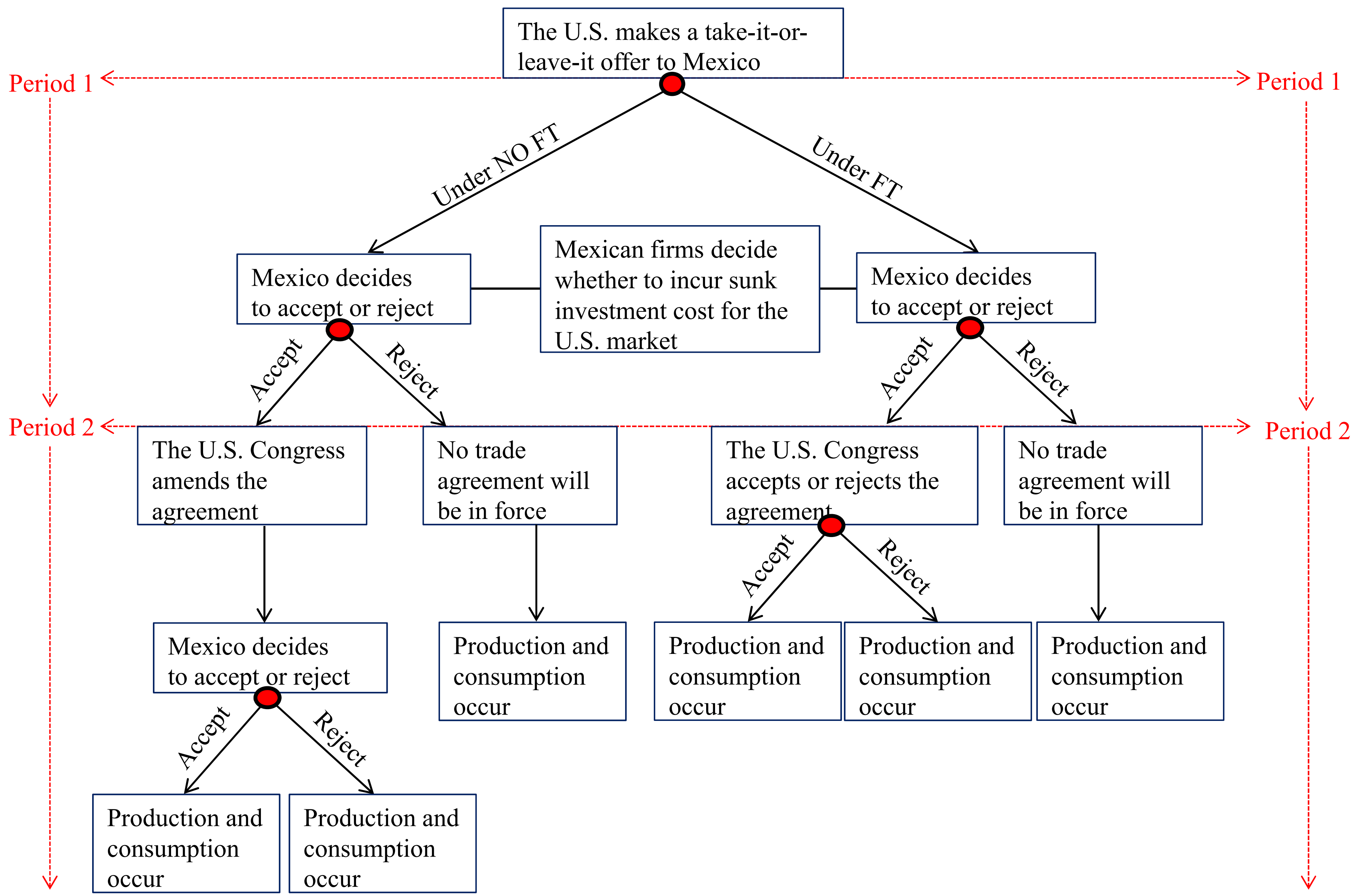

Figure 1. Timeline