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ABSTRACT

We formalize the GATT/WTO principle of reciprocity in workhorse quantitative trade models, characterizing reciprocal tariff cuts that hold terms of trade fixed and investigating their labor-market impacts. We provide closed-form expressions mapping reciprocal tariff cuts to labor market dislocation. We demonstrate that a country's own tariff liberalization is a sufficient statistic for the labor-market adjustments it can expect from tariff negotiations that satisfy reciprocity. Applying our theoretical results to China's 2001 WTO accession, we find that China's tariff reductions exceeded reciprocity norms, increasing real incomes but amplifying the manufacturing employment dislocation – the China Shock – in the United States and globally.

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1 Introduction

When China joined the World Trade Organization (WTO) in 2001, it secured from the United States a promise of Permanent Normal Trade Relations. This promise implied a permanent grant to China of the Most Favored Nation (MFN) tariff reductions and related market access commitments that the United States had agreed to at the 1995 conclusion of the Uruguay Round negotiations sponsored by the General Agreement on Tariffs and Trade (GATT) that created the WTO. In exchange, as the core of its protocol of accession China agreed to a set of MFN market access commitments of its own. Similar exchanges of market access commitments occurred between China and many of the WTO's other member countries. At the time, China's representative to the WTO Working Party on China's accession stated that the achievement of balance between rights and obligations – *reciprocity* in GATT/WTO parlance – was the basic principle in its negotiation of WTO accession (WTO, 2001a, p 2), a statement that is not surprising given the central role that reciprocity (along with MFN) is understood to play in the GATT/WTO architecture. Nevertheless, the United States among others has accused China of not living up to its commitment to reciprocity, and of harming US workers as a result.¹

In this paper we develop a framework that is suitable for studying the link between reciprocity and labor market adjustments, and we apply it to the case of China's accession to the WTO. In particular, we ask: In its market access negotiations for WTO accession, did China live up to its commitment to reciprocity?; And if it did not, as the United States and others have claimed, how did China's deviation from reciprocity contribute to the large loss of US manufacturing jobs that occurred after China joined the WTO, the "China Shock" that was first documented by Autor, Dorn and Hanson (2013)?

Economists and legal scholars have long acknowledged the potential link between the reciprocity norm in GATT/WTO market access negotiations and the labor market adjustments that negotiated tariff cuts imply. For example, in describing the presumed benefits of reciprocity, Trebilcock (2014) observes:

Despite wide recognition of the theoretical support for unilateral trade liberalization, countries rarely agree to open their markets to foreign competition without a reciprocal agreement from trading partners to liberalize foreign access to their own economies. Reciprocity provides a liberalizing country some assurance that adjustment costs caused by greater import penetration can be partially offset by increased access to export markets into which displaced resources can be redeployed over time. (p 73)

What we offer in this paper is a first formal analysis of this link, and a quantitative analysis of its importance for the US labor market and labor markets globally in the context of the China Shock.

China's accession to the WTO provides a natural case study for the link between reciprocity and labor market adjustments, both because China's non-market economy status has raised questions about the effectiveness of the commitments China took on under its protocol of WTO accession and whether China's post-accession behavior has in fact been consistent with the reciprocity norm, and also because China's economic size makes its ability to hew to reciprocity in tariff negotiations potentially highly consequential for its trading partners. But we emphasize that the basic issue we explore – namely, the relationship between deviations from reciprocity in trade negotiations on the one hand, and the impact of those deviations on the resulting pressure for labor market

¹See, for example, the United States Trade Representative's *2020 Report to Congress on China's WTO Compliance* (USTR, 2020).

reallocations associated with trade liberalization on the other – is more general, and the approach we develop in this paper to analyze this issue applies more generally as well.

Our starting point is an insight that follows from Bagwell and Staiger’s (1999, 2002) formalization of reciprocity in GATT practice. Bagwell and Staiger show that when countries exchange tariff cuts that abide by reciprocity, relative world prices (the terms of trade between them) do not change. Bagwell and Staiger emphasize the implied ability of reciprocity to eliminate inefficient international cost-shifting incentives from the tariff choices of countries who might otherwise be caught in a terms-of-trade driven prisoner’s dilemma. But their finding also has implications for the relative price movements *within* a country that can be expected as the result of reciprocal tariff changes. And in the textbook two-good neoclassical trade model where Bagwell and Staiger derive their basic results, the local relative price within each country determines the allocation of the country’s productive resources across sectors. This suggests in turn that the properties of reciprocity identified by Bagwell and Staiger may have important implications for the size of the labor market adjustments that can be expected under tariff negotiations that abide by reciprocity.

This insight is simple to illustrate. Suppose that the country under consideration (the “home” country) imports manufactures from and exports services to its trading partner (the “foreign” country). We can then use the international arbitrage condition to write the relationship between changes in the home country’s local relative price, changes in the relative world price, and changes in the home country’s tariff:

$$d \log \left(\frac{p_m}{p_s} \right) = d \log \left(\frac{p_m^w}{p_s^w} \right) + d \log (1 + \tau_m), \quad (1)$$

where $\frac{p_m}{p_s}$ is the home country’s price of manufactures relative to the price of services, $\frac{p_m^w}{p_s^w}$ is the relative world price, and τ_m is the home country’s (non-prohibitive) ad valorem import tariff. In light of (1), an immediate implication of Bagwell and Staiger’s (1999, 2002) reciprocity result is that if the foreign country responds to the home country’s cut in τ_m with a reciprocal cut in its own tariff, then $\frac{p_m^w}{p_s^w}$ will not change, and the change in the home country’s local relative price is then completely pinned down by the change in the home country’s tariff alone. That is, under negotiated tariff cuts that conform to reciprocity, a country’s own tariff cuts are a *sufficient statistic* for the change in local relative price that it will experience as a result of the negotiations. Moreover, as long as the Lerner Paradox is ruled out so that a smaller than (larger than) reciprocal cut in the foreign tariff would lead to a rise in (fall in) $\frac{p_m^w}{p_s^w}$, it follows that the change in the home country’s local relative price will be dampened (amplified) by a foreign-country tariff cut that falls short of (exceeds) the requirements of reciprocity. All that remains is to then translate these movements in local prices into implied labor market adjustments (as would follow directly for example under the specific assumptions of the Ricardo-Viner model with labor the mobile factor).

The first contribution of our paper is to provide a first formal characterization of reciprocity in quantitative trade models that, unlike the textbook neoclassical trade model, can be taken to data, and to show that this basic insight survives.

More specifically, we consider the Ricardian settings of the two-country model of Dornbusch, Fischer and Samuelson (1977), the multi-country version of this model developed by Eaton and Kortum (2002), and the multi-sector version of the Eaton and Kortum model developed by Costinot, Donaldson and Komunjer (2012). These last two models are of particular interest given their widespread use in the quantitative trade literature. We extend these models to incorporate the role of trade policy, we propose for these models a definition of reciprocity analogous to that in Bagwell and Staiger (1999, 2002), and we characterize reciprocal tariff cuts and interpret their features. We show that reciprocal tariff changes depend on the relative country size as well as

trade openness. In particular, a larger or less open country reciprocates with a tariff change that is smaller in magnitude, relative to a smaller or more open country. And we show that in all of these Ricardian settings, tariff changes that satisfy (multilateral) reciprocity leave each country's wage unchanged, which we show is the analog of Bagwell and Staiger's finding in the neoclassical trade model setting that reciprocity fixes the terms-of-trade.

Focusing on the models of Eaton and Kortum (2002) and Costinot, Donaldson and Komunjer (2012) with an eye toward taking these models to the data, we include a non-tradable sector and consider what these models imply for movements of labor from the tradable sectors to the non-tradable sector when tariffs are reduced, which we adopt as our central empirical measure of the labor market dislocation associated with tariff liberalization. We derive closed-form expressions for this measure of labor market dislocation that partition the contributions of multilateral tariff changes to a country's labor market dislocation into two components: first, conditional on reciprocity, the country's own tariff changes; second, conditional on the country's own tariff changes, the deviation from reciprocity that the negotiated tariff changes imply and the consequences of this deviation for changes in relative wages and the terms of trade. The second component has a clear sign: deviations from reciprocity that improve (worsen) a country's terms of trade will reduce (increase) its tradable-sector employment. The sign of the first component is ambiguous, but if a country has sufficiently low tariffs then a reduction in its own tariffs will increase its tradable-sector employment. In general, both components will contribute to the size of the change in a country's tradable-sector employment as a result of negotiated tariff cuts, possibly making contributions of opposite signs. But we find that if the negotiated tariff cuts satisfy multilateral reciprocity for all countries, then the second component is shut down and the first component – a country's own tariff changes – is a sufficient statistic for calculating the change in the country's tradable-sector employment, thereby extending this insight from the textbook neoclassical model to the multi-country multi-sector Ricardian trade model. We also derive a closed-form expression for within-tradable-sector labor reallocation, and we demonstrate that this same finding applies.

This last finding is of particular interest because of what it implies for assessing the expected labor market dislocation from tariff negotiations. According to this finding, as long as a country is confident that the outcome of its tariff negotiations will conform to MFN and satisfy the multilateral reciprocity norm, it can assess the expected labor market dislocation that will result from those negotiations by focusing entirely on the labor market consequences of its own tariff cuts and need not be concerned with the details of the tariff cuts that other countries agree to implement.

We also translate these findings into the Caliendo and Parro (2015) model that features intermediate goods and input-output linkages across sectors. In this setting, the cost of an input bundle in a country – which includes the country's wage of labor but also now includes the country's cost of acquiring the intermediate goods used in production – plays the role of the wage in Ricardian models without intermediates. We show that our earlier results on reciprocity must be qualified in this setting, because it is possible that sets of tariff changes may exist that could satisfy reciprocity even while inducing in some sectors changes in relative world prices, provided that these changes in sectoral relative world prices balance out in a way that fixes each country's overall terms of trade as the reciprocity restriction requires. And if reciprocity is satisfied in this way, a country's own tariff changes will no longer be a sufficient statistic for its labor dislocation. Nevertheless, we argue that if tariff changes satisfy reciprocity also at the *sectoral* level, our earlier results extend without qualification to this setting, and a country's own tariff changes continue to be a sufficient statistic for its labor dislocation.

Armed with these analytical results, we turn to our quantitative analysis. Employing a many-sector version of the Eaton and Kortum (2002) model along the lines of the model of Costinot, Donaldson and Komunjer (2012), and also the extension of these models to include intermediate

goods as in Caliendo and Parro (2015), we focus on whether or not China’s agreed market access commitments, as specified in its protocol of accession to the WTO, reciprocated the Uruguay Round tariff commitments that the rest of the WTO membership granted to China when China joined the WTO in 2001. And using the loss of jobs in the tradable sector and also within-tradable-sector labor reallocation as our empirical measures of labor market dislocation, we assess according to these models the extent to which our measures of China’s deviation from reciprocity contributed to the China Shock experienced by the United States and to the need for post-China-WTO-accession labor market adjustments globally.

Our quantitative results indicate that China did indeed fail to deliver reciprocity, but that in fact the tariff reductions China implemented after its WTO accession *exceeded* the norm of reciprocity. This deviation from reciprocity increased aggregate real incomes in the United States and in the rest of the world through improvements in their terms of trade, but it also amplified the magnitude of the China Shock experienced by the United States and other countries that was attributable to tariff changes over the post-China-WTO-accession period. In fact, we find that with respect to the China Shock experienced by the United States, the contribution of China’s deviation from reciprocity was roughly comparable in magnitude to the contribution of the United States’ own tariff cuts over this period. And compared with the case of no intermediate goods, we find that the presence of intermediate goods magnified these effects.

These results confirm the significance of deviations from reciprocity for understanding how negotiated tariff liberalization contributed to the size of the China Shock experienced by the United States. Moreover, while our finding that China’s market access commitments exceeded rather than fell short of reciprocity may seem at odds with the broadly held view that, subsequent to its WTO accession, China has intervened in its foreign trade to stifle its imports and promote its exports, we argue that there is an interpretation of that view that lines up with our finding. In particular, our results indeed imply that China’s export volumes were too high, and its import volumes too low, *relative to the reciprocity benchmark*, since under balanced trade this is simply the trade-volume counterpart of the deteriorating terms-of-trade that China would have experienced as a result of its tariff cuts in excess of reciprocity. This insight and the quantitative results that underlie it is the second contribution of our paper.

Finally, we extend our analysis of reciprocity to account for the implications of China’s growing trade surplus over the period. Taking trade balances as exogenous to the exchange of market access concessions between China and other WTO members, we first characterize an extension of the definition of reciprocity that will preserve the world-price-stabilizing consequences of reciprocity not only when trade is balanced as in the original formalization of Bagwell and Staiger (1999, 2002), but also when trade imbalances exist and change through time, and we offer an interpretation of this extension as applied to the Chinese economy. We then explore quantitatively how different the demands of this extended reciprocity norm would have been on China’s reciprocity-consistent tariff cuts, and what difference it would have made to the magnitude of the China Shock experienced by China’s trading partners, if China’s WTO accession protocol had required that China abide by this extended notion of reciprocity.

We find that with no offsetting Chinese tariff adjustments, China’s growing trade surplus implies that its terms of trade would deteriorate even further than under balanced trade. Thus, under an extended view of reciprocity where China would further adjust its tariffs to neutralize the terms-of-trade impact of its growing trade surplus, China would have had to lower its tariffs even less to maintain reciprocity than in the case of balanced trade, and hence its tariff cuts could be said to have exceeded by even more the tariff cuts that would have been required under this extended view of reciprocity. And we find that asking China to abide by this extended view of reciprocity could have further reduced the size of the China Shock experienced by the United States. This is

the third contribution of our paper.

The remainder of the paper proceeds as follows. In section 2 we describe the role of reciprocity in the GATT/WTO. In section 3 we present our analytical results in the Ricardian settings of Eaton and Kortum (2002) and its multi-sector extension contained in Costinot, Donaldson and Komunjer (2012), while in section 4 we show how our analytical results extend to a world of intermediate goods and input-output linkages across sectors as in Caliendo and Parro (2015). Section 5 presents our main quantitative results. Section 6 extends our analysis to allow for changing trade imbalances. Finally, section 7 discusses the policy implications of our findings while section 8 concludes. A pair of Appendices present supporting material not included in the body of the paper.

2 Reciprocity in the GATT/WTO

Along with MFN, reciprocity is a key feature of the GATT/WTO architecture. The concept of reciprocity refers to mutual changes in trade policy that bring about changes in the volume of each country's imports that are roughly equal to changes in the volume of its exports. Reciprocity plays a critical role in two aspects of GATT/WTO practice.

First, when governments negotiate reductions in trade barriers, they do so with the goal, found in the preamble to GATT, of striking "reciprocal and mutually advantageous arrangements directed to the substantial reduction in tariffs and other barriers to trade and to the elimination of discriminatory treatment in international commerce." In this context, governments approach negotiations seeking a "balance of concessions," whereby the market access benefit from a tariff cut offered by one government is matched by an "equivalent" concession from its trading partner. This aspect of reciprocity applies to changes in tariffs and other trade barriers resulting in trade liberalization. For example, Preeg (1970, pp. 130-134) observes that negotiators in the GATT Kennedy Round sought to achieve a balance between the forecasted increases in the volume of imports and the estimated increase in the volume of exports that would accompany a proposed set of tariff concessions.²

Second, when a government seeks to withdraw or modify its liberalizing commitments, or otherwise takes an action that impairs the benefits of the agreement to another government, adversely affected trading partners are permitted to respond by withdrawing "substantially equivalent concessions" of their own. This second aspect of reciprocity applies to changes in trade policy that restrict trade.

The balance achieved through reciprocity in tariff negotiations and the role of withdrawing prior concessions to restore that balance when the benefits of the bargain are impaired is reflected in a remark by a drafter of the GATT Articles quoted by Jackson (1969, pp. 170-71):

What we have really provided, in the last analysis, is not that retaliation shall be invited or sanctions invoked, but that a balance of interests once established, shall be maintained.

This commitment to maintain the balance of concessions through retaliatory suspension of concessions is further emphasized by Dam (1970, pp. 80-81):

The best guarantee that a commitment of any kind will be kept (particularly in an international setting where courts are of limited importance and, even more important, marshals and jails are nonexistent) is that the parties continue to view adherence to their agreement as in their mutual interest. ... Thus, the GATT system, unlike most legal systems... is not designed

²Dam (1970, pp. 58-61 and pp. 87-91) and Hoekman and Kostecki (1995, pp. 68-76) provide further discussion of the concept of reciprocity in GATT negotiations, as well as the various manners in which reciprocity has been measured in practice.

to exclude self-help in the form of retaliation. Rather, retaliation, subjected to established procedures and kept within prescribed bounds, is made the heart of the GATT system.

Accordingly, one important virtue of reciprocity lies in calibrating the penalty for deviating from the bargain, which promotes stability in trade agreements that by their nature must be self-enforcing.

A further virtue is emphasized by Bagwell and Staiger (1999, 2002). They observe that adopting a natural formalization of the notion of reciprocity as it occurs in GATT practice leads to the conclusion that (MFN) tariff changes conforming to reciprocity will leave the terms of trade unchanged. The literature on the economics of trade agreements has shown that a key purpose of trade agreements is to expand market access to internationally efficient levels, a purpose that is formally equivalent to providing members with an escape from an international terms-of-trade-driven prisoner’s dilemma.³ To this end, the potential benefits of a reciprocity norm that fixes the terms of trade in the face of changes in trade policy become apparent. These benefits have been explored in various papers (see Staiger, 2022, for a recent review) and include the following: the mitigation of beggar-thy-neighbor incentives in tariff setting; the mitigation of third-party spillovers from bilateral tariff negotiations; and the mitigation of strategic features in multilateral tariff negotiations.

The concept of reciprocity can apply either bilaterally or multilaterally. In a multi-country setting such as the GATT/WTO, trade negotiating rounds involve the entire membership, and each member’s desire for reciprocity is best understood as a desire for multilateral reciprocity – an expansion of global export opportunities commensurate with the market access opportunities afforded to other members by trade concessions on imports. Indeed, according to one early GATT Report (ICITO 1949), a key innovation of GATT relative to the US Reciprocal Trade Agreements Act that preceded it was precisely that the multi-country tariff bargaining rounds of GATT facilitated multilateral as opposed to bilateral reciprocity (see also Bagwell, Staiger and Yurukoglu, 2020, for evidence of the importance of multilateral reciprocity in the specific context of the bargaining records from the GATT Torquay Round). But in other contexts – such as the suspension of concessions against a nation that withdraws or violates its commitments – members tend to focus on bilateral reciprocity between themselves and the counterparty at issue. An agreement to permit the accession of a new member country (such as China, the focus of our quantitative analysis below) may fall somewhere in between these two settings depending on how the negotiations are structured, but often new member countries negotiate their accession agreements in the context of an ongoing multilateral negotiating round (as was the case with China), which would then place such accession negotiations firmly in the first setting.

3 Reciprocity in the Eaton and Kortum Model

In the Introduction we appealed to the two-good two-country neoclassical trade model to illustrate the link between reciprocity in tariff negotiations and labor market dislocation. That model has the advantage of extreme simplicity and transparency, but it is too abstract to take to data. To serve as an analytical bridge to our quantitative analysis in section 5, in this section we consider a multi-country Ricardian world with a continuum of tradable goods produced under constant returns, as in Eaton and Kortum (2002) and its multi-sector extension developed in Costinot, Donaldson and Komunjer (2012). The specification of technologies in the Eaton and Kortum model is a special case of the Ricardian technologies proposed by Dornbusch, Fischer and Samuelson (1977) and Wilson

³This point was made by Bagwell and Staiger (1999, 2002). See Bagwell, Bown and Staiger (2016) and Staiger (2022) for recent reviews of this literature.

(1980) that facilitates analysis in a multi-country world. For the interested reader, in Appendix A.1 we work out the link between reciprocity and labor market dislocation in the two-country Dornbusch, Fischer and Samuelson model.

As in the model of Eaton and Kortum (2002), the world consists of N countries which we index by i , and there is a constant mass of households denoted by $L = (L_1, \dots, L_N)$ in each country. Goods are produced with a constant-returns-to-scale technology using labor, and we denote by $w = (w_1, \dots, w_N)$ the vector of wages paid in each country. Tradable goods are subject to tariffs, denoted by τ_{in} and defined as one plus the ad-valorem tariff applied by country i to purchases from country n , where $\tau_{in} \equiv 1$ for $i = n$ and with tariff revenue redistributed lump sum to consumers. We also assume that shipping goods from country n to country i is subject to iceberg trade costs κ_{in} , where κ_{in} is the quantity of a good that must be shipped from country n in order for one unit of the good to arrive in country i , and where we assume that $\kappa \geq 1$ for $i \neq n$ and $\kappa_{in} \equiv 1$ for $i = n$. Below we will extend this setup to multiple tradable sectors, and in section 4 we allow for intermediate goods.

Throughout we also assume that there is a non-tradable sector in each country. For now we keep this sector in the background, as it plays no role in the first set of results that we derive. We will describe the non-tradable sector in detail when we introduce our measures of labor-market dislocation in section 3.1.4.

Let $z = (z_1, \dots, z_N)$ be the vector of technology draws (output per worker) for any given tradable good for the N countries, with $z \in \mathbb{R}_+^N$. Following Eaton and Kortum (2002), we assume that the z 's are independent draws from a Frechet distribution. A tradable good $z = (z_1, \dots, z_N)$ is available in country i at unit prices

$$\frac{w_1 \kappa_{i1} \tau_{i1}}{z_1}, \frac{w_2 \kappa_{i2} \tau_{i2}}{z_2}, \dots, \frac{w_N \kappa_{iN} \tau_{iN}}{z_N},$$

and country i buys from the lowest cost suppliers in the world. Hence, the effective price of any good z in country i is given by

$$p_i(z) = \min_m \left\{ \frac{w_m \kappa_{im} \tau_{im}}{z_m} \right\}.$$

We define the set $B_{in} \subset \mathbb{R}_+^N$ as the set of goods that households in country i purchase from producers in country n (or the set of z 's in which country n is the lowest cost supplier to country i):

$$B_{in} = \left\{ z \in \mathbb{R}_+^N : p_i(z) = \frac{w_n \kappa_{in} \tau_{in}}{z} \right\}.$$

Denoting by $D_i(z)$ the quantity of good z demanded in country i , and denoting by

$$p_{in}^w(z) \equiv \frac{p_i(z)}{\tau_{in}} = \frac{w_n \kappa_{in}}{z_n} \quad (2)$$

the “world” (exporter) price of good z between country i and the lowest cost supplier country n , country i 's trade balance condition is given by

$$\sum_{n \neq i} \int_{B_{in}} p_{in}^w(z) D_i(z) \phi(z) dz = \sum_{n \neq i} \int_{B_{ni}} p_{ni}^w(z) D_n(z) \phi(z) dz,$$

where $\phi(z)$ is the joint density of z .

We now proceed to define reciprocity in this setting, and to characterize (i) the implications of reciprocity for changes in the terms of trade, (ii) the tariff changes that conform to reciprocity, and (iii) the implications of reciprocal tariff changes for labor market dislocation. We first do so in the special case of a world of two countries and one tradable sector, then we consider a two-country world with many tradable sectors, and finally we extend the analysis to a multi-country world with many tradable sectors.

3.1 Two Countries and One Tradable Sector

We consider first a two-country world with one tradable sector. We will refer to this world as a two-country “Eaton and Kortum” world. We index the two countries by i and n . We will use the superscripts 0 and 1 to denote equilibrium magnitudes under the initial and new tariff schedules $(\tau_{in}^0, \tau_{ni}^0)$ and $(\tau_{in}^1, \tau_{ni}^1)$, respectively.

3.1.1 Reciprocity

To define reciprocity, we first define $\hat{p}_{in}^{w0}(z) \equiv \frac{w_n^0 \kappa_{in}}{z_n^0}$ as the world price that would have prevailed for a good z under the initial tariff schedule $(\tau_{in}^0, \tau_{ni}^0)$ and the implied initial equilibrium wage in country n , w_n^0 , had this good been sourced by country i from country n . Notice that $\hat{p}_{in}^{w0}(z)$ is not necessarily equal to the *equilibrium* world price $p_{in}^{w0}(z)$ since z can potentially be a good that was not sourced by country i from country n under the initial tariffs. In other words, $\hat{p}_{in}^{w0}(z) = p_{in}^{w0}(z)$ only for the set of goods that actually *were* imported by country i from country n under the initial tariffs.

We are now ready to define reciprocity. Following Bagwell and Staiger (1999, 2002) we say that a change in tariffs between countries n and i satisfies reciprocity for country i if these tariff changes lead to a change in the volume of country i imports, measured at initial world prices $\hat{p}_{in}^{w0}(z)$ for those country- i imports, that is equal in magnitude to the change in volume in country i exports, measured at initial world prices $\hat{p}_{ni}^{w0}(z)$ for those country- i exports.

Formally, we say that the change in tariffs implied by the tariff schedules $(\tau_{in}^0, \tau_{ni}^0)$ and $(\tau_{in}^1, \tau_{ni}^1)$ satisfies reciprocity for country i if and only if

$$\int_{B_{in}^1} \hat{p}_{in}^{w0}(z) D_i^1(z) \phi(z) dz - \int_{B_{in}^0} \hat{p}_{in}^{w0}(z) D_i^0(z) \phi(z) dz = \int_{B_{ni}^1} \hat{p}_{ni}^{w0}(z) D_n^1(z) \phi(z) dz - \int_{B_{ni}^0} \hat{p}_{ni}^{w0}(z) D_n^0(z) \phi(z) dz. \quad (3)$$

The left-hand side of the reciprocity condition (3) is the change in the volume of country i 's imports sourced from country n , where imports of the different goods z are aggregated using the initial world prices $\hat{p}_{in}^{w0}(z)$ that would have prevailed under the initial set of tariffs $(\tau_{in}^0, \tau_{ni}^0)$ and country n 's implied initial equilibrium wage w_n^0 had these goods initially been sourced from country n . The right-hand side of the reciprocity condition (3) is the change in the volume of country i 's exports to country n , where exports of the different goods z are aggregated using the world prices $\hat{p}_{ni}^{w0}(z)$ that would have prevailed under the initial set of tariffs $(\tau_{in}^0, \tau_{ni}^0)$ and country i 's implied initial equilibrium wage w_i^0 had these goods initially been sourced from country i . It is straightforward to show that if the reciprocity condition holds for country i , it must also hold for country n .

Exploiting the Ricardian structure of the Eaton and Kortum (2002) model, we can also express the reciprocity condition (3) in a more compact form. In particular, denoting by

$$D_{in} \equiv \int_{B_{in}} \frac{\kappa_{in} D_i(z)}{z} \phi(z) dz \quad (4)$$

the labor content of the volume of country i 's imports from country n inclusive of trade costs, we can use (4) and $\hat{p}_{in}^{w0}(z) \equiv \frac{w_n^0 \kappa_{in}}{z_n}$ to express the reciprocity condition (3) equivalently as

$$w_n^0 (D_{in}^1 - D_{in}^0) = w_i^0 (D_{ni}^1 - D_{ni}^0). \quad (5)$$

According to (5), tariff changes satisfy reciprocity in this setting if and only if each country experiences a change in the labor content of its imports valued at its trading partner's initial wage that is equal to the change in the labor content of its exports valued at its own initial wage. We record this in:

Proposition 1 *In a two-country Eaton and Kortum world, tariff changes that satisfy reciprocity as defined by Bagwell and Staiger (1999, 2002) lead each country to experience a change in the labor content of its imports valued at its trading partner's initial wage that is equal to the change in the labor content of its exports valued at its own initial wage.*

3.1.2 Reciprocity and the Terms of Trade

To derive the implications of reciprocity for the terms of trade, we first write down country i 's trade balance condition at the initial tariffs $(\tau_{in}^0, \tau_{ni}^0)$ and at the new tariffs $(\tau_{in}^1, \tau_{ni}^1)$ respectively,

$$\begin{aligned} \int_{B_{in}^0} p_{in}^{w0}(z) D_i^0(z) \phi(z) dz &= \int_{B_{ni}^0} p_{ni}^{w0}(z) D_n^0(z) \phi(z) dz \\ \int_{B_{in}^1} p_{in}^{w1}(z) D_i^1(z) \phi(z) dz &= \int_{B_{ni}^1} p_{ni}^{w1}(z) D_n^1(z) \phi(z) dz. \end{aligned}$$

As with the reciprocity condition, these trade balance conditions can be written in the more compact form using (4) and the definition of $p_{in}^{w0}(z)$:

$$w_n^0 D_{in}^0 = w_i^0 D_{ni}^0, \quad (6)$$

$$w_n^1 D_{in}^1 = w_i^1 D_{ni}^1. \quad (7)$$

As (6) and (7) reflect, in this Ricardian setting trade balance requires that, for a given pair of tariffs, the labor content of a country's imports valued at its trading partner's wage given those tariffs is equal to the labor content of the country's exports valued at its own wage given those tariffs.

But substituting the trade balance condition (6) that must hold under the initial tariffs $(\tau_{in}^0, \tau_{ni}^0)$ into the reciprocity condition (5) and defining $\omega_i \equiv w_i/w_n$ we obtain

$$\omega_i^0 D_{ni}^1 = D_{in}^1. \quad (8)$$

And substituting the trade balance condition (7) that must hold under the new tariffs $(\tau_{in}^1, \tau_{ni}^1)$ into the right-hand side of (8) yields

$$(\omega_i^1 - \omega_i^0) D_{ni}^1 = 0. \quad (9)$$

Since $D_{ni}^1 > 0$ given that in any country there is a positive measure of lowest-cost suppliers under the properties of the Frechet distribution, it follows from (9) that reciprocity implies $\omega_i^1 = \omega_i^0$: tariff changes that conform to reciprocity hold fixed the relative wage between country i and country n . We may therefore state:

Proposition 2 *In a two-country Eaton and Kortum world, relative wages are unchanged by reciprocal tariff changes, that is, $\omega_i^1 - \omega_i^0 = 0$.*

In the Ricardian framework considered here, for given iceberg costs and productivities, world (exporter) prices are pinned down by wages as (2) reflects. Hence, country i 's export prices can be expressed in terms of country i 's wage while country n 's export prices can be expressed in terms of country n 's wage, and the relative wage plays the role that the terms of trade plays in the neoclassical model. By showing that reciprocal tariff changes hold fixed the relative wage between country i and country n , we have therefore established for the Eaton and Kortum (2002) model the analog of the reciprocity-fixes-the-terms-of-trade result that was derived by Bagwell and Staiger (1999, 2002) in the context of the neoclassical trade model.

We therefore may also state:

Corollary *In a two-country Eaton and Kortum world, the terms of trade is unchanged by reciprocal tariff changes.*

The result in Proposition 2 and its corollary complements and generalizes the result of Bagwell and Staiger (1999, 2002) to a two-country Eaton and Kortum (2002) model. Note also that it is straightforward to generalize the result in Proposition 2 to other trade models with product differentiation such as Armington (1969).

3.1.3 Reciprocal Tariff Changes

We next characterize reciprocal tariff changes in a two-country Eaton and Kortum world. To illustrate more clearly the intuition behind the reciprocal tariff formula, here we derive this formula in the absence of a non-tradable sector. In Appendix A.2 we extend the characterization of reciprocal tariff changes to include the non-tradable sector.

We denote the total expenditure of country i by X_i and the expenditure (inclusive of tariffs) on goods purchased by country i from country n as X_{in} . The share of the total expenditure in country i that is spent on imported goods is given by $\pi_{in} \equiv X_{in}/X_i$. In the context of the model's structure described above, it can be shown that $\int_{B_{in}} p_i(z) D_i(z) \phi(z) dz = X_i \pi_{in}$, where the bilateral trade shares π_{in} adopt a gravity structure as in Eaton and Kortum (2002), namely

$$\pi_{in} = \frac{A_n (w_n \tau_{in})^{-\theta}}{A_i (w_i)^{-\theta} + A_n (w_n \kappa_{in} \tau_{in})^{-\theta}}, \quad (10)$$

where θ and A are the shape and scale parameters of the Frechet distribution. The trade balance condition for country i can then be expressed as

$$\frac{\pi_{in}}{\tau_{in}} X_i = \frac{\pi_{ni}}{\tau_{ni}} X_n. \quad (11)$$

Total expenditure on goods in country i is equal to income, which is the sum of labor income and tariff revenue, or

$$X_i = w_i L_i + (\tau_{in} - 1) X_i \frac{\pi_{in}}{\tau_{in}}.$$

We can then rewrite total expenditure as

$$X_i = \frac{w_i L_i \tau_{in}}{1 + \pi_{ii} (\tau_{in} - 1)}. \quad (12)$$

Taking the total differential of the expression for total expenditure in (12) yields

$$d\ln X_i = d\ln w_i + d\ln \tau_{in} - \left(\frac{\pi_{ii}(\tau_{in} - 1) d\ln \pi_{ii} + \pi_{ii} \tau_{in} d\ln \tau_{in}}{1 + \pi_{ii}(\tau_{in} - 1)} \right). \quad (13)$$

Similarly, the total differential of the domestic expenditure share in country i , namely equation (10) when $i = n$, is given by

$$d\ln \pi_{ii} = (1 - \pi_{ii})\theta (d\ln w_n - d\ln w_i) + (1 - \pi_{ii})\theta d\ln \tau_{in}. \quad (14)$$

And taking the total differential of the trade balance condition (11) yields

$$d\ln X_i - \frac{\pi_{ii}}{1 - \pi_{ii}} d\ln \pi_{ii} - d\ln \tau_{in} = d\ln X_n - \frac{\pi_{nn}}{1 - \pi_{nn}} d\ln \pi_{nn} - d\ln \tau_{ni}. \quad (15)$$

Plugging the expressions for total expenditure (13) and domestic expenditure shares (14) into expression (15), and noting that $d\ln \omega_i = d\ln w_i - d\ln w_n$, we then obtain

$$\begin{aligned} d\ln \omega_i - \left(\frac{\pi_{ii}(\tau_{in} - 1)}{1 + \pi_{ii}(\tau_{in} - 1)} + \frac{\pi_{ii}}{1 - \pi_{ii}} \right) d\ln \pi_{ii} - \left(\frac{\pi_{ii} \tau_{in}}{1 + \pi_{ii}(\tau_{in} - 1)} \right) d\ln \tau_{in} = \\ - \left(\frac{\pi_{nn}(\tau_{ni} - 1)}{1 + \pi_{nn}(\tau_{ni} - 1)} + \frac{\pi_{nn}}{1 - \pi_{nn}} \right) d\ln \pi_{nn} - \left(\frac{\pi_{nn} \tau_{ni}}{1 + \pi_{nn}(\tau_{ni} - 1)} \right) d\ln \tau_{ni}. \end{aligned}$$

And using the expressions for $d\ln \pi_{ii}$ and $d\ln \pi_{nn}$, and denoting the share of production sold to domestic producers as $\tilde{\pi}_{ii} = \frac{\pi_{ii} \tau_{in}}{1 + \pi_{ii}(\tau_{in} - 1)}$, we obtain

$$\left(\frac{1 + \theta(\tilde{\pi}_{ii} + \tilde{\pi}_{nn})}{1 + \theta} \right) d\ln \omega_i = \tilde{\pi}_{ii} d\ln \tau_{in} - \tilde{\pi}_{nn} d\ln \tau_{ni}. \quad (16)$$

With Proposition 2 establishing that reciprocal tariff changes leave relative wages unchanged, it follows that such tariff changes must ensure that the left-hand side of (16) is equal to zero, leading to the characterization of reciprocal tariff changes that we record in the following proposition:

Proposition 3 *In a two-country Eaton and Kortum world, reciprocal changes in tariffs between country i and country n must satisfy*

$$\frac{d\ln \tau_{in}}{d\ln \tau_{ni}} = \frac{\tilde{\pi}_{nn}}{\tilde{\pi}_{ii}}. \quad (17)$$

According to Proposition 3, reciprocal changes in tariffs between countries i and n must be proportional to their country size and initial level of trade openness, contained in the terms $\tilde{\pi}_{ii}$ and $\tilde{\pi}_{nn}$. If, for example, country i is larger or less open than country n so that $\tilde{\pi}_{ii} > \tilde{\pi}_{nn}$, then the change in country i 's tariff needed to reciprocate country n 's tariff change is smaller in magnitude than country n 's tariff change. Intuitively, this is because the tariff change of a larger or less-open country has a greater impact on relative wages and hence the terms of trade than the same tariff change from a smaller or more open country, and so a relatively small tariff change is needed from the former country to reciprocate the latter and hold the terms of trade fixed. It also follows that if countries i and n are symmetric, achieving reciprocity requires the same change in tariffs between both countries, as Proposition 3 implies when $\tilde{\pi}_{ii} = \tilde{\pi}_{nn}$.

Finally, the same logic can be used to explain the fact that, for a given change in tariff applied by country n , there is always a change in tariff applied by country i that can neutralize the movements

in the terms of trade. This property in an environment with product differentiation as in Eaton and Kortum (2002) follows from the fact that any country has a world's lowest cost supplier located within its borders for a positive measure of goods, hence the country can always exploit its “monopsony power” to move its terms of trade.

In Appendix A.3 we show (Proposition A5) that a reciprocal reduction in tariffs in this world is Pareto improving as long as both tariffs remain non-negative. In Appendix A.4, we extend the characterization of reciprocal tariff changes in Proposition 3 to a setting of many countries and many tradable sectors (Proposition A6). That proposition also establishes the conditions for the existence of a set of tariff changes that satisfies multilateral reciprocity (since in a world with multiple countries and tradable sectors, further conditions are required to ensure that there are enough instruments (tariffs) to fix all the terms of trade across all countries).

3.1.4 Reciprocity and Labor Market Dislocation

We now consider the implications of reciprocity for the magnitude of labor market dislocation associated with tariff negotiations in the two-country Eaton and Kortum world. To this end, recall that in this world each country has two sectors, a tradable sector (that we now distinguish with the superscript T) modeled as above that we will interpret as the “manufacturing” sector, and its non-tradable sector (that we distinguish with the superscript NT) that we will now interpret as the “services” sector, with a constant final consumption share in the tradable sector given by α . We begin by associating labor market dislocation with the loss of jobs in the tradable sector which, given our interpretation of this sector as the manufacturing sector, resonates broadly with the China Shock literature.⁴ This is not the only possible measure of interest for labor market dislocation, and we will return to discuss alternative measures at the end of the section.

To develop a measure of the loss of jobs in the tradable sector, we begin with the labor market clearing condition in the non-tradable sector, which is given by

$$w_n L_n^{NT} = X_n^{NT}, \quad (18)$$

where total expenditure in the non-tradable sector can be written as

$$X_n^{NT} = (1 - \alpha) \left(w_n L_n + X_n^T \frac{(\tau_{ni} - 1)(1 - \pi_{nn}^T)}{\tau_{ni}} \right)$$

with π_{nn}^T the share of total expenditure in country n that is spent on tradable goods produced in country n . Using the fact that $X_n^{NT}/X_n^T = (1 - \alpha)/\alpha$, we obtain

$$X_n^{NT} = \frac{(1 - \alpha) w_n L_n}{\left(1 - \frac{\alpha(\tau_{ni} - 1)(1 - \pi_{nn}^T)}{\tau_{ni}} \right)}. \quad (19)$$

Combining expressions (18) and (19) yields

$$\frac{L_n^{NT}}{L_n} = (1 - \alpha) \left[1 - \frac{\alpha(\tau_{ni} - 1)(1 - \pi_{nn}^T)}{\tau_{ni}} \right]^{-1}. \quad (20)$$

⁴We say “resonates broadly” here because a main emphasis of the China Shock literature is on the local labor market impacts of job losses in manufacturing (see, e.g., Autor, Dorn and Hanson, 2021), and our model has only national labor markets. An additional question is where the US manufacturing workers displaced by the China Shock went. Autor, Dorn and Hanson provide evidence that many of these workers left the labor force entirely, while Feenstra and Sasahara (2018) observe that the loss of import-competing manufacturing jobs in the United States over this period was offset by a gain in export-oriented jobs in manufacturing and services. The measures of labor-market dislocation that we consider here and below do not accommodate the possibility of exit from work as emphasized by Autor, Dorn and Hanson, and in this sense they are more compatible with the observation of Feenstra and Sasahara.

Taking the total differential of (20), we obtain

$$d\ln L_n^{NT} = -\frac{\alpha L_n^{NT}}{(1-\alpha)L_n} \left[\frac{\pi_{nn}^T (\tau_{ni} - 1)}{\tau_{ni}} d\ln \pi_{nn}^T - \frac{(1 - \pi_{nn}^T)}{\tau_{ni}} d\ln \tau_{ni} \right].$$

Using the total differential for the bilateral expenditure shares

$$d\ln \pi_{nn}^T = \theta(1 - \pi_{nn}^T) (d\ln w_i - d\ln w_n) + \theta(1 - \pi_{nn}^T) d\ln \tau_{ni},$$

and defining employment dislocation in the tradable sector as $d\ln L_n^T = \frac{-L_n^{NT}}{L_n^T} d\ln L_n^{NT}$, we arrive at

$$\begin{aligned} d\ln L_n^T = & -\frac{L_n^{NT}}{L_n^T} \frac{L_n^{NT}}{L_n} \frac{1}{(1-\alpha)} \left[\frac{\alpha(1 - \pi_{nn}^T) \pi_{nn}^T (\tau_{ni} - 1) \theta}{\tau_{ni}} d\ln \omega_n \right] \\ & - \frac{L_n^{NT}}{L_n^T} \frac{L_n^{NT}}{L_n} \frac{1}{(1-\alpha)} \left[\frac{\alpha(1 - \pi_{nn}^T) (1 - \pi_{nn}^T) (\tau_{ni} - 1) \theta}{\tau_{ni}} d\ln \tau_{ni} \right]. \end{aligned} \quad (21)$$

Equation (21) describes the employment effect in the tradable sector that arises from changes in tariffs. It is a closed-form expression for the analog in the Eaton and Kortum world of the decomposition suggested by (1) in the two-good neoclassical trade model. In particular, in light of Proposition 2, Equation (21) describes how deviations from reciprocity that result in changes in the world prices, as reflected by changes in the relative wage $d\ln \omega_n$, impact the employment in the tradable sector L_n^T . The coefficient on $d\ln \omega_n$ is negative provided that $\tau_{ni} > 1$. This implies that if country i 's tariff cut falls short of (exceeds) that necessary to reciprocate the tariff cut of country n and leads to a fall (rise) in ω_n , country n 's labor market dislocation – as reflected by the loss of employment in the tradable sector – will be dampened (amplified) compared to the dislocation that country n would experience under a reciprocal tariff cut from country i .⁵

We summarize these results with:

Proposition 4 *In a two-country Eaton and Kortum world, deviations from reciprocity have implications for the size of labor market disruption associated with tariff liberalization. If country i 's tariff cuts fall short of (exceed) those necessary to reciprocate the tariff cuts of country n , country n 's labor market dislocation will be dampened (amplified) compared to the dislocation that country n would experience under reciprocal tariff cuts from country i .*

We may also state the following:

Corollary *In a two-country Eaton and Kortum world, a country's own tariff changes are a sufficient statistic for calculating the labor market dislocation it will experience as a result of negotiated tariff liberalization with its trading partner if and only if those tariff negotiations conform with the reciprocity norm.*

⁵As we note, the coefficient on $d\ln \omega_n$ is negative provided that $\tau_{ni} > 1$, which is the relevant starting point for the negotiated tariff reductions that we are considering. But it is informative to consider why the coefficient would be positive if one were to consider starting at an import subsidy ($\tau_{ni} < 1$). The reason is that country n 's labor income increases more than its total income (labor income + tariff revenue) when it subsidizes imports and there is an increase in its terms of trade (i.e., when $d\ln \omega_n > 0$), because with an increase in the terms of trade country n becomes more open (π_{nn}^T declines) and since country n is subsidizing imports its tariff revenue becomes more negative. But for the labor market to clear in the non-tradable sector, the payment to labor employed in the non-tradable sector must be equal to the total expenditure on non-tradable-sector goods as (18) indicates; and since the wage increases by more than total income, labor must then move away from the non-tradable sector and find employment in the tradable sector.

The result reported in Proposition 4 is intuitive. If country i falls short of (exceeds) reciprocating country n 's tariff cuts and as a result country n experiences a deterioration (an improvement) in its terms of trade, the resulting decrease (increase) in country n 's real income contributes to a fall (rise) in expenditures on non-tradable-sector goods that dampens (amplifies) the reallocation of country n 's labor toward the non-tradable sector. The corollary then follows because under the reciprocity norm the terms of trade remain fixed, and hence only the movement in country n 's local relative prices are relevant for determining the reallocation of country n 's labor toward the non-tradable sector, and under reciprocity the movement in country n 's local relative prices is fully determined by its own tariff cuts.

Notice from the coefficient on $d\ln\tau_{ni}$ in (21) that country n 's own tariff change has an ambiguous effect on employment in the tradable sector, depending on whether $(\tau_{ni} - 1)$ is greater than or less than $\frac{1}{\theta\pi_{nn}^T}$, which we show in Appendix A.5 is the value of country n 's tariff that would maximize tariff revenue for fixed ω_n . In particular, when τ_{ni} is set below this revenue-maximizing level, as is typically the case for the tariffs that we consider in our quantitative analysis of section 5, the coefficient on $d\ln\tau_{ni}$ is negative, implying that, with the terms of trade (and hence ω_n) held fixed, a drop in τ_{ni} would lead to a *rise* in L_n^T . In other words, absent terms-of-trade effects, lowering a country's tariff pulls resources into its tradable sector. Intuitively, this can be understood by referring to the labor market-clearing condition in the non-tradable sector given by (18). With ω_n and therefore w_n held fixed, country n 's labor income is held fixed and hence its total income – and therefore its expenditure in the non-tradable sector X_n^{NT} – changes in the same direction as the change in its tariff revenue. And (18) implies that with w_n held fixed L_n^{NT} then also changes in the same direction as the change in tariff revenue, which falls with a drop in τ_{ni} beginning from any tariff below the revenue-maximizing level.

Our focus above on the movements of labor from the tradable (manufacturing) sector to the non-tradable (services) sector is not the only measure of labor market dislocation associated with tariff liberalization that might be of interest. A possible alternative would be to focus on country n 's “trade-displaced” workers, defined as those country- n workers who under the initial tariffs were employed in the production of goods that under the new tariffs are replaced by imports and hence no longer produced in country n . According to this definition, trade-displaced workers are the country- n workers whose jobs were eliminated as a result of falling tariffs, and who will have to find work elsewhere in the economy producing goods that they were not producing under the initial tariffs. Some of these workers would be absorbed into country n 's non-tradable sector and hence would be captured by the measure of labor market dislocation on which we have focused above; but some of these workers could be re-absorbed within the tradable sector and employed in the production of tradable goods whose output expands under the tariff cuts (e.g., goods that country n exports under the new tariffs, or possibly goods in the tradable sector that are nevertheless non-traded at the new tariffs). This alternative measure of labor market dislocation is more in line with Feenstra and Sasahara's (2018) evidence on the nature of the China Shock experienced by the United States (see footnote 4). In Appendix A.1, we consider this alternative measure in our analysis of the Dornbusch, Fischer and Samuelson (1977) model, and there we show (Proposition A3) that the analog of the results reported in Proposition 4 and its Corollary continue to apply.

To explore related issues in the two-country Eaton and Kortum world, we now consider a second notion of labor market dislocation that complements our earlier focus on employment dislocation from the tradable to the non-tradable sector, namely employment dislocation *within* the tradable sector.⁶ For simplicity and without loss of generality, here we assume that this tradable sector is

⁶One could also consider an interpretation of labor market dislocation from the tradable sector that focused on adjustments in relative wages across sector rather employment, as would occur in an economy with frictional labor

the only sector in the economy.

To proceed, we begin with country n 's labor market clearing condition,

$$w_n L_n = \pi_{nn} X_n + \frac{\pi_{in} X_i}{\tau_{in}}. \quad (22)$$

We can also express the labor market clearing condition for the labor employed in the production that is sold domestically, L_{nn} , as

$$w_n L_{nn} = \pi_{nn} X_n. \quad (23)$$

The trade balance condition implies

$$\frac{\pi_{in} X_i}{\tau_{in}} = \frac{\pi_{ni} X_n}{\tau_{ni}}. \quad (24)$$

Hence, using the expressions (22), (23), and (24), we have

$$L_{nn} = \pi_{nn} \frac{X_n}{w_n} = \frac{\tau_{ni} \pi_{nn}}{1 + (\tau_{ni} - 1) \pi_{nn}} = \tilde{\pi}_{nn}.$$

Differentiating this expression yields a measure of within-sector labor market dislocation,

$$d \ln \frac{L_{nn}}{L_n} = - \left(\frac{(1 - \pi_{nn}) \theta}{1 + (\tau_{ni} - 1) \pi_{nn}} \right) d \ln \omega_n + \left(\frac{(1 - \pi_{nn}) (1 + \theta)}{1 + (\tau_{ni} - 1) \pi_{nn}} \right) d \ln \tau_{ni}, \quad (25)$$

where the right-hand-side of (25) is the total differential of $\tilde{\pi}_{nn}$ in country n as derived previously.

When $d \ln \frac{L_{nn}}{L_n} \neq 0$, country n 's labor in the tradable sector must reallocate between production that serves domestic demand and export-oriented production. In other words, if country i 's tariff changes exceed reciprocity so that country n 's terms of trade improve, increased imported varieties in country n will displace labor used for production that was sold domestically. Equation (25) has an analogous interpretation to equation (21), and we may therefore state:

Proposition 5 *In a two-country Eaton and Kortum world, deviations from reciprocity have implications for the size of within-sector labor market disruption associated with tariff liberalization. If country i 's tariff cuts fall short of (exceed) those necessary to reciprocate the tariff cuts of country n , country n 's within-sector labor market dislocation will be dampened (amplified) compared to the dislocation that country n would experience under reciprocal tariff cuts from country i .*

We may also state the following:

Corollary *In a two-country Eaton and Kortum world, a country's own tariff changes are a sufficient statistic for calculating the within-sector labor market dislocation it will experience as a result of negotiated tariff liberalization with its trading partner if and only if those tariff negotiations conform with the reciprocity norm.*

mobility across sectors. In Appendix A.6, we derive the labor market dislocation formula under the assumption that labor is fixed across sectors, which is given by

$$d \ln \frac{w_n^{NT}}{w_n^T} = \frac{(1 - \pi_{nn}^T)}{1 + \pi_{nn}^T (\tau_{ni} - 1)} \left((\tau_{ni} - 1) \pi_{nn}^T \theta d \ln \omega_n + (1 - \pi_{nn}^T (\tau_{ni} - 1) \theta) d \ln \tau_{ni} \right),$$

where it is understood that ω_n is the relative wage in the tradable sector between country n and country i . The expression states that if country i 's tariff cut falls short of (exceeds) that necessary to reciprocate the tariff cut of country n and leads to a fall (rise) in ω_n , then country n 's labor market dislocation – as reflected by the reduction in the relative wage of tradable sector workers as compared to workers in the non-tradable sector – will be dampened (amplified) compared to the dislocation that country n would experience under a reciprocal tariff cut from country i .

3.2 Two Countries and Many Tradable Sectors

Do the results of Propositions 2, 4 and 5 extend to an Eaton and Kortum (2002) world with many tradable sectors? Here we maintain our assumption of two countries but extend the analysis to a many tradable-sectors world as in Costinot, Donaldson and Komunjer (2012) which we will refer to as a two-country “CDK” world, and we show that these results extend without qualification.

3.2.1 Reciprocity and the Terms of Trade

We index tradable sectors by the subscript j , and we continue to index the two countries by i and n . As before, we say that the tariff changes between countries n and i satisfy reciprocity for country i if these tariff changes lead to a change in the volume of country i imports, measured at initial world prices, that is equal in magnitude to the change in volume in country i exports, measured at initial world prices.

Formally, we say that the change in tariffs implied by the tariff schedules $(\tau_{in1}^0, \tau_{in2}^0, \dots, \tau_{inJ}^0, \tau_{ni1}^0, \tau_{ni2}^0, \dots, \tau_{niJ}^0)$ and $(\tau_{in1}^1, \tau_{in2}^1, \dots, \tau_{inJ}^1, \tau_{ni1}^1, \tau_{ni2}^1, \dots, \tau_{niJ}^1)$ satisfies reciprocity for country i if and only if

$$\begin{aligned} \sum_j \int_{B_{inj}^1} \hat{p}_{inj}^{w0}(z) D_{ij}^1(z) \phi_j(z) dz - \sum_j \int_{B_{inj}^0} \hat{p}_{inj}^{w0}(z) D_{ij}^0(z) \phi_j(z) dz = \\ \sum_j \int_{B_{nij}^1} \hat{p}_{nij}^{w0}(z) D_{nj}^1(z) \phi_j(z) dz - \sum_j \int_{B_{nij}^0} \hat{p}_{nij}^{w0}(z) D_{nj}^0(z) \phi_j(z) dz, \end{aligned}$$

which using $\hat{p}_{inj}^{w0}(z) \equiv \frac{w_n^0 \kappa_{inj}}{z_{nj}}$ and $D_{inj} \equiv \int_{B_{inj}} \frac{\kappa_{inj} D_{ij}(z)}{z} \phi_j(z) dz$ can be rewritten as

$$w_n^0 \left(\sum_j D_{inj}^1 - \sum_j D_{inj}^0 \right) = w_i^0 \left(\sum_j D_{nij}^1 - \sum_j D_{nij}^0 \right).$$

Similarly, the trade balance conditions for country i at the initial tariff schedules and the new tariff schedules are given respectively by,

$$\begin{aligned} \sum_j \int_{B_{inj}^0} p_{inj}^{w0}(z) D_{ij}^0(z) \phi_j(z) dz = \sum_j \int_{B_{nij}^0} p_{nij}^{w0}(z) D_{nj}^0(z) \phi_j(z) dz \\ \sum_j \int_{B_{inj}^1} p_{inj}^{w1}(z) D_{ij}^1(z) \phi_j(z) dz = \sum_j \int_{B_{nij}^1} p_{nij}^{w1}(z) D_{nj}^1(z) \phi_j(z) dz, \end{aligned}$$

and using $p_{inj}^w(z) \equiv \frac{p_{ij}(z)}{\tau_{inj}} = \frac{w_n \kappa_{inj}}{z_{nj}}$ and the definition of D_{inj} these conditions can be rewritten as

$$\begin{aligned} w_n^0 \sum_j D_{inj}^0 &= w_i^0 \sum_j D_{nij}^0 \\ w_n^1 \sum_j D_{inj}^1 &= w_i^1 \sum_j D_{nij}^1. \end{aligned}$$

Substituting the trade balance condition under the initial tariffs into the reciprocity condition and using $\omega_i \equiv w_i/w_n$, we obtain

$$\omega_i^0 \sum_j D_{nij}^1 = \sum_j D_{inj}^1.$$

And substituting the trade balance condition under the new tariffs into this expression and rearranging yields

$$(\omega_i^1 - \omega_i^0) \sum_j D_{nij}^1 = 0 \quad (26)$$

which, given that $\sum_j D_{nij}^1 > 0$, implies the following:

Proposition 6 *In a two-country CDK world, relative wages are unchanged by reciprocal tariff changes, that is, $\omega_i^1 - \omega_i^0 = 0$.*

Recalling that, for given iceberg costs and productivities, world prices for each sector are pinned down by wages according to (2), we therefore may also state:

Corollary *In a two-country CDK world, tariff changes that satisfy reciprocity leave the terms of trade unchanged sector by sector.*

Proposition 6 and its Corollary extend without qualification Proposition 2 and its Corollary to a two-country Eaton and Kortum (2002) world with many tradable sectors. The Corollary to Proposition 6 is notable in part because, unlike in a many-good extension of the neoclassical model (see Bagwell and Staiger, 1999, note 16), in the Eaton and Kortum model with many tradable sectors reciprocity pins down the terms of trade sector by sector – not just the overall terms of trade – so the result is as strong in the many-tradable-sector case as it is when there is only a single tradable sector. As we will see, when we introduce intermediate goods as in Caliendo and Parro (2015), this strong result must be qualified for the many-tradable-sector case as in the neoclassical model.

3.2.2 Reciprocity and Labor Market Dislocation

We now describe the implications of reciprocity for the magnitude of labor market dislocation associated with tariff negotiations in the two-country CDK world. In light of our result in Proposition 6, it is direct to extend the expression for the employment dislocation in the tradable sector given in (21) to the case of many tradable sectors. For the many-tradable-sector case, the analogous expression is given by

$$\begin{aligned} d \ln L_n^T = & - \frac{L_n^{NT}}{L_n^T} \frac{L_n^{NT}}{L_n} \frac{1}{\alpha^{NT}} \left[\sum_{s=1}^J \frac{\alpha^s (1 - \pi_{nn}^s) \pi_{nn}^s (\tau_{ni}^s - 1) \theta^s}{\tau_{ni}^s} d \ln \omega_n \right] \\ & - \frac{L_n^{NT}}{L_n^T} \frac{L_n^{NT}}{L_n} \frac{1}{\alpha^{NT}} \left[\sum_{s=1}^J \frac{\alpha^s (1 - \pi_{nn}^s) (1 - \pi_{nn}^s (\tau_{ni}^s - 1) \theta^s)}{\tau_{ni}^s} d \ln \tau_{ni}^s \right]. \end{aligned} \quad (27)$$

As can be seen, expression (27) has the same interpretation as expression (21). We summarize these results with:

Proposition 7 *In a two-country CDK world, deviations from reciprocity have implications for the size of labor market disruption associated with tariff liberalization. If country i 's tariff cuts fall short of (exceed) those necessary to reciprocate the tariff cuts of country n , country n 's labor market dislocation will be dampened (amplified) compared to the dislocation that country n would experience under reciprocal tariff cuts from country i .*

We may also state the following:

Corollary *In a two-country CDK world, a country's own tariff changes are a sufficient statistic for calculating the labor market dislocation it will experience as a result of negotiated tariff liberalization with its trading partner if and only if those tariff negotiations conform with the reciprocity norm.*

Proposition 7 and its Corollary extend without qualification Proposition 4 and its Corollary to a two-country Eaton and Kortum (2002) world with many tradable sectors. It is also straightforward to show that the results of Proposition 5 and its Corollary extend without qualification to this many tradable-sector setting as well.

3.3 Many Countries and Many Tradable Sectors

We now extend our analysis to a many-country world. As we observed in section 2, while the concept of reciprocity in the GATT/WTO can apply either bilaterally or multilaterally, in the context of multi-country tariff negotiating rounds (including China's accession negotiations which occurred in the context of the ongoing Uruguay Round) each member's desire for reciprocity is best understood as a desire for multilateral reciprocity. We will therefore focus on multilateral reciprocity. In particular, we will say that multilateral reciprocity is satisfied for country i if the change in the volume of country i 's aggregate imports from all trading partners, measured at the initial world prices, is equal in magnitude to the change in the volume in country i 's aggregate exports to all trading partners, measured at initial world prices.

For expositional ease, we will undertake our many-country analysis restricting attention to the case of a one tradable-sector (Eaton and Kortum) world for most of our derivations and an initial result. We then show how this result extends naturally to the many tradable-sector (CDK) world.

Formally, in a N -country world, we say that the change in tariffs implied by the tariff schedules τ_{im}^0 and τ_{im}^1 for all $m \neq i$ satisfies multilateral reciprocity for country i if and only if

$$\sum_{m \neq i} w_m^0 (D_{im}^1 - D_{im}^0) = w_i^0 \left(\sum_{m \neq i} D_{mi}^1 - \sum_{m \neq i} D_{mi}^0 \right). \quad (28)$$

Balanced trade at initial world prices for country i can be written as

$$\sum_{m \neq i} w_m^0 D_{im}^0 = w_i^0 \sum_{m \neq i} D_{mi}^0,$$

and substituting this condition into the multilateral reciprocity condition for country i in (28) yields

$$\sum_{m \neq i} w_m^0 D_{im}^1 = w_i^0 \sum_{m \neq i} D_{mi}^1. \quad (29)$$

But we also have balanced trade at the new world prices for country i , which can be written as

$$\sum_{m \neq i} w_m^1 D_{im}^1 = w_i^1 \sum_{m \neq i} D_{mi}^1,$$

and subtracting (29) from this condition yields

$$\sum_{m \neq i} w_m^1 D_{im}^1 - \sum_{m \neq i} w_m^0 D_{im}^1 = w_i^1 \sum_{m \neq i} D_{mi}^1 - w_i^0 \sum_{m \neq i} D_{mi}^1,$$

or

$$[w_i^1 - w_i^0] \sum_{m \neq i} D_{mi}^1 - \sum_{m \neq i} D_{im}^1 [w_m^1 - w_m^0] = 0.$$

Imposing multilateral reciprocity for every country then implies

$$\begin{pmatrix} \sum_{m \neq 1} D_{m1}^1 & -D_{12}^1 & -D_{13}^1 & \dots & -D_{1N}^1 \\ -D_{21}^1 & \sum_{m \neq 2} D_{m2}^1 & -D_{23}^1 & \dots & -D_{2N}^1 \\ -D_{31}^1 & -D_{32}^1 & \sum_{m \neq 3} D_{m3}^1 & \dots & -D_{3N}^1 \\ \dots & \dots & \dots & \dots & \dots \\ -D_{N1}^1 & -D_{N2}^1 & -D_{N3}^1 & \dots & \sum_{m \neq N} D_{mN}^1 \end{pmatrix} \begin{pmatrix} w_1^1 - w_1^0 \\ w_2^1 - w_2^0 \\ w_3^1 - w_3^0 \\ \dots \\ w_N^1 - w_N^0 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ \dots \\ 0 \end{pmatrix}.$$

Finally, choosing country 1 wage as the numeraire so that $w_1^1 = w_1^0 \equiv 1$, we arrive at

$$\begin{pmatrix} -D_{12}^1 & -D_{13}^1 & \dots & -D_{1N}^1 \\ \sum_{m \neq 2} D_{m2}^1 & -D_{23}^1 & \dots & -D_{2N}^1 \\ -D_{32}^1 & \sum_{m \neq 3} D_{m3}^1 & \dots & -D_{3N}^1 \\ \dots & \dots & \dots & \dots \\ -D_{N2}^1 & -D_{N3}^1 & \dots & \sum_{m \neq N} D_{mN}^1 \end{pmatrix} \begin{pmatrix} w_2^1 - w_2^0 \\ w_3^1 - w_3^0 \\ \dots \\ w_N^1 - w_N^0 \end{pmatrix} = \begin{pmatrix} 0 \\ 0 \\ 0 \\ \dots \\ 0 \end{pmatrix}. \quad (30)$$

Restricting our attention to non-discriminatory (MFN) tariffs, for any vector of new tariffs τ^1 , the vector of new wages $(w_2^1 \ w_3^1 \ \dots \ w_N^1)$ is determined, and the matrix of D_{mk}^1 is determined as well. To find the vector of original tariffs τ^0 that combined with the vector of new tariffs τ^1 would satisfy multilateral reciprocity for all countries, we look for the vector of original wages $(w_2^0 \ w_3^0 \ \dots \ w_N^0)$ that solves (30) given the vector of new wages $(w_2^1 \ w_3^1 \ \dots \ w_N^1)$. But the sum of any $N - 1$ rows of the left-hand side matrix in (30) equals the negative of the N^{th} row, and so (30) describes a system of $N - 1$ independent linear equations in the $N - 1$ unknowns $(w_2^0 \ w_3^0 \ \dots \ w_N^0)$, which therefore has a unique solution, given by $w_m^0 = w_m^1$ for $m = 2, 3, \dots, N$.

We may therefore state

Proposition 8 *In a many-country Eaton and Kortum world, relative wages are unchanged by tariff changes that deliver multilateral reciprocity for each country, that is, $\omega_i^1 - \omega_i^0 = 0$ for all i .*

It should be clear from the above that the same steps that allowed us to generalize Proposition 2 to a setting with many sectors in a two-country world and deliver Proposition 6 will also deliver this generalization in a many-country world, hence we also have:

Proposition 9 *In a many-country CDK world, relative wages are unchanged by tariff changes that deliver multilateral reciprocity for each country, that is, $\omega_i^1 - \omega_i^0 = 0$ for all i .*

Finally, the same steps that led to (27) in the context of our two-country CDK analysis allow us derive an expression for labor market dislocation in a many-country CDK world. As we show in Appendix A.7, for this case the analogous expression to (27) is given by

$$\begin{aligned} d \ln L_n^T = & -\frac{L_n^{NT}}{L_n^T} \frac{L_n^{NT}}{L_n} \frac{1}{\alpha^{NT}} \left[\sum_{i=1}^N \sum_{s=1}^J \frac{\alpha^s \pi_{ni}^s (\tau_{ni}^s - 1) \theta^s}{\tau_{ni}^s} d \ln \omega_{ni}^s \right] \\ & - \frac{L_n^{NT}}{L_n^T} \frac{L_n^{NT}}{L_n} \frac{1}{\alpha^{NT}} \left[\sum_{i=1}^N \sum_{s=1}^J \left[\theta^s \pi_{ni}^s \sum_{m=1}^N \frac{\alpha^s \pi_{nm}^s (\tau_{nm}^s - 1)}{\tau_{nm}^s} + \frac{\alpha^s \pi_{ni}^s [1 - \theta^s (\tau_{ni}^s - 1)]}{\tau_{ni}^s} \right] d \ln \tau_{ni}^s \right], \end{aligned} \quad (31)$$

where $d \ln \omega_{ni}^s = \sum_{m=1}^N \pi_{nm}^s d \ln w_m - d \ln w_i$. Armed with (31) and Proposition 9, we may now state a many-country generalization of Proposition 7:

Proposition 10 *In a many-country CDK world, deviations from multilateral reciprocity have implications for the size of labor market disruption associated with tariff liberalization. If the rest of the world's tariff cuts fall short of (exceed) those necessary to reciprocate the tariff cuts of country n , country n 's labor market dislocation will be dampened (amplified) compared to the dislocation that country n would experience under reciprocal tariff cuts from the rest of the world.*

We may also state the following:

Corollary *In a many-country CDK world, a country's own tariff changes are a sufficient statistic for calculating the labor market dislocation it will experience as a result of negotiated tariff liberalization with its trading partners if and only if those tariff negotiations conform with the multilateral reciprocity norm.*

The Corollary to Proposition 10 is of particular interest because of what it implies for assessing the expected labor market dislocation from tariff negotiations. In particular, according to the Corollary, as long as a country is confident that the outcome of the tariff negotiations it is engaged in will conform to MFN and satisfy the multilateral reciprocity norm, it can assess the expected labor market dislocation that will result from those negotiations by focusing entirely on the labor market consequences of its own tariff cuts and need not be concerned with the details of the tariff cuts that other countries agree to implement.

It is also straightforward to show with analogous arguments that our results on within-sector labor market dislocation contained in Proposition 5 and its Corollary generalize to the many-country case (see Appendix A.8 for the derivation). In particular, the within sector employment dislocation in a multi-country world is given by

$$d\ln \frac{L_{nn}}{L_n} = -\frac{\theta}{\pi_{nn} + \sum_{i \neq n} \frac{\pi_{ni}}{\tau_{ni}}} \sum_{i \neq n} \frac{\pi_{ni}}{\tau_{ni}} d\ln \omega_{ni} + \frac{(1 + \theta)}{\pi_{nn} + \sum_{i \neq n} \frac{\pi_{ni}}{\tau_{ni}}} \sum_{i \neq n} \frac{\pi_{ni}}{\tau_{ni}} d\ln \tau_{ni},$$

from which the many-country analogs of Proposition 5 and its Corollary follow directly.

4 Reciprocity in the Caliendo and Parro Model

In this section we extend the analysis to incorporate intermediate goods as in Caliendo and Parro (2015). We begin by focusing on a Caliendo and Parro world with a single tradable sector, before considering a world with many tradable sectors and input-output linkages across sectors. As before, there is also a non-tradable sector which we keep in the background until we need it.

In particular, we assume that a good z is produced with labor and input materials that are aggregated with Cobb-Douglas shares. As a result a tradable good $z = (z_1, \dots, z_N)$ is now available in country i at unit prices

$$\frac{w_1^\beta P_1^{1-\beta} \kappa_{i1} \tau_{i1}}{z_1}, \frac{w_2^\beta P_2^{1-\beta} \kappa_{i2} \tau_{i2}}{z_2}, \dots, \frac{w_N^\beta P_N^{1-\beta} \kappa_{iN} \tau_{iN}}{z_N},$$

where β is the share of value added in gross output and P_i is the price index of materials in country i . As in Eaton and Kortum (2002), in this formulation we assume that intermediates goods z are aggregated into a composite good, whose price is P_i and which can be used for the production of intermediate varieties and for final consumption. The cost of a bundle of inputs in country i is therefore given by

$$c_i = w_i^\beta P_i^{1-\beta}. \quad (32)$$

As before, all producers in i buy from the lowest cost suppliers in the world. Hence, the effective price of any good z in country i is given by

$$p_i(z) = \min_m \left\{ \frac{c_m \kappa_{im} \tau_{im}}{z_m} \right\}.$$

The set B_{in} of goods that households in i purchases from producers in n (or the set of z 's for which country n is the lowest cost supplier) is given by

$$B_{in} = \left\{ z \in \mathbb{R}_+^n : p_i(z) = \frac{c_n \kappa_{in} \tau_{in}}{z} \right\}.$$

With $D_i(z)$ denoting the quantity of good z demanded in country i , and denoting by

$$p_{in}^w(z) \equiv \frac{p_i(z)}{\tau_{in}} = \frac{c_n \kappa_{in}}{z_n} \quad (33)$$

the “world” (exporter) price of good z between country i and the lowest cost supplier country n , country i 's trade balance condition is given by

$$\sum_{n \neq i} \int_{B_{in}} p_{in}^w(z) D_i(z) \phi(z) dz = \sum_{n \neq i} \int_{B_{ni}} p_{ni}^w(z) D_n(z) \phi(z) dz.$$

We now proceed to revisit the implications of reciprocity in a world with intermediate goods, which we will refer to as a “Caliendo and Parro” world. For simplicity, in what follows we focus our attention on a two-country world and only briefly discuss extensions to a many-country world.

4.1 Reciprocity and the Terms of Trade

As with our earlier discussion of a two-country world in the absence of intermediate goods, we index the two countries by i and n , and we follow Bagwell and Staiger (1999, 2002) in saying that a change in tariffs between countries n and i satisfies reciprocity for country i if these tariff changes lead to a change in the volume of country i imports, measured at initial world prices, that is equal in magnitude to the change in volume in country i exports, also measured at initial world prices. We also continue to denote by $\hat{p}_{in}^{w0}(z)$ the initial world price for an import good z of country i , defined as the world price that would have prevailed for a good z under the initial tariff schedule $(\tau_{in}^0, \tau_{ni}^0)$ had this good been sourced by country i from country n . And we continue to denote by $\hat{p}_{ni}^{w0}(z)$ the initial world price for an export good z of country i , defined as the world price that would have prevailed for a good z under the initial tariff schedule $(\tau_{in}^0, \tau_{ni}^0)$ had this good been sourced by country n from country i . Notice, though, that as a comparison of (33) and (2) confirms, in the presence of intermediate goods the world price now includes the price of intermediate materials, with c_n taking the place of w_n .

It follows that the reciprocity condition with intermediate goods is defined exactly as in (3), with the only difference that now world prices include the price of intermediate materials. In analogy with (5), therefore, we can write the reciprocity condition in the more compact form

$$c_n^0 (D_{in}^1 - D_{in}^0) = c_i^0 (D_{ni}^1 - D_{ni}^0),$$

where the only difference with (5) is that c now takes the place of w . And following similar steps, the trade balance conditions for country i at the initial and new tariffs, respectively, can be written as

$$c_n^1 D_{in}^1 = c_i^1 D_{ni}^1,$$

$$c_n^0 D_{in}^0 = c_i^0 D_{ni}^0.$$

Finally, defining $\tilde{\omega}_i \equiv c_i/c_n$ as the relative cost of an input bundle in countries i and n and using the reciprocity and trade balance conditions, we obtain

$$(\tilde{\omega}_i^1 - \tilde{\omega}_i^0) D_{ni}^1 = 0.$$

As with the case of no intermediate goods, since $D_{ni}^1 > 0$, we can state the following:

Proposition 11 *In a two-country Caliendo and Parro world with a single tradable sector, relative input-bundle costs are unchanged by reciprocal tariff changes, that is, $\tilde{\omega}_i^1 - \tilde{\omega}_i^0 = 0$.*

With world prices pinned down by input bundles for given iceberg costs and productivities as (33) reflects, we can also state the following:

Corollary *In a two-country Caliendo and Parro world with a single tradable sector, the terms of trade are unchanged by reciprocal tariff changes.*

It should also be clear that the implications of reciprocity for world prices and the terms of trade in a many-country world with intermediate goods are the same as in the case with no intermediate goods, since we can follow the same steps as before after observing that, for given iceberg costs and productivities, world prices are given by the cost of a bundle of inputs c_n instead of wages w_n . Hence, Proposition 11 and its Corollary extend without qualification to a many-country world.

4.2 Reciprocal Tariff Changes

We next characterize reciprocal tariff changes in a world with intermediate goods. The bilateral trade shares π_{in} with intermediate goods is given by

$$\pi_{in} = \frac{A_n (c_n \tau_{in})^{-\theta}}{A_i (c_i)^{-\theta} + A_n (c_n \kappa_{in} \tau_{in})^{-\theta}}. \quad (34)$$

The trade balance condition for country i can then be expressed as

$$\frac{\pi_{in}}{\tau_{in}} X_i = \frac{\pi_{ni}}{\tau_{ni}} X_n. \quad (35)$$

And total expenditure on goods in country i is now the sum of intermediate consumption and final consumption, which as before, is the sum of labor income and tariff revenue, namely

$$X_i = (1 - \beta) \left(\frac{\pi_{ni}}{\tau_{ni}} X_n + X_i \pi_{ii} \right) + w_i L_i + (\tau_{in} - 1) X_i \frac{\pi_{in}}{\tau_{in}}.$$

Using the trade balance condition (35), we express total expenditure in country i as

$$X_i = \frac{w_i L_i \tau_{in}}{\beta (1 + \pi_{ii} (\tau_{in} - 1))}. \quad (36)$$

Taking the total differential of total expenditure (36) yields

$$d \ln X_i = d \ln w_i + d \ln \tau_{in} - \left(\frac{\pi_{ii} (\tau_{in} - 1) d \ln \pi_{ii} + \pi_{ii} \tau_{in} d \ln \tau_{in}}{1 + \pi_{ii} (\tau_{in} - 1)} \right).$$

Similarly, the total differential of the domestic expenditure share (equation (34) when $i = n$) in country i is given by

$$d\ln\pi_{ii} = \theta(1 - \pi_{ii})(d\ln c_n - d\ln c_i) + \theta(1 - \pi_{ii})d\ln\tau_{in}. \quad (37)$$

Taking the total differential of the trade balance condition (35) yields

$$d\ln X_i - \frac{\pi_{ii}}{1 - \pi_{ii}}d\ln\pi_{ii} - d\ln\tau_{in} = d\ln X_n - \frac{\pi_{nn}}{1 - \pi_{nn}}d\ln\pi_{nn} - d\ln\tau_{ni}.$$

Finally, using the total differential equations for total expenditure (36) we obtain,

$$\begin{aligned} d\ln w_i - \left(\frac{\pi_{ii}(\tau_{in} - 1)}{1 + \pi_{ii}(\tau_{in} - 1)} + \frac{\pi_{ii}}{1 - \pi_{ii}} \right) d\ln\pi_{ii} - \left(\frac{\pi_{ii}\tau_{in}}{1 + \pi_{ii}(\tau_{in} - 1)} \right) d\ln\tau_{in} = \\ d\ln w_n - \left(\frac{\pi_{nn}(\tau_{ni} - 1)}{1 + \pi_{nn}(\tau_{ni} - 1)} + \frac{\pi_{nn}}{1 - \pi_{nn}} \right) d\ln\pi_{nn} - \left(\frac{\pi_{nn}\tau_{ni}}{1 + \pi_{nn}(\tau_{ni} - 1)} \right) d\ln\tau_{ni} \end{aligned}$$

and, using the expression for $d\ln\pi_{ii}$ and $d\ln\pi_{nn}$ in (37), we arrive at

$$\begin{aligned} \frac{d\ln w_i}{1 + \theta} - \frac{\theta}{1 + \theta} \left(\frac{\pi_{ii}(\tau_{in} - 1)}{1 + \pi_{ii}(\tau_{in} - 1)} + \frac{\pi_{ii}}{1 - \pi_{ii}} \right) [(1 - \pi_{ii})(d\ln c_n - d\ln c_i)] - \tilde{\pi}_{ii}d\ln\tau_{in} = \\ \frac{d\ln w_n}{1 + \theta} - \frac{\theta}{1 + \theta} \left(\frac{\pi_{nn}(\tau_{ni} - 1)}{1 + \pi_{nn}(\tau_{ni} - 1)} + \frac{\pi_{nn}}{1 - \pi_{nn}} \right) [(1 - \pi_{nn})(d\ln c_i - d\ln c_n)] - \tilde{\pi}_{nn}d\ln\tau_{ni} \end{aligned}$$

where recall that $\tilde{\pi}_{ii} = \frac{\pi_{ii}\tau_{in}}{1 + \pi_{ii}(\tau_{in} - 1)}$. Therefore, using the result of Proposition 11 and its Corollary, reciprocal changes in tariffs between country i and country n (i.e., the tariff changes that satisfy $d\ln c_n - d\ln c_i = 0$) are characterized by

$$\frac{d\ln w_i}{1 + \theta} - \tilde{\pi}_{ii}d\ln\tau_{in} = \frac{d\ln w_n}{1 + \theta} - \tilde{\pi}_{nn}d\ln\tau_{ni}.$$

Notice that this expression is similar to the expression for reciprocal tariffs with no intermediate goods in Proposition 3, with the main difference being that with intermediate goods relative wages can change as long as they preserve the input bundle costs c_i and c_n and hence world prices according to (33). In particular, the changes in relative wages in country i and country n that preserve the input bundle costs must satisfy

$$d\ln w_i - d\ln w_n = \frac{(1 - \beta)}{\beta} (\pi_{ni}d\ln\tau_{ni} - \pi_{in}d\ln\tau_{in}).$$

This expression is intuitive; it says that in order to keep the input bundle costs unchanged, wages must change to offset the changes in prices due to the changes in reciprocal tariffs, taking into account the importance of intermediate goods in the input bundle cost. Using this condition, we arrive at the characterization of reciprocal tariff changes in the presence of intermediate goods described in the next proposition:

Proposition 12 *In a two-country Caliendo and Parro world with a single tradable sector, reciprocal changes in tariffs between country i and country n must satisfy*

$$\frac{d\ln\tau_{in}}{d\ln\tau_{ni}} = \frac{\left(\tilde{\pi}_{nn} + \frac{(1 - \beta)}{\beta(1 + \theta)}(1 - \pi_{nn}) \right)}{\left(\tilde{\pi}_{ii} + \frac{(1 - \beta)}{\beta(1 + \theta)}(1 - \pi_{ii}) \right)}.$$

The result in Proposition 12 shows that the reciprocal change in tariffs between countries i and n depends on two terms. First, as in the case with no intermediate goods, reciprocal tariffs depends on the relative country sizes ($\tilde{\pi}_{ii}$ and $\tilde{\pi}_{nn}$), reflecting the extent to which each country is able to affect the terms of trade when changing tariffs. However, the reciprocal tariffs also depend on the importance of intermediate goods in production, β , interacted with the level of trade openness ($1 - \pi_{ii}$). The intuition is that tariff changes in country n will affect the terms of trade through the cost of intermediate goods. In particular, conditional on country size, if country i is more open than country n , reciprocal tariff changes require that country i change its tariff more relative to country n compared with the case of no intermediate goods, since the terms-of-trade effects will be partly offset by the effect of the change in country i 's tariffs on intermediate goods in the other countries, which will impact its export price.

What are the welfare effects of reciprocal tariff changes with intermediate goods? As in the world without intermediate goods, in Appendix A.9 we show (Proposition A7) that a reciprocal reduction in tariffs in this world is Pareto improving as long as both country's tariffs remain positive.

4.3 Reciprocity and Labor Market Dislocation

We turn now to discuss the labor market dislocation effects of reciprocity and deviations from reciprocity in the two-country Caliendo and Parro world with a single tradable sector. For simplicity, we consider here only a measure of the loss of jobs in the tradable sector, and we will also abstract from input-output linkages between the tradable and non-tradable sector.

The labor market clearing conditions in the tradable and non-tradable sectors, respectively, are given by

$$w_n L_n^T = \beta \left(\frac{\pi_{in}^T}{\tau_{in}} X_i^T + \pi_{nn}^T X_n^T \right) \quad (38)$$

$$w_n L_n^{NT} = \beta X_n^{NT}. \quad (39)$$

Total expenditure in the tradable sector is given by

$$X_n^T = (1 - \beta) \left(\frac{\pi_{in}^T}{\tau_{in}} X_i^T + X_n^T \pi_{nn}^T \right) + \alpha \left(w_n L_n + (\tau_{ni} - 1) X_n^T \frac{\pi_{ni}^T}{\tau_{ni}} \right),$$

which applying trade balance can be expressed as

$$X_n^T = \frac{\alpha \left(w_n L_n + (\tau_{ni} - 1) X_n^T \frac{(1 - \pi_{nn}^T)}{\tau_{ni}} \right)}{\left(1 - (1 - \beta) \left(\frac{1 + \pi_{nn}^T (\tau_{ni} - 1)}{\tau_{ni}} \right) \right)}. \quad (40)$$

The total expenditure in the non-tradable sector is given by

$$X_n^{NT} = \frac{(1 - \alpha)}{\beta} \left(w_n L_n + X_n^T \frac{(\tau_{ni} - 1) (1 - \pi_{nn}^T)}{\tau_{ni}} \right). \quad (41)$$

Finally using the labor market clearing conditions (38) and (39), the expression for total expenditures (40) and (41), the trade share expressions (34), taking the total differential in the tradable sector, and defining $d \ln \tilde{\omega}_n \equiv d \ln c_n - d \ln c_i$, we derive in Appendix A.10 the following expression:

$$\begin{aligned} d \ln L_n^T = & - \frac{L_n^{NT}}{L_n^T} \frac{L_n^{NT}}{L_n} \frac{\beta}{(1 - \alpha)} \left[\frac{\alpha (1 - \pi_{nn}^T) \pi_{nn}^T (\tau_{ni} - 1) \theta \tau_{ni}}{(\tau_{ni} - (1 - \beta) (1 + (\tau_{ni} - 1) \pi_{nn}^T))^2} \right] d \ln \tilde{\omega}_n \\ & - \frac{L_n^{NT}}{L_n^T} \frac{L_n^{NT}}{L_n} \frac{\beta}{(1 - \alpha)} \left[\frac{\alpha (1 - \pi_{nn}^T) (1 - \pi_{nn}^T (\tau_{ni} - 1) \theta) \tau_{ni}}{(\tau_{ni} - (1 - \beta) (1 + (\tau_{ni} - 1) \pi_{nn}^T))^2} \right] d \ln \tau_{ni}. \end{aligned} \quad (42)$$

The expression in (42) extends the expression in (21) to the case of intermediate goods (where $\beta < 1$). Using this expression, we may now state:

Proposition 13 *In a two-country Caliendo and Parro world with a single tradable sector, deviations from reciprocity have implications for the size of labor market disruption associated with tariff liberalization. If country i 's tariff cuts fall short of (exceed) those necessary to reciprocate the tariff cuts of country n , country n 's labor market dislocation will be dampened (amplified) compared to the dislocation that country n would experience under reciprocal tariff cuts from country i .*

We may also state the following:

Corollary *In a two-country Caliendo and Parro world with a single tradable sector, a country's own tariff changes are a sufficient statistic for calculating the labor market dislocation it will experience as a result of negotiated tariff liberalization with its trading partner if and only if those tariff negotiations conform with the reciprocity norm.*

It is straightforward to show that the results recorded in Proposition 13 and its Corollary extend without qualification to a many-country world provided the (MFN) tariff cuts satisfy multilateral reciprocity for all countries. But as we next show, the results recorded in Proposition 13 and its Corollary must be qualified in a world of many tradable sectors and hence input-output linkages across sectors, because in that case it might be possible that reciprocity could be satisfied even though the terms of trade is not held fixed sector by sector.

4.4 Many Tradable Sectors

We now consider a Caliendo and Parro world with many tradable sectors that we again index by j , and hence a world that features input-output linkages across sectors. In particular, we assume that the production of a good z requires labor plus materials from all sectors according to the input-output structure of the economy. Therefore, the cost of a bundle of inputs in country i and sector j is now given by

$$c_{ij} = w_i^{\gamma^j} \prod_k (P_i^k)^{\gamma^{kj}},$$

where $\gamma^j + \sum_k \gamma^{kj} = 1$.

As before, we say that the tariff changes between countries n and i satisfy reciprocity for country i if these tariff changes lead to a change in the volume of country i imports, measured at the initial world prices, that is equal in magnitude to the change in volume in country i exports, measured at initial world prices. Hence, following the same steps as before, the reciprocity condition can now be written as

$$\sum_j (c_{nj}^0 D_{inj}^1 - c_{nj}^0 D_{inj}^0) = \sum_j (c_{ij}^0 D_{nij}^1 - c_{ij}^0 D_{nij}^0).$$

And similarly, the trade balance condition in country i at initial and new tariffs can be written respectively as

$$\begin{aligned} \sum_j c_{nj}^0 D_{inj}^0 &= \sum_j c_{ij}^0 D_{nij}^0, \\ \sum_j c_{nj}^1 D_{inj}^1 &= \sum_j c_{ij}^1 D_{nij}^1. \end{aligned}$$

Substituting the trade balance condition at the initial tariffs into the reciprocity condition, and substituting the trade balance condition at the new tariffs into the resulting expression, we obtain

$$\sum_j (c_{nj}^1 - c_{nj}^0) D_{inj}^1 - \sum_j (c_{ij}^1 - c_{ij}^0) D_{nij}^1 = 0. \quad (43)$$

Notice from (32) that, in the absence of intermediates, we would have $c_{nj} = w_n$ and $c_{ij} = w_i$. And with w_n chosen as the numeraire, in this case (43) would collapse to (26), ensuring that reciprocity fixes the relative wage and therefore the terms of trade sector by sector, as Proposition 6 and its Corollary record. In the presence of intermediates and many sectors and hence input-output linkages across sectors, (43) implies that tariff changes that fix c_{nj} and c_{ij} for all j – and hence by (33) fix the terms of trade sector by sector – will still satisfy reciprocity, and when (43) is satisfied in this way it can be shown that the results from Proposition 7 and its Corollary can be extended without qualification to the two-country Caliendo and Parro model with many tradable sectors; and therefore, a country’s own tariff changes will continue to be a sufficient statistic for its labor dislocation in this setting as long (43) is satisfied in this way.

But in the presence of intermediates it is also possible that additional solutions to (43) may exist in which tariff changes satisfy reciprocity even while leading to changes in c_{nj} and c_{ij} for some j ’s, provided that these changes in sectoral relative world prices balance out in a way that fixes each country’s overall terms of trade in the way that (43) requires, much as Bagwell and Staiger (1999, note 16) describe for the many-good case of the neoclassical model. Whether these additional solutions to (43) exist will depend on the underlying details of the world economy.⁷ But if they do exist, then under such solutions a country’s own tariff changes will no longer be a sufficient statistic for its labor dislocation.

Nevertheless, we now argue that a country’s own tariff changes continue to be a sufficient statistic for its labor dislocation in the two-country Caliendo and Parro model with many tradable sectors, provided that the tariff changes satisfy reciprocity *at the sectoral level*. To formalize this statement, notice that we can always choose the numeraire to rewrite the reciprocity condition in (43) equivalently as

$$\sum_j (c_{nj}^1 - c_{nj}^0) D_{inj}^1 = \sum_j (c_{ij}^1 - c_{ij}^0) D_{nij}^1 = 0. \quad (44)$$

Using the characterization of reciprocity in (44), we say that reciprocity holds “at the sectoral level” if and only if (44) holds sector by sector, so that

$$(c_{nj}^1 - c_{nj}^0) D_{inj}^1 = (c_{ij}^1 - c_{ij}^0) D_{nij}^1 = 0 \text{ for } j = 1, \dots, N. \quad (45)$$

Of course, if reciprocity holds at the sectoral level then it must hold when summed over all sectors, as the reciprocity restriction in (44) requires. But if reciprocity holds at the sectoral level we can say something more. In particular, it is immediate from (45) that we must have $c_{nj}^1 = c_{nj}^0$ and $c_{ij}^1 = c_{ij}^0$ for $j = 1, \dots, N$. But then as discussed just above, in that case the results from Propositions 6, 7 and their Corollaries extend without qualification to the two-country Caliendo and Parro model with many tradable sectors.

Summarizing this discussion, we state the following:

⁷For example, it is direct to derive a multi-country version of (43) and show that, once a numeraire is chosen, the restriction of multilateral reciprocity for each of the N countries implies a set of $(N - 1)$ equations. If we fix the new tariffs and hence all outcomes evaluated at the new tariffs, then we have $(N - 1)$ independent linear equations in $(N - 1)J$ unknowns, namely, the c_{nj}^0 associated with the original tariffs, and we have as well the $(N - 1)J$ inequality constraints that $c_{nj}^0 \geq 0$ for all n and j . While $c_{nj}^0 = c_{nj}^1$ for all n and j is always a solution, whether or not there exist other solutions that satisfy the inequality constraints will depend on the details of the underlying world economy.

Proposition 14 *The results from Propositions 6, 7 and their Corollaries extend without qualification to the two-country Caliendo and Parro world with many sectors and hence input-output linkages across sectors, provided that the tariff changes satisfy reciprocity at the sectoral level.*

To be clear, we are not claiming that in their trade negotiations governments actually seek the sectoral form of reciprocity defined by (45). Instead we are simply observing that (45) can be interpreted as a natural sectoral strengthening of the aggregate reciprocity condition that has been the focus of our analysis, and that with this strengthening our earlier results extend without qualification to the Caliendo and Parro world with many sectors.

5 Quantitative Analysis

We now turn to the quantitative analysis. On December 11, 2001, China joined the WTO. As a new WTO member, China secured the right to access the markets of other WTO member countries at the MFN tariff levels that had been agreed by the GATT membership at the end of the Uruguay Round of GATT negotiations that created the WTO in 1995. In exchange, China was obligated to implement the MFN tariff cuts that it had negotiated with WTO member governments and that were enumerated in its Protocol of Accession. As we noted in the Introduction, the central goal of China’s accession negotiations was to achieve a balance between China’s WTO market access rights and obligations consistent with the GATT/WTO norm of reciprocity. Our quantitative analysis seeks to answer the following questions. Were the increases in import and export volumes that China experienced after its WTO accession consistent with GATT/WTO norms of reciprocity? If not, what were the consequences of China’s deviation from reciprocity? In particular, how did this deviation impact the terms of trade and employment dislocation in the rest of the world?

5.1 Reciprocity and the China Shock

To answer these questions, we first abstract from intermediate goods and employ versions of the Eaton and Kortum (2002) model as characterized in section 3.1 and the model of Costinot, Donaldson and Komunjer (2012) as characterized in sections 3.2 and 3.3. We take the model to the trade data at the end of the year 2000, and we study whether the changes in tariffs between 1990 and 2007 that were applied by China – reflecting China’s agreed tariff cuts in its Protocol of Accession – reciprocated the changes in tariffs between 1990 and 2007 that were applied by the rest of the world – reflecting the tariff cuts made by the rest of the world as a result of the Uruguay Round of GATT negotiations.⁸

Our rationale for gauging reciprocity based on the tariff cuts specified in China’s Protocol of Accession in relation to the Uruguay Round tariff cuts of GATT/WTO members is as follows. First, China began its bid for GATT/WTO membership at the beginning of the Uruguay Round in 1986, so China was negotiating its accession agreements with GATT/WTO members at the same time that those countries were negotiating their Uruguay Round tariff cuts.⁹ Second, reciprocity

⁸It is worth noting that the GATT/WTO legal commitment is the binding of tariffs at legal maximum levels, and gauging reciprocity in those legal commitments might suggest using bindings rather than applied tariffs for this purpose. However, the applied tariffs are arguably more relevant for the quantitative evaluation of reciprocity performed in this section, since satisfying reciprocity implies a balance in the change of volume of exports and imports evaluated at original world prices, and the use of applied rates is likely to have a tighter connection to trade volumes and to changes in trade volumes. Still, for most industrialized countries and for China, the difference between applied and bound tariff rates is small (see, for example, Bagwell, Bown, and Staiger, 2016).

⁹As described in USTR (2001), China applied for admission to GATT in July of 1986, the year that the Uruguay Round of GATT negotiations was initiated, and GATT formed a Working Party in March of 1987 “to examine China’s

was a stated goal of all of these negotiations, but in the context of China’s accession to the WTO there are a number of plausible interpretations of what reciprocity with China might entail, and we are not in a position to take a stand on which of these interpretations is “correct.”¹⁰ Instead we are simply asking: What if the United States (and every other country that negotiated a bilateral accession agreement with China) had viewed reciprocity in its accession negotiations with China as satisfied if China made market access concessions that, together with the Uruguay Round market access concessions of the rest of the WTO membership, ensured multilateral reciprocity in the outcome of the Uruguay-Round-plus-China-accession negotiations? We acknowledge that this is not the only plausible interpretation of how countries evaluated reciprocity in the context of China accession. But it is one plausible interpretation, and it has the advantage that it can be quantified in terms of specific policy actions and has interesting implications for the China Shock according to our theory.

We obtain trade flows between China and the rest of the world from the World Input-Output Database (WIOD). For our first set of quantitative results, we aggregate agricultural, mining, and manufacturing industries into a single tradable sector, and the rest of the industries into a non-tradable sector. We allow the final expenditure shares α and the input shares β to vary across countries and sectors. We obtain bilateral sectoral applied tariffs across countries from Caliendo et al. (2023).¹¹ We aggregate tariff rates across sectors and countries using 1995 trade shares. In Appendix B we also present quantitative results using unweighted tariffs, as well as quantitative results for different initial years, and time frames for tariff changes. We obtain the trade elasticities from Caliendo and Parro (2015).

To quantify whether China’s accession to the WTO was reciprocal with the rest of the world or not, we need to confront the fact that after China joined the WTO, several reforms and changes in economic structure took place in all countries around the world. As a consequence, part of the observed changes in trade flows and other economic outcomes might have been the consequence of China’s accession to the WTO or the consequence of changes in economic fundamentals other than tariffs. To address this issue, we use the exact-hat algebra method (e.g., Dekle, Eaton and Kortum (2007), Costinot and Rodriguez Clare (2014), Caliendo and Parro (2015)). In particular,

application and negotiated terms of China’s accession.” These negotiations continued for the next eight years until, on January 1 1995, the WTO was formed, at which point a successor WTO Working Party took over the negotiations until their successful conclusion in 2001 which led to China’s Protocol of Accession.

¹⁰To our knowledge there is no publicly available record of discussions over the basis from which reciprocity was to be gauged in this context. Various possibilities seem plausible. For example, given that many WTO members had engaged in multiple previous rounds of negotiated reciprocal tariff reductions from which China was absent, China might have been asked as a condition of joining the WTO to reciprocate the market access value to its exporters of the entire negotiating history of the member governments under GATT. Alternatively, given that China was already receiving MFN tariff treatment from a number of its important trade partners – but not always unconditional MFN treatment – even before it became a WTO member, China might have been asked to reciprocate the value of the promise that its MFN treatment would be permanent upon joining the WTO and receiving Permanent Normal Trade Relations (PNTR) with the United States and others (see Handley and Limao, 2017, on the market access value that the elimination of uncertainty under a grant of PNTR conveys). Both of these notions of reciprocity seem plausible in the case of China’s accession to the WTO, as do others, and in private conversations with trade lawyers experienced in accession negotiations we have heard support for these and other notions as possibly relevant in the case of China’s WTO accession.

¹¹Caliendo et al. (2023) collected tariff lines from five primary sources: raw tariff schedules from the TRAINS and IDB databases accessed via the World Bank’s WITS website, manually collected tariff schedules published by the International Customs Tariffs Bureau (BITD), U.S. tariff schedules from the U.S. International Trade Commission, U.S. tariff schedules derived from detailed U.S. tariff revenue and trade data maintained by the Center for International Data at UC Davis, and the texts of preferential trade agreements primarily sourced from the WTO’s website, the World Bank’s Global Preferential Trade Agreements Database, or the Tuck Center for International Business Trade Agreements Database.

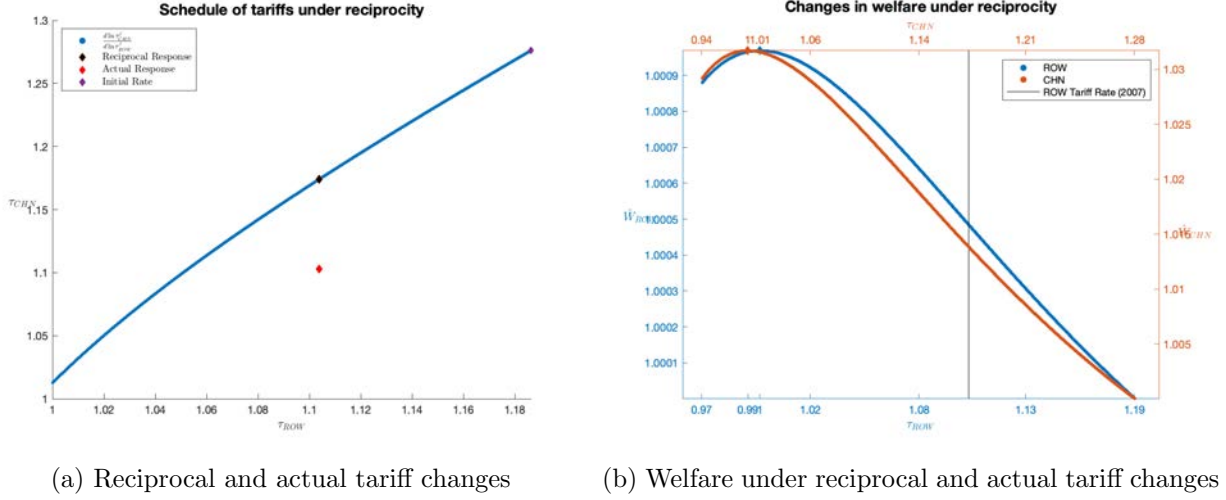


Figure 1: Reciprocity and welfare

Note: The left panel in the figure presents the schedule of reciprocal tariffs between China and the rest of the world starting from the initial equilibrium in 1990, and the actual tariff applied between China and the rest of the world in 2007. The axes shows the ad-valorem tariff applied between China and the rest of the world. The right panel presents the welfare effects of the reciprocal tariff schedule between China and the rest of the world. The bottom and left axes (in blue) show the reciprocal tariff schedule and the welfare effects for the rest of the world, the right and top axes (in red) show the same outcomes for China.

we evaluate the reciprocity of the actual changes in bilateral tariffs while holding other economic fundamentals constant. To this end, we condition on the data in 2000 just prior to China’s 2001 WTO accession, and by doing so, the observed allocation in that year contains all the information on economic fundamentals at the time of China’s accession to the WTO. Of course, after the year 2000, changes to other fundamentals might have offset potential terms of trade effects of tariff changes and could have made the tariff changes reciprocal, but since those changes were unrealized in the year 2000, we assume they were unknown and therefore were not part of the tariff negotiations.

We first apply our reciprocal tariff formula to compute the reciprocal tariffs schedule applied between China and the rest of the world. To do so, we start from the economy in 2000 under the actual tariffs applied between China and the rest of the world. We then apply small incremental reductions in the tariffs applied by the rest of the world and use the formula in Proposition 3 (extended to include a non-tradable sector, see Appendix A.2) to compute the corresponding reciprocal tariff changes applied by China.

Figure 1, Panel (a), shows the schedule of reciprocal tariffs between China and the rest of the world. Consistent with our theoretical results, we can see that reciprocal tariffs between China and the rest of the world are heterogeneous, and that the change in reciprocal tariffs in China (the smaller country) is larger than the reciprocal tariff changes applied by the rest of the world (the larger country). Notably, given the fact that the rest of the world has lower initial tariffs than China, we can see that the rest of the world is the first country to achieve free trade (zero tariff) under the reciprocal tariff schedule.

The diamond marker on the upper right corner of the schedule shows the tariff rates applied between China and the rest of the world in 1990. China applied an average tariff of about thirty percent to the rest of the world, while the rest of the world applied a lower average tariff of around seventeen percent to China. The other diamond marker on the schedule shows that the reciprocal tariff applied by China in response to the rest of the world’s tariffs is approximately twenty percent. However, the diamond marker below the schedule signifies the actual 2007 tariff level between China

and the rest of the world. It is evident from the figure that with a tariff rate of roughly ten percent, China exceeded reciprocity according to our model-based formula.

Panel (b) in Figure 1 displays the welfare (aggregate real income) effects in China and in the rest of the world resulting from the reciprocal tariff schedule. In this figure, the bottom and left axes (marked in blue) represent the reciprocal tariff schedule and the welfare effects for the rest of the world, while the right and top axes (marked in red) indicate the same outcomes for China. As shown in the figure, once the rest of the world achieves free trade (zero tariffs), China implements a reciprocal tariff of around about one percent. Notably, these reciprocal tariffs are Pareto improving as welfare increases for both China and the rest of the world until free trade in the rest of the world is reached, consistent with our theoretical results. The figure also reveals that if China continues to reduce tariffs until it reaches free trade, the reciprocal change in tariffs imposed by the rest of the world leads to the subsidization of their imports from China. And as the theory would predict, under that tariff schedule, welfare in China is maximized, but the rest of the world becomes worse off.

The vertical line in the figure marks the actual tariff level achieved by 2007. The figure demonstrates that both China and the rest of the world realize welfare gains under the reciprocal tariff changes, though these gains fell short of what would have been achieved under a reciprocal tariff schedule leading the rest of the world to free trade.

We turn next to quantify the employment dislocation in the rest of the world as a consequence of the deviation from reciprocity, specifically from the fact that China exceeded multilateral reciprocity with the rest of the world, as discussed in the previous figure. In particular, Figure 2 presents the percentage change in employment in the tradable sector and in the non-tradable sector in the rest of the world due to the movement in the terms of trade resulting from the actual changes in tariff between China and the rest of the world from 1990-2007. We find that China exceeding reciprocity with the rest of the world resulted in employment shifting from the tradable sector to the non-tradable sector in the rest of the world. As discussed previously, this employment dislocation effect is a consequence of the increase in the terms of trade (and income) in the rest of the world that shifted expenditure towards the non-tradable sector.

In Appendix B, we present a series of robustness exercises. Specifically, we first recompute the reciprocal tariffs and employment effects using unweighted bilateral sectoral tariffs. Additionally, we present results taking the model to the year 1995, evaluating the reciprocity and employment effects of actual changes in tariffs over the period from 1995 to 2007. The results from all these alternative exercises affirm the conclusions described in this section; namely, we consistently find that the change in tariffs applied by China to the rest of the world exceeded reciprocity, which consequently led to a shift in employment to the non-tradable sector in the rest of the world.

We also quantify the employment effects across individual countries in a world with multiple countries (41), tradable sectors (16), and a non tradable sector. As discussed in section 3.1.3 and described further in Appendix A.4, in a world with multiple countries and sectors there is a dimensionality issue associated with finding a unique schedule of reciprocal tariff changes that preserve world prices, and the dimensionality of our many-country many-sector model ensures that there is in fact a multiplicity of tariff-change schedules that could satisfy multilateral reciprocity; therefore, we cannot derive closed-form formulas for reciprocal tariff changes as we did for the two country case, and compare the actual tariff changes to the tariff changes predicted by the formula.

However, in order to compute the employment dislocation in a world with multiple countries and sectors, we can rely on the total differential of the employment effects derived in (31). In particular, we use that equation to calculate the share of the employment effects resulting from actual changes in each country's tariffs that can be attributed to the influence of terms-of-trade movements on employment in the non-tradable sector. That is, we can take advantage of expression (31) to

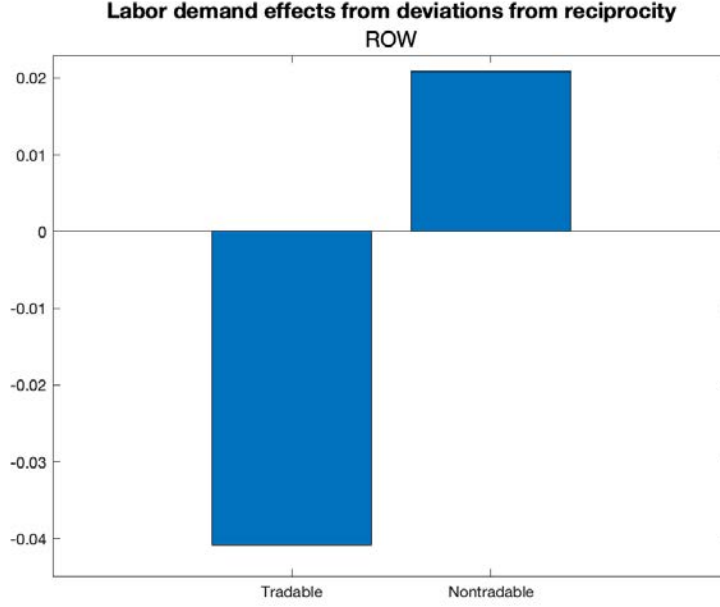


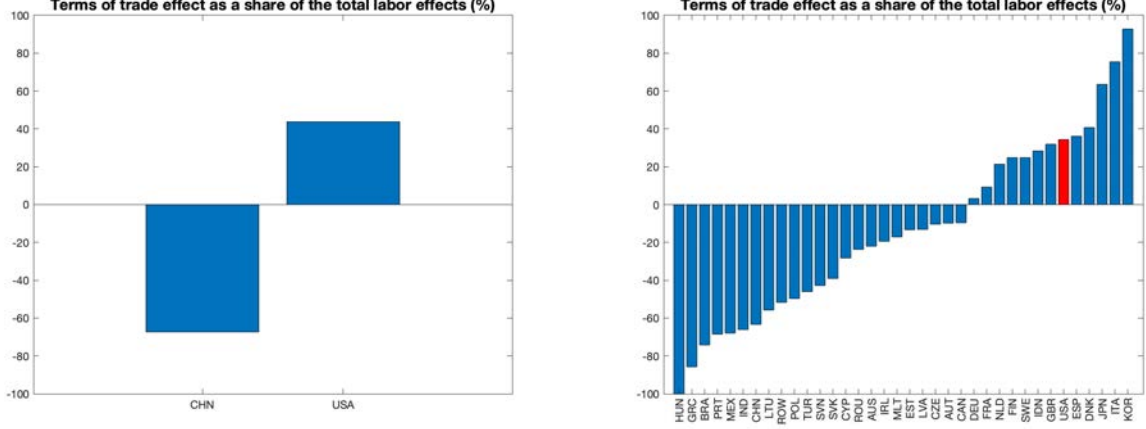
Figure 2: Employment effects across sectors in the rest of the world

Note: The figure presents the employment effects in the tradable sector and in the non-tradable sector in the rest of the world resulting from the change in wages due to the actual changes in tariffs between China and the rest of the world over the period 1990-2007.

answer the following question: What is the contribution of the change in terms of trade (which according to our theory would not have occurred under reciprocity) to the change in employment in the non-tradable sector of a country that arises from the combined effect of the change in the terms of trade and the change in the country's own tariffs? Recalling from (31) that the impact of a country's own tariff cuts and terms-of-trade movements on its non-tradable sector employment can be of opposite signs, we calculate this share in terms of absolute magnitudes to ensure that the share must fall between 0 and 1.

Figure 3 displays the employment dislocation effects across individual countries, measured as the percentage change in employment in the non-tradable sector due to deviation from reciprocity as a share of absolute employment effects given by (31). As constructed, the magnitude of this measure provides an understanding of the significance of the deviation from reciprocity on employment in the non-tradable sector, in comparison to the effect of the changes in the country's own tariffs on employment in that same sector.

On the left panel, we highlight the impacts on the United States by computing the effects of the actual bilateral change in tariffs between the United States and China over the period from 1990 to 2007. Consistent with our previous results, we find that the deviation from reciprocity, specifically the fact that China exceeded reciprocity, led to a shift of employment from the tradable sector into the non-tradable sector in the United States, with the opposite effects in China. Quantitatively, and using the decomposition of effects given by (31), the left panel can be interpreted as showing that the contribution of China's deviation from reciprocity to changes in tradable sector employment in the United States over this period is roughly comparable in magnitude to the contribution of the United States' own tariff cuts over the period. In this sense, the left panel confirms the relative significance of deviations from reciprocity for understanding how negotiated tariff liberalization implemented over the 1990-2007 period contributed to the size of the China Shock experienced by



(a) Bilateral terms of trade effects on employment (b) Multilateral terms of trade effects on employment

Figure 3: Employment dislocation across countries

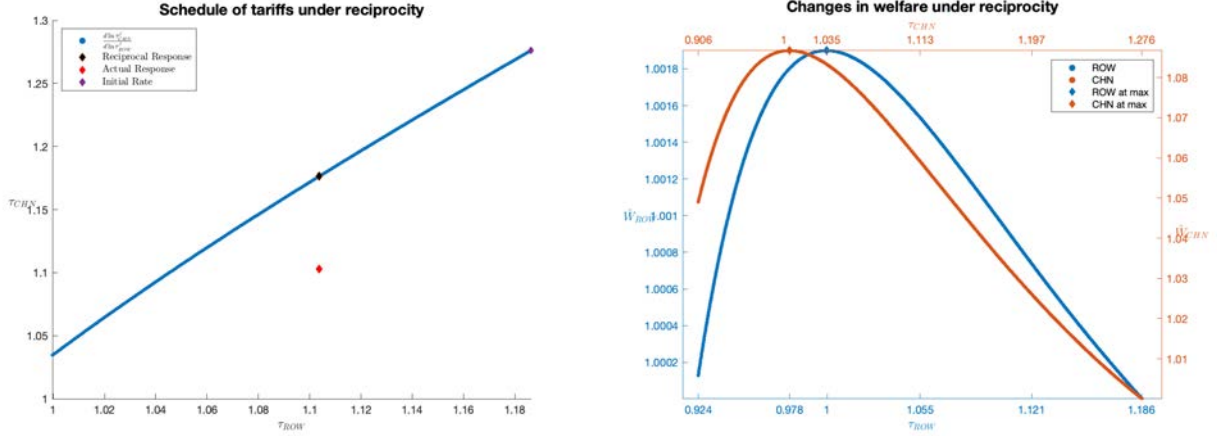
Note: The left panel in the figure presents the employment dislocation effects from a bilateral change in tariffs between China and the United States over the period 1990-2007. The right panel shows the employment dislocation effect across countries from multilateral changes in tariffs over the period 1990-2007. The employment effects in the non-tradable sector due to the deviations from reciprocity are computed as the percentage change in employment in the non-tradable sector due to deviation from reciprocity as a share of absolute employment effects given by (31).

the United States.

On the right panel, we present the effects across individual countries from the actual changes in bilateral tariffs between China and the individual countries over the same period. Interestingly, we find positive employment effects in the non-tradable sector for some countries and negative for others. Intuitively, China's tariff reduction worsened the terms of trade in countries that compete in exports with China, such as Mexico and India, which resulted in employment moving into the tradable sector in those countries.

Finally, turning to our within-tradable-sector measure of labor-market dislocation, we return to our more aggregate (China and the rest of the world, one tradable sector) specification of the model. We find that the improvement in rest-of-world terms of trade as a result of China exceeding reciprocity resulted in a within sector employment dislocation of 0.76% in the rest of the world: put differently, if China's tariff cuts had conformed to reciprocity, the share of workers in the tradable sector of the rest of the world that was devoted to production for domestic consumption would have fallen by 0.76 percentage points less. Intuitively, and as discussed before, the terms-of-trade improvement experienced by the rest of the world resulted in access to cheaper imported varieties that before were produced domestically, which moved employment away from production of those varieties within the tradable sector.¹²

¹²Following the discussion in footnote 6, we also computed the alternative interpretation of labor market dislocation in an economy with frictional labor mobility across sectors. To do so, in Appendix A.11 we derive the formula for reciprocal tariffs in a two-country economy with a tradable sector, a non-tradable sector, and fixed labor across sectors. We show that the formula for reciprocal tariff changes in this economy is the same formula as the formula in Proposition 3 for the frictionless one-sector economy. We then computed the labor market dislocation as a result of deviation from reciprocity, measured by changes in relative wages. We find that as a consequence of China exceeding reciprocity, the relative wage between the non-tradable and tradable sectors in the rest of the world increases by 0.07 percentage points, while this relative wage declines by 0.93 percentage points in China. As expected, there is a mapping between employment dislocation in an economy with labor mobility and the change in relative wages between the non-tradable and the tradable sectors in the economy with mobility frictions.



(a) Reciprocal and actual tariff changes with intermediate goods (b) Welfare under reciprocal and actual tariff changes with intermediate goods

Figure 4: Reciprocity and welfare with intermediate goods

Note: The left panel in the figure presents the schedule of reciprocal tariffs between China and the rest of the world starting from the initial equilibrium in 1990, and the actual tariff applied between China and the rest of the world in 2007. The axes show the ad-valorem tariff applied between China and the rest of the world. The right panel presents the welfare effects of the reciprocal tariff schedule between China and the rest of the world. The bottom and left axes (in blue) show the reciprocal tariff schedule and the welfare effects for the rest of the world, the right and top axes (in red) show the same outcomes for China.

5.2 Reciprocity with Intermediate Goods

We next extend our quantitative analysis to incorporate intermediate goods. Similar to our quantitative analysis with no intermediate goods, we study reciprocity as the changes in tariffs that preserve world prices. These prices are given, in this case, by the input bundle costs. However, as discussed in section 4.4, in the presence of intermediate goods and multiple tradable sectors, it is possible that specific movements in the world prices across sectors might also satisfy the reciprocity condition (43). As Proposition 14 indicates, this possibility is ruled out if tariff changes satisfy reciprocity at the sectoral level. Rather than impose a sector-level reciprocity restriction in the many sector Caliendo and Parro world, we choose for simplicity to rule out this possibility by restricting our focus here to a (two-country) Caliendo and Parro world with a single tradable (and a non-tradable) sector. This approach ensures that the reciprocal tariffs are unique and keep the input bundle cost and hence the world price in the tradable sector unchanged, and we can apply our reciprocal tariff formula with intermediate goods derived in Proposition 12 (extended to include a non-tradable sector as we did before). Of course, the input bundle cost in the non-tradable sector can still vary due to changes in wages.

Figure 4, Panel (a), shows the schedule of reciprocal tariffs between China and the rest of the world with intermediate goods. Similar to the quantitative results in the previous section, we can see that reciprocal tariffs between China and the rest of the world are heterogeneous, and that the change in reciprocal tariffs in China (the smaller country) is larger than the reciprocal tariffs applied by the rest of the world (the larger country). We can also see that the rest of the world is the first country to achieve free trade (zero tariff) under the reciprocal tariff schedule. In addition, the figure shows that with intermediate goods, the actual tariff applied by China to the rest of the world (the diamond marker below the reciprocal tariff schedule) was about ten percentage points lower than the reciprocal tariff given the actual tariff change by the rest of the world over the period 1990-2007. Therefore, in line with our results with no intermediate goods, we also find that

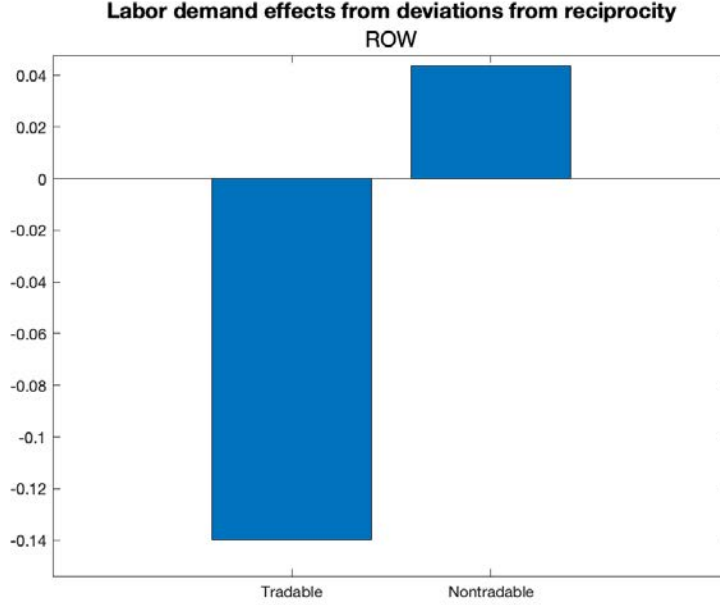


Figure 5: Employment effects across sectors in the rest of the world with intermediate goods

Note: The figure presents the employment effects in the tradable sector and in the non-tradable sector in the rest of the world resulting from the change in wages due to the actual changes in tariffs between China and the rest of the world over the period 1990-2007.

China exceeded reciprocity with respect to the rest of the world. And similar to our analysis of reciprocity with no intermediate goods, but consistent with our theoretical results, Panel (b) shows that under reciprocity the tariff cuts are Pareto improving as long as both country's tariffs remain positive.

Figure 5 presents the percentage change in employment in the tradable sector and in the non-tradable sector in the rest of the world due to the movement in the terms of trade resulting from the actual changes in tariff between China and the rest of the world from 1990 to 2007. We find that China exceeding reciprocity with the rest of the world resulted in employment shifting from the tradable sector to the non-tradable sector in the rest of the world. Compared to the results with no intermediate goods, we find that the presence of intermediate goods magnified this employment dislocation.

As we did before, in Appendix B we present a series of robustness exercises, using unweighted tariffs, and evaluating reciprocity for different time periods and tariff changes. We consistently find that the change in tariffs applied by China to the rest of the world exceeded reciprocity, which consequently led to a shift in employment to the non-tradable sector in the rest of the world.

6 China's Growing Trade Surplus

Until now we have maintained the assumption of balanced trade between countries in our formal analysis. A prominent feature of China's economic performance during the period over which the China Shock occurred, however, was its large and growing trade surplus. According to data from the International Monetary Fund (IMF), China's current account surplus as a share of its GDP fell from 4 percent in 1997 to 1 percent in 2001 at the time of its WTO accession. However, immediately upon WTO entry, China's surplus began to grow and ultimately peaked at 10 percent of GDP in

2007, at which point the surplus subsequently declined alongside the global financial crisis and trade collapse. During most of that early period especially, China intervened to fix the value of its currency vis-a-vis the US dollar – despite calls on China to allow it to appreciate – which provoked allegations that China was manipulating its currency.¹³

Motivated by these facts, in this section we consider how accounting for changing trade imbalances can impact our conclusions.¹⁴ We treat any changes in trade balance as exogenous to the exchange of market access commitments, on the grounds that the determination of a country’s trade balances reflect macro-economic policies that impact intertemporal prices, rather than trade policies which are usually thought to primarily impact intratemporal prices. Still, these changing trade imbalances can, by the logic of the transfer problem, have their own implications for world prices and the terms of trade, and hence for labor market dislocation in other countries. We wish now to factor the possibility of changing trade imbalances into our analysis, account for the impacts they would have on the terms of trade and hence on labor market dislocation, and assess whether the China Shock experienced by the United States and other countries would have been materially different if China, as part of its WTO accession protocol, had been required to adjust its tariffs to neutralize the terms-of-trade impacts not only of the tariff cuts offered to it by other WTO members – as would have been expected under the GATT/WTO norm of reciprocity – but also any impacts on the terms of trade that its growing trade surplus would otherwise have implied.

We are not suggesting that these additional tariff adjustments would themselves necessarily also be implied by the GATT/WTO norm of reciprocity: as traditionally interpreted in the GATT/WTO context, reciprocity would almost certainly not include an obligation to make these additional tariff adjustments. Nevertheless, as we discuss further at the end of this section, the additional tariff adjustments envisioned in our extended notion of reciprocity could be seen as broadly consistent with the spirit of the reciprocity norm if not its practice, as well as a possible complement to the IMF’s rules promoting “external stability,” and our goal here is simply to investigate whether the extended notion of reciprocity implied by such adjustments would have made a material difference to our labor market dislocation results.

To this end, below we first characterize an extension of the definition of reciprocity originally proposed for a world of balanced trade by Bagwell and Staiger (1999, 2002) that will preserve the world-price-stabilizing consequences of reciprocity in a world where trade imbalances change through time. We then explore quantitatively how different the demands of this extended reciprocity norm would have been on China’s reciprocity-consistent tariff cuts from the reciprocal tariff cuts for China that we characterized in previous sections, and what difference it would have made to the magnitude of the China Shock experienced by China’s trading partners if China’s WTO accession protocol had required that China abide by this extended notion of reciprocity.

6.1 Reciprocity and Trade Imbalances in a Two-Country World

We begin by extending our section 3.1 analysis of reciprocity in the two-country Eaton and Kortum (2002) world to accommodate changes in trade balances. As noted above, we will treat any changes in trade balances as exogenous to the exchange of market access commitments.

We consider the following extension of the definition of reciprocity for country i , exploiting the Ricardian structure of the Eaton and Kortum (2002) model and written in the compact form analogous to (5) for the case of balanced trade:

¹³For a broader discussion of the accusations that China was manipulating its currency, see Staiger and Sykes (2010).

¹⁴See also Beshkar, Chang and Song (2024), who emphasize changing trade imbalances as an important determinant of deviations from reciprocity since the WTO was formed.

$$w_i^0 (D_{ni}^1 - D_{ni}^0) - w_n^0 (D_{in}^1 - D_{in}^0) = (TB_i^1 - TB_i^0), \quad (46)$$

where TB_i is the trade balance in country i (positive if trade surplus, negative if trade deficit). As before, the first term on the left-hand side of equation (46) is the change in the labor content of country i 's exports valued at its initial wage, while the second term on the left-hand side is the change in the labor content of country i 's imports valued at its trading partner's initial wage. The term on the right-hand side is the change in country i 's trade balance, measured at contemporaneous world prices. It is straightforward to see that if the reciprocity condition is satisfied for country i , then it is also satisfied for country n .

To see what the extended notion of reciprocity in (46) implies, consider first the case of a constant trade balance $TB_i^1 = TB_i^0$ that may be positive or negative. In this case, the right-hand side of (46) is zero and (46) collapses to (5), but we know from Proposition 2 and its Corollary that tariff changes which satisfy (5) must hold fixed the terms of trade. Tariff changes that satisfy equation (46) must therefore hold fixed the terms of trade when the trade balance does not change through time. Now suppose that the trade balance is changing through time, and to fix ideas suppose that $TB_i^1 > TB_i^0 > 0$ so that country i runs a trade surplus in period 0 that grows in period 1. Rewriting (46) in the equivalent form

$$(w_i^0 D_{ni}^1 - w_n^0 D_{in}^1) - (w_i^0 D_{ni}^0 - w_n^0 D_{in}^0) = (TB_i^1 - TB_i^0), \quad (47)$$

it is apparent that equation (46) requires that this growth in country i 's trade surplus (the right-hand side of (47)) must be accomplished through changes in trade *volumes* (the left-hand side of (47)) – *not* changes in wages, world prices or the terms of trade – and for the exogenous changes in country i 's trade balance over time equation (46) implicitly defines the additional tariff adjustments that will be needed to accomplish this.¹⁵ In what follows we will sometimes refer to the extended notion of reciprocity defined by (46) as simply “extended reciprocity.”

Formalizing this logic, we prove in Appendix A.12 the following:

Proposition 15 *In a two-country Eaton and Kortum world with exogenous changes in trade imbalances, achieving extended reciprocity defined by (46) implies that world prices are preserved.*

6.1.1 Reciprocal Tariffs with Trade Imbalances

We next characterize the tariff changes that, in the presence of changing trade imbalances, would satisfy our extended definition of reciprocity in the two-country Eaton and Kortum world. According to Proposition 15, these are the tariff changes that will hold world prices fixed in this environment. Noting that the trade balance condition for country i can be expressed as

$$\frac{\pi_{in}}{\tau_{in}} X_i = \frac{\pi_{ni}}{\tau_{ni}} X_n - TB_i, \quad (48)$$

and that total expenditure on goods in country i is equal to income, which is the sum of labor income, tariff revenue and the trade deficit in i ,

$$X_i = w_i L_i + (\tau_{in} - 1) X_i \frac{\pi_{in}}{\tau_{in}} - TB_i,$$

¹⁵To be clear, the terms of trade being referred to here are the intratemporal terms of trade between a country's export goods and its import goods that can be manipulated with a classic Johnson (1953-54) optimal tariff. See Costinot, Lorenzoni and Werning (2014) on the incentive to manipulate *intertemporal* terms of trade with capital controls that alter trade imbalances through time.

we then rewrite total expenditure as

$$X_i = \frac{\tau_{in} w_i L_i - \tau_{in} T B_i}{1 + \pi_{ii} (\tau_{in} - 1)}. \quad (49)$$

Substituting (49) into the trade balance condition (48) yields

$$\frac{(1 - \pi_{ii})}{(1 + \pi_{ii} (\tau_{in} - 1))} (w_i L_i - T B_i) = \frac{(1 - \pi_{nn})}{(1 + \pi_{nn} (\tau_{ni} - 1))} (w_n L_n - T B_n) - T B_i. \quad (50)$$

Taking the total differential of (50), using the relationship defined in (14), and using the fact that $T B_i = -T B_n$ and that $T B_i d \ln T B_i = -T B_n d \ln T B_n$, we obtain an expression that defines the changes in τ_{in} and τ_{ni} that, in the presence of changing trade imbalances, would satisfy our extended definition of reciprocity and hence hold world prices fixed:

$$\begin{aligned} \frac{(1 - \pi_{ii}) X_i}{\tau_{in}} \tilde{\pi}_{ii} (\theta + 1) d \ln \tau_{in} = & \left(1 - \frac{(1 - \pi_{ii})}{(1 + \pi_{ii} (\tau_{in} - 1))} - \frac{(1 - \pi_{nn})}{(1 + \pi_{nn} (\tau_{ni} - 1))} \right) T B_i d \ln T B_i + \\ & \left(\frac{(1 - \pi_{ii}) X_i}{\tau_{in}} + T B_i \right) \tilde{\pi}_{nn} (\theta + 1) d \ln \tau_{ni}. \end{aligned} \quad (51)$$

Notice that for $T B_i = -T B_n = 0$ (51) implies (17), the tariff changes implied by reciprocity in a balanced-trade world. What (51) describes is the further tariff adjustments that would also have to be made in a world where trade balances are changing to continue to fix world prices and the terms of trade.

For instance, the term multiplying $d \ln T B_i$ is generally positive given that the domestic expenditure shares across countries tend to be very large. Hence, if country i starts with a trade surplus that grows over time, everything else constant, a reduction in tariffs applied by country n must be reciprocated with a smaller tariff decline by country i , compared with the case of balanced trade. The opposite happens when country i is running a growing trade deficit; in this case country i must reciprocate with a larger decline in tariffs. In addition, we have the terms related to the country size multiplying $d \ln \tau_{in}$ and $d \ln \tau_{ni}$.

6.1.2 Employment Dislocation with Trade Imbalances

We turn now to discuss the employment dislocation effects of extended reciprocity and deviation from extended reciprocity in this environment. As before, the labor market clearing condition in the non-tradable sector is given by

$$w_n L_n^{NT} = X_n^{NT},$$

where, using the fact that $X_n^{NT} / X_n^T = (1 - \alpha) / \alpha$, total expenditure in the non-tradable sector can be written as

$$X_n^{NT} = \frac{(1 - \alpha) (w_n L_n - T B_n)}{\left(1 - \frac{\alpha (\tau_{ni} - 1) (1 - \pi_{nn}^T)}{\tau_{ni}} \right)}.$$

Combining these equations and normalizing $w_n = 1$ yields

$$L_n^{NT} = \frac{(1 - \alpha) (L_n - T B_n)}{\left(1 - \frac{\alpha (\tau_{ni} - 1) (1 - \pi_{nn}^T)}{\tau_{ni}} \right)}. \quad (52)$$

Finally, combining the total differential of (52) with the total differential of the bilateral expenditure share π_{nn}^T and using $d\ln L_n^T = -\frac{L_n^{NT}}{L_n^T} d\ln L_n^{NT}$, we find that employment dislocation for the tradable sector is given by

$$\begin{aligned}
d\ln L_n^T = & -\frac{L_n^{NT}}{L_n^T} \frac{L_n^{NT}}{(L_n - TB_n)} \frac{1}{(1-\alpha)} \left[\frac{\alpha (1 - \pi_{nn}^T) \pi_{nn}^T (\tau_{ni} - 1) \theta}{\tau_{ni}} \right] d\ln \omega_n \\
& - \frac{L_n^{NT}}{L_n^T} \frac{L_n^{NT}}{(L_n - TB_n)} \frac{1}{(1-\alpha)} \left[\frac{\alpha (1 - \pi_{nn}^T) (1 - \pi_{nn}^T (\tau_{ni} - 1) \theta)}{\tau_{ni}} \right] d\ln \tau_{ni} \\
& + \frac{L_n^{NT}}{L_n^T (L_n - TB_n)} [TB_n] d\ln TB_n.
\end{aligned} \tag{53}$$

For the case of balanced trade where $TB_i = -TB_n = 0$, the expression for tradable-sector employment dislocation in (53) collapses to the expression in (21). And as was true there, it is straightforward to generalize the expression in (53) to a world with many tradable sectors.

More generally, then, when trade balances are non-zero and changing through time, (53) confirms that the analog of Proposition 4 still applies. That is, focusing on the term on the first line of (53) and using the result from Proposition 15 that tariff changes that conform to extended reciprocity will leave the terms of trade (and hence ω_n) unchanged, in a two-country Eaton and Kortum world deviations from extended reciprocity have implications for the size of labor market disruption associated with tariff liberalization. If country i 's tariff cuts fall short of (exceed) those necessary to achieve extended reciprocity in light of the tariff cuts of country n , country n 's labor market dislocation will be dampened (amplified) compared to the dislocation that country n would experience under tariff cuts from country i that satisfy extended reciprocity. Moreover, under extended reciprocity, the magnitude of the labor market disruption experienced by country n will be determined by two things: according to the second line of (53), it will reflect the tariff cuts that country n itself has made ($d\ln \tau_{ni}$), the implications of which will depend in part on country n 's trade imbalance TB_n ; and according to the third line of (53), it will reflect as well the direct impact of country n 's changing trade imbalance ($d\ln TB_n$), with a growing trade deficit (surplus) shifting employment to country n 's non-tradable (tradable) sector.

6.2 Quantitative Analysis with Trade Imbalances

We turn now to evaluate quantitatively whether China's accession to the WTO satisfied extended reciprocity with its trading partners as defined by (46) in a world with trade imbalances, and to evaluate quantitatively the implications of extended reciprocity for employment dislocation. Recalling that extended reciprocity differs from reciprocity only when trade imbalances are changing through time, Table 1 reports the actual tariffs applied by China to the rest of the world in 2000 and in 2007, as well as the Chinese tariffs that would satisfy reciprocity and extended reciprocity given the actual changes in tariffs applied by the rest of the world with (i) balanced trade, (ii) a constant Chinese trade surplus set at its initial 2000 level, and (iii) the actual (exogenous) growth in China's trade surplus between 2000 and 2007. As Table 1 reflects, we can conclude that whether or not trade imbalances are incorporated into our calculations, China exceeded the tariff cuts that would have been implied by extended reciprocity. Compared with balanced trade, the growing trade surplus experienced by China over the period 2000-2007 would have required an even smaller change in tariffs – and as a result, China exceeded reciprocity by a larger margin – when reciprocity takes the extended form defined by (46). These results follow closely our theoretical discussion in the previous section. If China had to reciprocate its initial trade surplus only, its tariff reduction

should have been slightly larger than under balanced trade, but we still find that the actual change exceeded reciprocity.

Table 1: China's Reciprocal Tariffs

Initial (2000)	Actual (2007)	Balanced trade	Constant surplus	Growing surplus
27.6%	10.3%	17.4%	16.6%	21.3%

Note: This table presents the initial (2000) ad valorem tariff rate applied by China to the rest of the world, the actual ad valorem tariff rate applied in 2007, and the ad valorem tariff rates that would satisfy reciprocity under balanced trade and under a constant trade imbalance set at the initial (2000) level, and that would satisfy extended reciprocity under the actual change in China's trade surplus with the rest of the world.

Turning to the employment dislocation effects associated with this deviation from reciprocity, Table 2 displays the employment effects under different scenarios. The first three rows present the employment effects across sectors in China and the rest of the world associated with deviation from extended reciprocity under (i) balanced trade, (ii) a constant trade surplus for China set at its initial (2000) level, and (iii) the actual growing trade surplus of China with respect to the world. The results follow intuitively those of the previous table. Since China exceeded both reciprocity and the extended reciprocity conditions, its actual tariff changes resulted in an improvement in the terms of trade in the rest of world, and following our theoretical discussion, result in employment moving away from the tradable sector in the rest of world, and in the opposite direction in China. The last row of Table 2 shows the employment effects if China would have only satisfied reciprocity as defined by (5), but not extended reciprocity as defined by (46), even when its trade surplus grew over this period. Comparing the numbers in the third and fourth rows of Table 2, our results indicate that in the presence of China's growing trade surpluses, while tradable employment in the rest of the world would have been 0.016% higher if China had conformed to reciprocity, it would have been 0.057% higher if China had conformed to extended reciprocity.

Table 2: Employment effects from deviation from reciprocity

	ROW		China	
	Non-tradable	Tradable	Non-tradable	Tradable
Reciprocity with balanced trade	0.021%	-0.041%	-0.433%	0.285%
Reciprocity with constant trade imbalance	0.019%	-0.037%	-0.405%	0.264%
Extended reciprocity with growing trade surplus	0.029%	-0.057%	-0.494%	0.321%
Reciprocity with growing trade surplus	0.008%	-0.016%	-0.057%	0.037%

Note: This table presents the employment effects in the tradable and non-tradable sectors from deviation from reciprocity, and from deviations from extended reciprocity. They are computed as the difference between the employment effects from a reciprocal change in tariffs and the employment effects from the actual change in tariffs applied between China and the rest of the world.

6.3 Interpreting Extended Reciprocity

We have found that our quantitative results under an assumption of balanced trade are reinforced when we take account of the growth in China's trade surplus that occurred over the period. In particular, our results above imply that, with no offsetting Chinese tariff adjustments, China's terms of trade deteriorated even further as a result of its growing trade surplus. Thus, we have argued that under an extended notion of reciprocity where China would further adjust its tariffs to neutralize the terms-of-trade impact of its growing trade surplus, China would have had to lower its tariffs by even less to maintain reciprocity than in the case of balanced trade, and hence its tariff

cuts could be said to have exceeded by even more the tariff cuts that would have been required under this extended notion of reciprocity.

But as we have noted, the GATT/WTO norm of reciprocity as traditionally interpreted would almost certainly not include an obligation to make these additional tariff adjustments. How, then, should our results under this extended notion of reciprocity be interpreted? We offer two related interpretations.

A first interpretation builds from the observation that, as a general matter, unanticipated and sustained growth in a country's trade surplus subsequent to GATT/WTO market access negotiations might in principal qualify as grounds for a claim of "nullification or impairment" of reciprocal benefits under the "other situation" provision of the GATT/WTO dispute settlement procedures. Here, Staiger and Sykes' (2013) observations about the drafting history of this so-called "situation complaint" pursuant to Article XXIII:1(c) of GATT 1994 are relevant:

Some insight about the [GATT] drafters' concerns may be gleaned from contemporaneous negotiations over the creation of the charter for the International Trade Organization (ITO), an institution that was to replace GATT but never came into being. Extensive discussions relating to the draft ITO charter centered on the possibility that the benefits of a trade agreement might not be realized for a variety of reasons. Among the prominent concerns was the possibility that the US economy would return to the depression conditions that preceded World War II. Such concerns motivated not only the provision that nullification or impairment might result from 'measures' legal under the treaty, but also the possibility that it might result from some 'other situation.' (pp 743-744)

At a conceptual level, concerns that a country's unexpected failure to recover from an economic depression might upset the anticipated reciprocal balance of the agreement are not so different from analogous concerns that might be triggered by unexpected and sustained growth in a country's trade surplus. This suggests that in the GATT/WTO context, the protection of legitimate expectations of reciprocity might in principle extend to cover potential disruptions of reciprocity due to large and sustained changes in trade surpluses, suggesting in turn that our extended notion of reciprocity could in this way be seen as consistent with the spirit of the reciprocity norm in the GATT/WTO. However, while confirming the broad reach of the situation complaint in principle, the WTO observes that the practical importance to date of such complaints is quite limited:

Literally understood, [a situation complaint] could cover any situation whatsoever, as long as it results in "nullification or impairment." However, although a few such situation complaints have been raised under the old GATT, none of them has ever resulted in a panel report. In the WTO, Article XXIII:1(c) of GATT 1994 has not so far been invoked by any complainant. WTO (2024)

In this light, the additional tariff adjustments envisioned in our extended notion of reciprocity might be interpreted as broadly consistent with the spirit of the reciprocity norm, but not its current practice. And under this interpretation, our quantitative results under extended reciprocity can be viewed as suggesting what might have been, had China's growing trade surpluses persisted over the period, but at the same time China had altered its tariffs so as to conform not just to reciprocity as such but to the broad spirit of the GATT/WTO reciprocity norm.

Relatedly, while GATT/WTO rules are typically not concerned with the trade balances of their member countries, the core rules of the IMF very much are. Hence, it is natural to consider how our notion of extended reciprocity might be interpreted from the perspective of IMF rules. Here our extended notion of the reciprocity norm might be seen as a complement to the IMF's

rules promoting “external stability” (see, for example, IMF, 2009), if it is accepted that external stability is undermined when sustained growth in one country’s trade imbalances leads to sustained changes in the terms of trade and hence labor-market dislocation for other countries. Given the important nonmarket features of China’s economy, these rules and norms arguably may have been less effectively applied to China.¹⁶

In light of this discussion, under a second interpretation our quantitative results under extended reciprocity can be viewed as suggesting what might have been, had China’s growing trade surpluses persisted over the period, but at the same time China had altered its tariffs so as to conform both to the GATT/WTO reciprocity norm *and* the IMF’s rules promoting external stability.

7 Policy Discussion

Several features of our quantitative results deserve further discussion, including issues of interpretation and questions that the results raise about the US policy response. Below we provide a brief discussion of each.

Interpretation As we have noted, under the assumption of balanced trade, our quantitative results in section 5 indicate that China’s agreed tariff cuts exceeded what would have been required to reciprocate the market access commitments that it received from other WTO members with its 2001 WTO accession. This deviation from reciprocity worsened China’s terms of trade and improved the terms of trade of the United States and other major industrialized economies. And we have shown in section 6 that these results are reinforced when we allow for China’s growing trade surplus over the period.

But aren’t these results at odds with the broadly held view, expressed most forcefully by the United States, that, subsequent to its WTO accession, China has intervened in its foreign trade to *stifle* its imports and *promote* its exports? In fact there is an interpretation of this view that is in line with our results. In particular, our results from section 5 indeed imply that China’s import volumes were too low, and its export volumes too high, *relative to the benchmark of reciprocity*, since under balanced trade this is simply the trade-volume counterpart of the worsening terms-of-trade for China (which under reciprocity would not have happened); and our results from section 6 confirm that China’s growing trade surpluses only reinforce this result. And although China’s deviation

¹⁶In the case of the GATT/WTO reciprocity norm, for example, the worry that conventional market access commitments would prove inadequate to ensure export opportunities in non-market economies was a familiar one in the GATT years. Various countries in the Soviet bloc, such as Poland, Hungary, Romania and Yugoslavia, all joined GATT at a time when their governments remained engaged in central economic planning. Mindful of the potential inadequacy of conventional market access commitments under these conditions, the GATT membership fashioned some special requirements for these accessions (see Thorstensen et al., 2013). The heart of Poland’s market access commitments in its 1967 protocol of accession to GATT, for example, came in the form of a commitment to expand the total value of its imports at a pre-specified annual rate, initially set at 7 per cent per annum and subject to renegotiation periodically thereafter. Interestingly, despite the non-market features of its economy, China’s WTO accession protocol followed the template of a typical market economy protocol and did not set any quantitative targets for Chinese imports akin to those established for Poland years earlier. This approach was based on an assumption that China was in the process of transitioning to a market economy in line with reforms introduced under Deng Xiaoping. In the years since its accession, however, China’s anticipated transition has been halted and, in some ways, reversed under Xi Jinping (see the discussion in Sykes, 2023, ch. 15). As a result, it is now the perception of many observers that the commitments in China’s accession protocol are insufficient to afford reciprocal market access. The perceived problem does not lie to any great extent with a violation of specific commitments in the protocol (see, for example, Wu, 2016, Webster, 2014, and Zhou, 2019). Rather, as suggested above, it is that China has not evolved toward a market economy as its trading partners expected.

from reciprocity increased the aggregate real income of the United States through favorable terms-of-trade improvements, it also amplified the magnitude of the US manufacturing-sector dislocation as we have emphasized, providing the United States with a possible reason to complain about this deviation from reciprocity.

The Options for US Policy Response If China’s deviation from reciprocity exacerbated the China Shock to competing U.S. industries, what options were available to the United States for a response?¹⁷ How did the United States respond? Why did it not do more? We next consider each of these questions in turn.

A preliminary question arises as to what policy instruments to employ in the face of the China shock, including a familiar issue as to whether distributional concerns resulting from trade liberalization are best addressed entirely through domestic policy instruments. We take no position on that issue here, but nevertheless limit our discussion below to commercial policy measures and related actions pursuant to international trade treaties.

With our focus circumscribed in this fashion, our starting point for this discussion is the “problem” that amplified the China Shock, namely, the fact that China over-reciprocated when joining the WTO – its tariff cuts exceeded what was necessary to preserve the terms of trade. In this respect, a useful first observation is that the case of China does not track the usual complaint at the WTO that some member has failed to provide the reciprocal market access that it promised (such as by failing to deliver promised tariff cuts, or frustrating market access expectations with behind the border measures that impede imports). Most WTO obligations are aimed at ensuring market access rather than curtailing it, and nothing in WTO obligations affords a general remedy for the problem of “over-reciprocation.” WTO law does provide options for dealing with injury to import-competing industries, however, as well as limited constraints on certain measures that may contribute to a deterioration in a member’s terms of trade.

One possible reason for deterioration in China’s terms of trade is the existence of subsidies. Subsidization has long been considered “unfair” in the GATT/WTO system when it causes material injury to import-competing firms. From the outset of GATT, members had the authority to use countervailing duties on subsidized imports to offset the effects of injurious subsidies. The WTO Agreement on Subsidies and Countervailing Measures expanded the remedial arsenal to permit legal challenges to subsidy practices at the WTO when they (a) undermine market access into the subsidizing country; (b) injure industries in an importing country; or (c) displace exports of another member to a third country market. An obstacle to employing these remedies in the case of China, however, concerns the meaningfulness of the “subsidy” concept in a non-market economy, where government policy infuses all manner of business decisions, and members of the Communist Party sit on the boards of nominally private firms and influence their behavior. Existing WTO subsidy rules are consequently viewed as ill-equipped to address “subsidization” by China for these reasons, although the United States has used countervailing duties against China as noted below.

Another possible reason for deterioration in China’s terms of trade is currency market intervention. China was clearly intervening in exchange rate markets for many years - the RMB was pegged to the US dollar at a constant rate of 8.28 RMB to the dollar from 1994 through 2005 and was loosely pegged to a basket of currencies thereafter. As noted above, IMF rules contain a concept of “currency manipulation” whereby a member uses exchange market intervention to suppress the value of its currency for the purpose of expanding exports and reducing imports, and China was often accused of manipulation for this purpose. Further, under GATT Article XV(4), countries

¹⁷One might also ask whether the China Shock was genuinely a “shock.” Bombardini, Li and Trebbi (2023) suggest that US politicians did anticipate much of the China Shock when they voted for Permanent Normal Trade Relations.

“shall not, by exchange action, frustrate the intent of the provisions of this Agreement.” But the GATT does not provide guidance as to what sorts of policies would “frustrate” the intent, and the issue has not arisen in formal GATT/WTO jurisprudence. Article XV instead essentially defers to the IMF on these matters, which has proven largely toothless from an enforcement standpoint (see Staiger and Sykes, 2010).

The WTO offers further options for members to address injury to import-competing industries. Under GATT Article XXVIII, the United States could have undertaken to raise its MFN tariffs to ameliorate the China Shock in affected industries. This approach would have required the US to enter negotiations with trading partners (including China) adversely impacted by any such tariff increases to allow them to raise their tariffs in response in accordance with the principle of reciprocity. In principle, such a policy response would have allowed the US to “lock in” the benefits of the improved terms of trade with China while addressing dislocation from the China Shock.

Why did the United States not use this Article XXVIII renegotiation approach in response to the China Shock? A key consideration is the fact that the tariff adjustments would have to be made on an MFN basis, so that numerous US trading partners in addition to China would have been entitled to increase their tariffs in response, potentially doing significant harm to US exporters (though in principle these tariff responses would all be moderated by the reciprocity norm).

An alternative option was to invoke the GATT “escape clause,” or “safeguards” mechanism, to impose temporary protection on behalf of industries affected by the China Shock.¹⁸ To do so would have required a lengthy and cumbersome administrative investigation of each “industry” that would be covered, however, and remedial measures would have been temporary and declining over time. WTO law has also been interpreted in ways that make it difficult to employ safeguard measures that will withstand legal challenge (see Sykes, 2003).

As a final option, the United States could employ “antidumping duties” in response to injurious pricing practices by China that involve price discrimination in favor of the United States, or sales below an approximation of long run average cost. Like countervailing duties, these measures can be initiated unilaterally (although they are subject to limits under WTO law). And in the case of a non-market economy such as China, they allow “costs” or reference prices to be computed based on data from “comparable” market economies, an approach that can be used to generate greater amounts of apparent “dumping.”

The Actual US Response From this menu of options, the United States mostly turned to its antidumping and countervailing duties to raise tariffs (often to prohibitive levels) on imports from China, actions that are permissible under WTO rules without triggering the right of reciprocal actions by trading partners.¹⁹ Both types of duties can only be imposed after lengthy investigations by the Department of Commerce and International Trade Commission and are almost always initiated by private sector petitioners and their attorneys. The US tariff response on this front could

¹⁸Interestingly, with one exception, the United States chose not to utilize the China-specific transitional safeguard that it and other existing WTO members had negotiated as part of China’s 2001 WTO accession protocol. Under that provision, tariffs could be imposed temporarily without reciprocally compensating China (Bown and Crowley, 2010). The exception was the 2009 transitional safeguard the United States imposed on imports of Chinese tires. China immediately retaliated with new antidumping import restrictions on US exports of chicken feet and autos (Bown 2018), suggesting that the United States may not have utilized the China-safeguard out of anticipation that China was unlikely to respect the no-compensation provision.

¹⁹Under its domestic regulations, the United States could not impose countervailing duties on imports from China until it reversed the 1986 Georgetown Steel decision which determined that the countervailing duty law did not apply to non-market economies like China and the former Soviet Union. The Commerce Department changed its view on this issue in 2007, at which point the United States began imposing countervailing duties as well as antidumping duties on non-market economy imports.

not be comprehensive enough to prevent the China Shock, but it was not trivial - the estimated trade coverage of such duties increased from 2 percent of US imports from China at the time of China's 2001 WTO accession to over 7 percent by 2017 (Bown 2018).

Then, beginning in 2018, the United States imposed a variety of new and broader import restrictions on China, rationalized as protecting national security (tariffs on imports of steel and aluminum) and as retaliation for Chinese intellectual property practices. By the end of 2019, roughly two-thirds of US imports from China were covered by some form of special tariffs. China's subsequent tariff retaliation covered more than 50 percent of US exports to China and remained in place under the US-China "Phase One" Trade Agreement with China (Bown 2021).

It is somewhat difficult to characterize these later measures as a response to the China Shock, however, as the bulk of the "shock" occurred years earlier. And even if the 2018-19 import restrictions could be viewed as a reaction to the China Shock, such policies do not directly address injury arising from excessive Chinese exports in sectors where the United States and China are competing exporters in third markets. In such cases, the only direct legal recourse would involve complaints to the WTO dispute settlement process, presumably on the theory that China's competition in third country markets was illegally subsidized. But for the reasons given earlier, such claims would have faced considerable obstacles given the non-market structure of China's economy.

In short, the US response to the China Shock was in significant ways uncoordinated and haphazard. Part of the problem no doubt lies with the reality that international trade rules offer no general remedy for "over-reciprocation" as well as the fact that WTO subsidies rules are difficult to invoke effectively against non-market economies. The antidumping and countervailing duty remedies had the advantage that they could be imposed unilaterally without any need to "compensate" trading partners, but they were available only to industries that were sufficiently organized and willing to bear the litigation costs of pursuing them.

8 Conclusion

The principle of reciprocity plays a central role in GATT/WTO market access negotiations. Motivated by the widespread belief that China has not abided by the norm of reciprocity since joining the WTO in 2001, and by the large loss of manufacturing jobs experienced by the United States after China's WTO accession, we investigate the link between reciprocity in tariff negotiations and the magnitude of the labor-market adjustments that can be expected to arise under tariff negotiations that conform to reciprocity.

In the textbook two-good two-country neoclassical trade model that has helped to illuminate the economic logic of many of GATT's design features, we have observed that a country's own tariff liberalization is a sufficient statistic for the labor-market adjustments it can expect from tariff negotiations that satisfy reciprocity. We have then demonstrated that this property extends to a number of workhorse quantitative trade models where we can provide closed-form expressions for the mapping between reciprocal tariffs and labor market dislocation. Using our theoretical results to guide a quantitative evaluation of reciprocity in the context of China's 2001 accession to the WTO, and focusing on how deviations from reciprocity may have impacted the extent of employment dislocation in the United States and globally, we have found that China did indeed fail to deliver reciprocity, but that in fact the tariff reductions that it implemented after its accession to the WTO *exceeded* the norm of reciprocity. This deviation from reciprocity increased aggregate real incomes in the United States and in the rest of the world through the channel of terms-of-trade improvements, but it also contributed to the magnitude of the China Shock experienced by the United States and other countries.

It is important to note that our quantitative analysis makes three key assumptions with respect to China. First, we assume that China actually implemented the tariff cuts that were specified in its Protocol of Accession. This first assumption is beyond controversy, given the lack of WTO violation complaints against China with claims that China violated its tariff bindings. Second, we assume that China's economy responded to those tariff cuts as would any market economy. This second assumption gets to the question of whether China behaves as a market economy, or rather whether through a web of opaque policy interventions China is able to thwart market forces. We have no measures of China's non-tariff interventions, and so we cannot speak to this question.²⁰ What we can say based on our quantitative findings, however, is this. If in fact China used other policy interventions to blunt the impacts of its agreed tariff commitments, then if those other policy interventions had been addressed and China had been induced to behave like a market economy given its tariff commitments, the US terms of trade would have been improved but the China Shock experienced by the United States would have been even more severe. This brings us to our third key assumption: we have restricted our analysis to consideration of the import tariff cuts agreed by China and its trading partners, putting to the side the many other commitments that WTO members agree to make. Perhaps most relevant for our analysis in the case of China are the commitments to reduce export taxes that China agreed to as part of its Protocol of Accession which, by Lerner symmetry, could be said to have trade effects analogous to and therefore complementary to China's commitments to reduce its import tariffs. Of course, if we had taken these additional commitments into account, they would have only reinforced our finding that China over-liberalized relative to the reciprocity norm.²¹

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²⁰Even if we did have data on Chinese subsidies, it is not clear how those subsidies would impact our results, since as a general matter the impact of production subsidies on the terms of trade is ambiguous and depends on where in the economy the subsidies are applied. As long as these policies were terms-of-trade neutral, our results would go through.

²¹Bond, Duan, Ji and Lu (2023) provide evidence that China offset to some degree the trade impacts of its commitment to reduce export taxes by reducing the rebates of the value added tax (VAT) for its exporters. In this light, it is not clear that accounting for China's export tax commitments would have much of an impact on our quantitative findings, if we were to also account for the VAT rebate changes described by Bond, Duan, Ji and Lu.

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A Appendix: Theory

A.1 Reciprocity in the Dornbusch-Fischer-Samuelson model

As a precursor to the analytical results in the context of the quantitative model that we present in section 3, in this Appendix section we explore the relationship between reciprocity and the China Shock in the two-country (US and China) Ricardian continuum-of-goods model of Dornbusch, Fischer and Samuelson (1977). We work with the version of this model in which trade incurs iceberg transport costs, so that only the fraction $g \leq 1$ units of any good shipped from one country actually arrives in the other country. And we allow each country to impose an ad valorem tariff on the (transport-cost-inclusive) imports from its trading partner, denoting this tariff by τ for the US and τ^* for China.

With $z \in [0, 1]$ indexing goods in order of decreasing US comparative advantage and $a(z)$ and $a^*(z)$ denoting unit labor requirements to produce good z in the US and China, respectively, and with w and w^* denoting any given values for these two countries’ respective wages of labor, we then have the marginal good produced in the US, denoted by \tilde{z} , defined for the wages w and w^* by the condition

$$wa(\tilde{z}) = \frac{w^*a^*(\tilde{z})}{g}(1 + \tau) \Rightarrow \omega = \frac{A(\tilde{z})}{g}(1 + \tau) \quad (54)$$

where $\omega \equiv \frac{w}{w^*}$ and $A(z) \equiv \frac{a^*(z)}{a(z)}$. And similarly, the marginal good produced in China, denoted by \tilde{z}^* , is defined by the condition

$$w^*a^*(\tilde{z}^*) = \frac{wa(\tilde{z}^*)}{g}(1 + \tau^*) \Rightarrow \omega = gA(\tilde{z}^*)\frac{1}{(1 + \tau^*)}. \quad (55)$$

In the absence of transport costs and tariffs (i.e., for $g = 1$ and $\tau = 0 = \tau^*$), (54) and (55) imply that $\tilde{z} = \tilde{z}^* \equiv \tilde{z}$ and all goods are traded, with the range of goods $z \in [0, \tilde{z}]$ produced only in the US and a portion of each good’s production exported to China, and with the range of goods $z \in (\tilde{z}, 1]$ produced only in China and a portion of each good’s production exported to the US. However, as (54) and (55) confirm, with transport costs and/or strictly positive tariffs we have $\tilde{z} > \tilde{z}^*$, and the range of goods $z \in [\tilde{z}^*, \tilde{z}]$ is produced by both countries and is non-traded. Finally, as Dornbusch, Fischer and Samuelson (1977) show, the equilibrium relative wage $\bar{\omega}$ and marginal

goods \bar{z} and \bar{z}^* are then uniquely determined for any value of transport costs g and tariffs τ and τ^* by the conditions (54) and (55) and the requirement of trade balance and world market clearing.

To consider how deviations from reciprocity in tariff reductions would impact the magnitude of the China Shock in this setting, we consider how a change from an initial set of US and China tariffs (τ_0, τ_0^*) to a new set of tariffs (τ_1, τ_1^*) , with $\tau_1 < \tau_0$ and $\tau_1^* < \tau_0^*$, would induce labor reallocation across goods in the US. We focus on the US workers who will lose their jobs to imports from China after the tariff cuts, and who must be reabsorbed into the rest of the US economy. As we will establish, for tariff cuts that are not too large, this corresponds to the set of US workers who were employed in the range of non-traded goods that, after the tariff cuts are implemented, become traded and produced only by China, with a portion of China's production of each of these goods then exported to the US. These are the US workers whose jobs are directly replaced by imports from China as a result of the US and Chinese tariff cuts. Our goal is to characterize how this measure of the China Shock would be impacted if, in response to a reduction in the US tariff from τ_0 to a lower tariff τ_1 , the reduction in China's tariff from τ_0^* to τ_1^* deviated from the reciprocity norm.

We first define reciprocity in the context of this model. To this end, we let $p(z)$ and $p^*(z)$ denote the price of good z in the US and China respectively. And we let $D(z)$ and $D^*(z)$ denote the demand for good z in the US and China respectively, defined implicitly by the Cobb-Douglas budget share $b(z) = \frac{p(z)D(z)}{I} = \frac{p^*(z)D^*(z)}{I^*}$ with I and I^* denoting US and China income levels. We will use the subscripts 0 and 1 to denote equilibrium magnitudes under the tariffs (τ_0, τ_0^*) and (τ_1, τ_1^*) respectively. We also define the world (exporter) price $\hat{p}_0^*(z) \equiv w_0^* a^*(z)$ that would have prevailed for good z under the initial set of tariffs (τ_0, τ_0^*) had this good been sourced from China; similarly, we define the world (exporter) price $\hat{p}_0(z) \equiv w_0 a(z)$ that would have prevailed for good z under the initial set of tariffs (τ_0, τ_0^*) had this good been sourced from the US.²²

We are now ready to define reciprocity in the context of this model. As embodied in (3), we will say that tariff changes satisfy reciprocity for the US if these tariff changes lead to a change in the volume of US imports, measured at initial world prices $\hat{p}_0^*(z)$ for those US import goods, that is equal in magnitude to the change in the volume of US exports, measured at initial world prices $\hat{p}_0(z)$ for those US export goods. Noting that goods $z \in (\bar{z}_0, 1]$ are imported by the US from China under the initial tariffs (τ_0, τ_0^*) while goods $z \in (\bar{z}_1, 1]$ are imported by the US from China under the new tariffs (τ_1, τ_1^*) , and that goods $z \in [0, \bar{z}_0^*)$ are exported by the US to China under the initial tariffs (τ_0, τ_0^*) while goods $z \in [0, \bar{z}_1^*)$ are exported by the US to China under the new tariffs (τ_1, τ_1^*) , tariff changes that conform to reciprocity for the US must then satisfy

$$\int_{\bar{z}_1}^1 \hat{p}_0^*(z) D_1(z) dz - \int_{\bar{z}_0}^1 \hat{p}_0^*(z) D_0(z) dz = \int_0^{\bar{z}_1^*} \hat{p}_0(z) D_1^*(z) dz - \int_0^{\bar{z}_0^*} \hat{p}_0(z) D_0^*(z) dz. \quad (56)$$

The left-hand side of (56) is the change in the volume of US imports from China, where imports of the different goods z are aggregated using the world prices $\hat{p}_0^*(z)$ that would have prevailed under the initial set of tariffs (τ_0, τ_0^*) had these goods initially been sourced from China. The right-hand side of (56) is the change in the volume of US exports to China, where exports of the different goods z are aggregated using the world prices $\hat{p}_0(z)$ that would have prevailed under the initial set of tariffs (τ_0, τ_0^*) had these goods initially been sourced from the US. It is intuitive and easy to show that if (56) is satisfied so that reciprocity holds for the US, then reciprocity must also hold for China.

²²We use the notation $\hat{p}^*(z)$ to emphasize the fact that under the original tariffs (τ_0, τ_0^*) good z might *not* have been sourced from China in equilibrium (and would not have been if $\bar{z}_1 < \bar{z}_0$ and $z \in (\bar{z}_1, \bar{z}_0)$), and hence that $\hat{p}^*(z)$ need not equal $p_0^*(z)$. An analogous statement applies to our use of the notation $\hat{p}(z)$.

To derive the implications of reciprocity, we first write down the US balanced trade condition at the initial tariffs (τ_0, τ_0^*) and at the new tariffs (τ_1, τ_1^*) respectively:

$$\begin{aligned} \int_{\bar{z}_0}^1 p_0^*(z) D_0(z) dz &= \int_0^{\bar{z}_0^*} p_0(z) D_0^*(z) dz \\ \int_{\bar{z}_1}^1 p_1^*(z) D_1(z) dz &= \int_0^{\bar{z}_1^*} p_1(z) D_1^*(z) dz. \end{aligned} \tag{57}$$

Noting that for $z \in [\bar{z}_0, 1]$ we have $p_0^*(z) = w_0^* a^*(z) \equiv \hat{p}_0^*(z)$ while for $z \in [0, \bar{z}_0^*]$ we have $p_0(z) = w_0 a(z) \equiv \hat{p}_0(z)$, we can substitute the top line of (57) into the reciprocity condition (56), yielding

$$\int_{\bar{z}_1}^1 \hat{p}_0^*(z) D_1(z) dz = \int_0^{\bar{z}_1^*} \hat{p}_0(z) D_1^*(z) dz,$$

or, using the definitions of $\hat{p}_0^*(z)$ and $\hat{p}_0(z)$,

$$\int_{\bar{z}_1}^1 a^*(z) D_1(z) dz = \bar{\omega}_0 \int_0^{\bar{z}_1^*} a(z) D_1^*(z) dz. \tag{58}$$

And rewriting the bottom line of (57) as

$$\int_{\bar{z}_1}^1 a^*(z) D_1(z) dz = \bar{\omega}_1 \int_0^{\bar{z}_1^*} a(z) D_1^*(z) dz,$$

and substituting into (58) yields

$$[\bar{\omega}_1 - \bar{\omega}_0] \int_0^{\bar{z}_1^*} a(z) D_1^*(z) dz = 0. \tag{59}$$

Hence, according to (59), as long as trade volumes remain positive, tariff changes that satisfy the reciprocity condition (56) will hold fixed $\bar{\omega}$, the relative wage between the US and China. From here, it is straightforward to confirm using (56) that if China's tariff cuts fall short of reciprocating the US tariff cuts so that the left-hand side of (56) is greater than the right-hand side, then $\bar{\omega}$ must fall, while if China's tariff cuts exceed the cuts necessary to reciprocate the US tariff cuts so that the left-hand side of (56) is less than the right-hand side, then $\bar{\omega}$ must rise. We summarize with:

Proposition A1. *Tariff changes that conform to reciprocity in the Dornbusch, Fischer and Samuelson (1977) model hold fixed the relative wage $\bar{\omega}$. If a country's tariff cuts fall short of (exceed) those necessary to reciprocate the tariff cuts of its trading partner, its relative wage will rise (fall).*

To understand what deviations from reciprocity imply for labor reallocation in the US, recall that at the initial tariffs (τ_0, τ_0^*) the range of goods $z \in [0, \bar{z}_0^*]$ are US export goods, the range of goods $z \in (\bar{z}_0^*, \bar{z}_0)$ are non-traded goods, and the range of goods $z \in [\bar{z}_0, 1]$ are US import goods, where \bar{z}_0 and \bar{z}_0^* are defined by (54) and (55), respectively, evaluated at the initial tariffs (τ_0, τ_0^*) . Restricting attention to changes from the initial tariffs (τ_0, τ_0^*) to a new set of tariffs (τ_1, τ_1^*) that preserve the ordering $\bar{z}_0^* \leq \bar{z}_1^* \leq \bar{z}_1 \leq \bar{z}_0$, a restriction which is guaranteed to hold if the tariff cuts in moving from (τ_0, τ_0^*) to (τ_1, τ_1^*) are not too large (or for any tariff cuts provided the deviation from reciprocity is not too large), we can then partition goods into five ranges: goods $z \in [0, \bar{z}_0^*]$,

which are US export goods under the initial tariffs that remain US export goods under the new tariffs; goods $z \in (\bar{z}_0^*, \bar{z}_1^*]$, which are non-traded goods under the initial tariffs that become US export goods under the new tariffs; goods $z \in (\bar{z}_1^*, \bar{z}_1]$, which are non-traded goods under the initial tariffs that continue to be non-traded goods under the new tariffs; goods $z \in (\bar{z}_1, \bar{z}_0)$, which are non-traded goods under the initial tariffs that become US import goods under the new tariffs; and goods $z \in [\bar{z}_0, 1]$, which are US import goods under the initial tariffs that remain US import goods under the new tariffs.

Of these five ranges of goods, the range that corresponds to a China-Shock-like dislocation of US labor is the fourth range of goods $z \in (\bar{z}_1, \bar{z}_0)$. These are the goods that were produced in the US as non-traded goods under the initial tariffs, and are replaced by US imports from China under the new tariffs. So, it is the US labor employed in the production of goods $z \in (\bar{z}_1, \bar{z}_0)$ under the initial tariffs that will be laid off due to increased imports from China and will have to relocate to the production of goods in the range $z \in (0, \bar{z}_1]$ under the new tariffs. Using

$$b(z) = \frac{p_0(z)D_0(z)}{I_0} = \frac{w_0a(z)D_0(z)}{I_0} \text{ for } z \in (\bar{z}_1, \bar{z}_0)$$

under the initial tariffs (τ_0, τ_0^*) , and noting that US income inclusive of tariff revenue under the initial tariffs is given by

$$I_0 = \frac{w_0L}{1 - \frac{\tau_0}{1+\tau_0}[1 - \gamma(\bar{z}_0)]},$$

where $\gamma(\bar{z}_0) \equiv \int_0^{\bar{z}_0} b(z)dz$ and $[1 - \gamma(\bar{z}_0)]$ is therefore the share of US income spent on imports from China, we have that the labor employed in the US to produce any good $z \in (\bar{z}_1, \bar{z}_0)$ under the initial tariffs (τ_0, τ_0^*) is given by

$$a(z)D_0(z) = \frac{L}{1 - \frac{\tau_0}{1+\tau_0}[1 - \gamma(\bar{z}_0)]}b(z).$$

Hence, the amount of US labor that will be laid off as a result of the China Shock is given by

$$\begin{aligned} LAYOFF &= \int_{\bar{z}_1}^{\bar{z}_0} a(z)D_0(z)dz \\ &= L \times \frac{1}{1 - \frac{\tau_0}{1+\tau_0}[1 - \gamma(\bar{z}_0)]} \int_{\bar{z}_1}^{\bar{z}_0} b(z)dz, \end{aligned}$$

or, expressed as a fraction of the US labor force,

$$\mathcal{L}(\bar{z}_1) \equiv \frac{1}{1 - \frac{\tau_0}{1+\tau_0}[1 - \gamma(\bar{z}_0)]} \int_{\bar{z}_1}^{\bar{z}_0} b(z)dz, \quad (60)$$

with $\mathcal{L}(\bar{z}_1)$ decreasing in \bar{z}_1 , and with the impact of the level of the new tariffs (τ_1, τ_1^*) on US layoffs \mathcal{L} traveling only through the impact of the new tariffs on \bar{z}_1 .²³ We summarize with:

²³Of the other four ranges of goods, the only range that could possibly be associated with a decline in US employment is the range of goods $z \in (\bar{z}_1^*, \bar{z}_1]$, which are non-traded goods under the original tariffs that continue to be non-traded goods under the new tariffs. Arguing as above, it can be shown that for goods in this range we have US employment given by $a(z)D_0(z) = \frac{L}{1 - \frac{\tau_0}{1+\tau_0}[1 - \gamma(\bar{z}_0)]}b(z)$ under the original tariffs and by $a(z)D_1(z) = \frac{L}{1 - \frac{\tau_1}{1+\tau_1}[1 - \gamma(\bar{z}_1)]}b(z)$ under the new tariffs, implying that

$$a(z)D_1(z) \lesseqgtr a(z)D_0(z) \text{ as } \frac{[1 - \gamma(\bar{z}_1)]}{[1 - \gamma(\bar{z}_0)]} \lesseqgtr \frac{[\tau_0/(1 + \tau_0)]}{[\tau_1/(1 + \tau_1)]}.$$

Proposition A2. *Provided that the tariff cuts from initial tariffs (τ_0, τ_0^*) to the new tariffs (τ_1, τ_1^*) are not too large, the fraction of the home-country labor force that will be laid off due to increased imports and will have to relocate to the production of other goods under the new tariffs is given by $L(\bar{z}_1) \equiv \frac{1}{1 - \frac{\tau_0}{1 + \tau_0} [1 - \gamma(\bar{z}_0)]} \int_{\bar{z}_1}^{\bar{z}_0} b(z) dz$. Moreover, home-country layoffs $L(\bar{z}_1)$ are decreasing in \bar{z}_1 , and the impact of the new tariffs on home-country layoffs travels only through the impact of the new tariffs on \bar{z}_1 .*

We are now ready to assess what deviations from reciprocity imply for labor reallocation in the US. To this end, we rearrange the expression in (54) to obtain

$$A(\bar{z}) = \bar{\omega}(\tau, \tau^*) \frac{g}{(1 + \tau)}. \quad (61)$$

Recalling that A is a decreasing function, and recalling from Proposition A1 that tariff changes that conform to reciprocity hold fixed the relative wage $\bar{\omega}$, while if a country's tariff cuts fall short of (exceed) those necessary to reciprocate the tariff cuts of its trading partner, its relative wage will rise (fall), we can use (61) to assess what deviations from reciprocity imply for labor reallocation in the US.

In particular, it follows from (61) that if the reduction in τ^* more than reciprocates the reduction in τ , then $\bar{\omega}(\tau_1, \tau_1^*) > \bar{\omega}(\tau_0, \tau_0^*)$ and \bar{z}_1 will be lower than if the reduction in τ^* reciprocates the reduction in τ and $\bar{\omega}(\tau_1, \tau_1^*) = \bar{\omega}(\tau_0, \tau_0^*)$. And by Proposition A2, it then follows that in this case home-country layoffs $\mathcal{L}(\bar{z}_1)$ will be larger than they would have been if the foreign country had reciprocated the reduction in the home-country tariff with its own tariff reduction. Similarly, it follows from (61) that if the reduction in τ^* falls short of reciprocating the reduction in τ , then $\bar{\omega}(\tau_1, \tau_1^*) < \bar{\omega}(\tau_0, \tau_0^*)$ and \bar{z}_1 will be higher than if the reduction in τ^* reciprocates the reduction in τ and $\bar{\omega}(\tau_1, \tau_1^*) = \bar{\omega}(\tau_0, \tau_0^*)$. And by Proposition A2, it then follows that in this case home-country layoffs $\mathcal{L}(\bar{z}_1)$ will be smaller than they would have been if the foreign country had reciprocated the reduction in the home-country tariff with its own tariff reduction.

We can now summarize:

Proposition A3. *In the Dornbusch, Fischer and Samuelson (1977) model, deviations from reciprocity have implications for the size of labor market disruption associated with tariff liberalization. If the tariff cut of the foreign country falls short of (exceeds) that necessary to reciprocate the tariff cut of the home country, home-country labor market dislocation will be dampened (amplified) compared to the labor market dislocation that the home country would experience under a reciprocal tariff cut from the foreign country.*

We may also state the following:

Corollary. *In the Dornbusch, Fischer and Samuelson (1977) model, a country's own tariff changes are a sufficient statistic for calculating the labor market dislocation it will experience as a result of negotiated tariff liberalization with its trading partner if and only if those tariff negotiations conform with the reciprocity norm.*

If $\tau_0 > 0$ and τ_1 is reduced to zero, then US employment in good $z \in (\bar{z}_1^*, \bar{z}_1]$ must fall, but this is due to the elimination of US tariff revenue, not import competition from China per se. And if $\tau_0 > \tau_1 > 0$, US employment in good $z \in (\bar{z}_1^*, \bar{z}_1]$ may rise. For these reasons, we feel justified in excluding the range of goods $z \in (\bar{z}_1^*, \bar{z}_1]$ from our measure of the China Shock.

A.2 Reciprocal Tariff Changes with a Non-Tradable Sector in an Eaton and Kortum World

In this section of the Appendix, we derive the schedule of the reciprocal tariff changes in a two-country Eaton and Kortum (2002) world with a tradable and a non-tradable sector. We first derive the formula in an economy with no intermediate goods and we then extend the formula to an economy with intermediate goods.

The trade balance condition is given by

$$\frac{\pi_{in}^T}{\tau_{in}} X_i^T = \frac{\pi_{ni}^T}{\tau_{ni}} X_n^T. \quad (62)$$

Total expenditure on goods in country i is equal to income, which is the sum of labor income and tariff revenue under the assumption that it is lump-sum transferred to consumers,

$$X_i^T = \alpha \left(w_i L_i + (\tau_{in} - 1) X_i^T \frac{\pi_{in}^T}{\tau_{in}} \right),$$

where as in the main text α is the share of the tradable sector in final consumption. We then rewrite total expenditure as

$$X_n^T = \frac{\alpha w_n L_n \tau_{ni}}{\tau_{ni} - \alpha (\tau_{ni} - 1) \pi_{ni}^T}.$$

And the same condition for country i is given by

$$X_i^T = \frac{\alpha w_i L_i \tau_{in}}{\tau_{in} - \alpha (\tau_{in} - 1) \pi_{in}^T},$$

which can be expressed as

$$X_i^T = \frac{\alpha w_i L_i \tau_{in}}{(1 - \alpha) \tau_{in} + \alpha (1 + (\tau_{in} - 1) \pi_{ii}^T)}. \quad (63)$$

Taking the total differential of the expression of total expenditure in (63), and imposing the reciprocity condition $d \ln w_i = 0$ we obtain

$$d \ln X_i^T = d \ln \tau_{in} - \frac{(1 - \alpha) \tau_{in} + \alpha \pi_{ii}^T \tau_{in}}{(1 - \alpha) \tau_{in} + \alpha (1 + (\tau_{in} - 1) \pi_{ii}^T)} d \ln \tau_{in} - \frac{\alpha (\tau_{in} - 1) \pi_{ii}^T}{(1 - \alpha) \tau_{in} + \alpha (1 + (\tau_{in} - 1) \pi_{ii}^T)} d \ln \pi_{ii}^T. \quad (64)$$

Using the total differential of the domestic expenditure shares $d \ln \pi_{ii}^T = (1 - \pi_{ii}^T) \theta d \ln \tau_{in}$ and taking the total differential of the trade balance condition (62), given by

$$d \ln X_i^T - \frac{\pi_{ii}^T}{1 - \pi_{ii}^T} d \ln \pi_{ii}^T - d \ln \tau_{in} = d \ln X_n^T - \frac{\pi_{nn}^T}{1 - \pi_{nn}^T} d \ln \pi_{nn}^T - d \ln \tau_{ni},$$

we obtain the formula for reciprocal tariff changes with no intermediate goods, given by

$$\frac{d \ln \tau_{ni}}{d \ln \tau_{in}} = \frac{\tau_{in} (1 - \alpha) + \tau_{in} \pi_{ii}^T (\alpha + \theta)}{\tau_{in} (1 - \alpha) + \alpha \pi_{ii}^T (\tau_{in} - 1) + \alpha} \frac{\tau_{ni} (1 - \alpha) + \alpha \pi_{nn}^T (\tau_{ni} - 1) + \alpha}{\tau_{ni} (1 - \alpha) + \tau_{ni} \pi_{nn}^T (\alpha + \theta)}. \quad (65)$$

We may therefore state:

Proposition A4. *In a two-country Eaton and Kortum (2002) world with a non-tradable sector, reciprocal changes in tariffs between country i and country n must satisfy equation (65).*

We now derive the formula for the reciprocal tariff changes with intermediate goods. Total expenditure on goods in country i is given by

$$X_i^T = (1 - \beta) X_i^T \frac{\pi_{in}^T}{\tau_{in}} + \alpha \left(w_i L_i + (\tau_{in} - 1) X_i^T \frac{\pi_{in}^T}{\tau_{in}} \right),$$

where as in the main text β is the share of intermediate goods in output. We then rewrite total expenditure as

$$X_i^T = \frac{\alpha_i w_i L_i \tau_{in}}{(\tau_{in} - 1) (1 - \alpha (1 - \pi_{ii}^T)) + \pi_{ii}^T (1 - \beta) + \beta}.$$

Taking the total differential of the total expenditure expression, using the expressions for the total differential of the trade balance condition and the expenditure shares described previously, we obtain the formula for reciprocal tariff changes, which is given by

$$\frac{d \ln \tau_{ni}}{d \ln \tau_{in}} = \frac{\left[\frac{(1-\beta)(1-\pi_{ii}^T)}{\beta} + \frac{\tau_{in}[1-\alpha(1-\pi_{ii}^T)-\pi_{ii}^T(1-\beta(\theta+1))]}{\tau_{in}-(1-\beta)(1-\pi_{ii}^T)-(1-\beta)\tau_{in}\pi_{ii}^T-\alpha(\tau_{in}-1)(1-\pi_{ii}^T)} \right]}{\left[\frac{(1-\beta)(1-\pi_{nn}^T)}{\beta} + \frac{\tau_{ni}[1-\alpha(1-\pi_{nn}^T)-\pi_{nn}^T(1-\beta(\theta+1))]}{\tau_{ni}-(1-\beta)(1-\pi_{nn}^T)-(1-\beta)\tau_{ni}\pi_{nn}^T-\alpha(\tau_{ni}-1)(1-\pi_{nn}^T)} \right]}. \quad (66)$$

A.3 The Welfare Effects of Reciprocal Tariff Changes in a Two-Country Eaton and Kortum World

In this Appendix section we show that under a reciprocal tariff change, a reduction in tariffs in the two-country model of Eaton and Kortum (2002) is Pareto improving provided that tariffs are positive. Once at least one country reaches free trade, a further reciprocal reduction in tariffs cannot improve welfare in both countries.

To see this result, consider the change in welfare given a change in tariffs that satisfies reciprocity; we know from Proposition 2 that this implies that relative wages and hence world prices are preserved. Welfare in country n is defined as the real income, given by

$$W_n = \frac{w_n L_n + R_n}{P_n}, \quad (67)$$

where $R_n = (\tau_{ni} - 1) X_n \frac{\pi_{ni}}{\tau_{ni}}$ is tariff revenue and $P_n = \Gamma \left(A_n (w_n)^{-\theta} + A_i (w_i \tau_{ni})^{-\theta} \right)^{-1/\theta}$ is the price index in country n (and Γ is a constant). Taking the total differential of equation (67) under reciprocity, we obtain

$$d \ln W_n = \frac{R_n}{(w_n L_n + R_n)} d \ln R_n - \log P_n.$$

Taking the total differential of tariff revenue and the price index, we obtain

$$d \ln R_n = - \frac{\tau_{ni} \pi_{nn}}{(1 - \pi_{nn})(1 + \pi_{nn}(\tau_{ni} - 1))} d \ln \pi_{nn} - \frac{\tau_{ni}}{(1 - \tau_{ni})(1 + \pi_{nn}(\tau_{ni} - 1))} d \ln \tau_{ni},$$

$$d \ln P_n = \pi_{ni} d \ln \tau_{ni}.$$

And using the expression derived in the main text for the total differential of the domestic expenditure shares $d \ln \pi_{nn} = \theta (1 - \pi_{nn}) d \ln \tau_{ni}$, it follows that the change in welfare in country n from a reciprocal change in tariff is given by

$$\frac{d \ln W_n}{d \ln \tau_{ni}} = -(1 + \theta) \frac{(1 - \pi_{nn}) \pi_{nn} (\tau_{ni} - 1)}{1 + \pi_{nn} (\tau_{ni} - 1)}.$$

As this expression confirms, welfare is a decreasing function of tariff changes provided $\tau_{ni} > 1$, and $\pi_{nn} < 1$. In other words, in the absence of terms-of-trade effects from tariff changes, the price effect of a tariff reduction always more than offset the revenue effect of the tariff reduction. In particular, note that at free trade we have that $\left. \frac{d \ln W_n}{d \ln \tau_{ni}} \right|_{\tau_{ni}=1} = 0$, and that if tariffs are negative (subsidy) we obtain that $\left. \frac{d \ln W_n}{d \ln \tau_{ni}} \right|_{\tau_{ni}<1} < 0$. Therefore, given that to achieve reciprocity countries need to change tariffs proportionally, reducing tariffs increases welfare in both countries; namely, reducing tariffs in a reciprocal way is Pareto improving as long as $\tau_{ni} > 1$, and $\tau_{in} > 1$. Once at least one country reaches the zero tariff (free trade) equilibrium, then a further reduction in tariffs does not increase welfare in both countries. Also, the initial level of tariffs as well as the relative country size matters for determining which country first reaches the free trade equilibrium.

We can now summarize with:

Proposition A5. *In a two-country Eaton and Kortum (2002) world, a reciprocal change in tariffs is Pareto improving up to the point that at least one country achieves free trade.*

In the quantitative section of the paper, we compute the schedule of reciprocal tariffs in the economy with a tradable and a non-tradable sector. As in the main text, the final consumption share in the tradable sector is given by α .

Taking the total differential of tariff revenue and the price index, which are given by

$$d \ln R_n = - \frac{\tau_{ni} \pi_{nn}^T (1 - \pi_{nn}^T)^{-1}}{(\alpha [1 + \pi_{nn}^T (\tau_{ni} - 1)] + (1 - \alpha) \tau_{ni})} d \ln \pi_{nn}^T - \frac{\tau_{ni} (1 - \tau_{ni}^{-1})}{(\alpha [1 + \pi_{nn}^T (\tau_{ni} - 1)] + (1 - \alpha) \tau_{ni})} d \ln \tau_{ni},$$

$$d \ln P_n = \alpha (1 - \pi_{nn}^T) d \ln \tau_{ni}.$$

And using the expression derived in the main text for the total differential of the domestic expenditure shares $d \ln \pi_{nn}^T = \theta (1 - \pi_{nn}^T) d \ln \tau_{ni}$, it follows that the change in welfare in country n from a reciprocal change in tariff is given by

$$d \ln W_n = \alpha \left[\frac{(1 - \pi_{nn}^T) [1 - \pi_{nn}^T \theta (\tau_{ni} - 1) - (\alpha [1 + \pi_{nn}^T (\tau_{ni} - 1)] + (1 - \alpha) \tau_{ni})]}{(\alpha [1 + \pi_{nn}^T (\tau_{ni} - 1)] + (1 - \alpha) \tau_{ni})} \right] d \ln \tau_{ni}.$$

Similar to the single sector case, at free trade we have that $\left. \frac{d \ln W_n}{d \ln \tau_{ni}} \right|_{\tau_{ni}=1} = 0$, and that if tariffs are negative (subsidy) we obtain that $\left. \frac{d \ln W_n}{d \ln \tau_{ni}} \right|_{\tau_{ni}<1} < 0$. Hence, Proposition A5. remains the same in the presence of a non-tradable sector.

A.4 Reciprocal Tariff Changes in a Many-Country Many-Sector Eaton and Kortum World

In this Appendix section, we characterize multilateral reciprocal tariff changes for the many-country many-sector Eaton and Kortum (2002) model. We first show the total differential of all equilibrium

conditions in a world with N countries and J sectors. In doing so, we allow all countries to change tariffs in order to achieve multilateral reciprocity, namely we impose that world prices are preserved.

The total differential of prices is given by

$$d \ln P_n^k = \sum_{i=1}^N \pi_{ni}^k d \ln \tau_{ni}^k, \quad (68)$$

and the total differential of the bilateral trade shares is given by

$$d \ln \pi_{in}^k = \theta^k \ln P_i^k - \theta^k d \ln \tau_{in}^k. \quad (69)$$

The total differential of the sectoral total expenditure is

$$d \ln X_n^j = \sum_{k=1}^J \sum_{i=1}^N \frac{\alpha_n^j (\tau_{ni}^j - 1) X_n^k \pi_{ni}^k}{X_n^j \tau_{ni}^k} d \ln X_n^k + \sum_{k=1}^J \sum_{i=1}^N \frac{\alpha_n^j (\tau_{ni}^j - 1) X_n^k \pi_{ni}^k}{X_n^j \tau_{ni}^k} d \ln \pi_{ni}^k + \sum_{k=1}^J \sum_{i=1}^N \frac{\alpha_n^j X_n^k \pi_{ni}^k}{X_n^j \tau_{ni}^k} d \ln \tau_{ni}^k. \quad (70)$$

Finally the labor market clearing condition is given by

$$d \ln w_n = \sum_{k=1}^J \sum_{i=1}^N \frac{X_i^k \pi_{in}^k}{w_n L_n \tau_{in}^k} d \ln X_i^k + \sum_{k=1}^J \sum_{i=1}^N \frac{X_i^k \pi_{in}^k}{w_n L_n \tau_{in}^k} d \ln \pi_{in}^k - \sum_{k=1}^J \sum_{i=1}^N \frac{X_i^k \pi_{in}^k}{w_n L_n \tau_{in}^k} d \ln \tau_{in}^k. \quad (71)$$

We then exploit the fact that the system of equilibrium conditions is square to express the previous equilibrium conditions in matrix form. Starting with prices from equation (68) we obtain,

$$d \ln P = \mathbf{A} d \ln w + \mathbf{B} d \ln \tau.$$

Similarly, we express bilateral trade shares (69) as

$$d \ln \pi = \mathbf{C} \ln P - \mathbf{D} d \ln w - \mathbf{E} d \ln \tau,$$

and plugging the vector of prices we have that

$$\begin{aligned} d \ln \pi &= [\mathbf{C}\mathbf{A} - \mathbf{D}] d \ln w + [\mathbf{C}\mathbf{B} - \mathbf{E}] d \ln \tau \\ &= \mathbf{F} d \ln w + \mathbf{G} d \ln \tau, \end{aligned}$$

with $\mathbf{F} = \mathbf{C}\mathbf{A} - \mathbf{D}$ and $\mathbf{G} = \mathbf{C}\mathbf{B} - \mathbf{E}$. The equilibrium condition for total expenditure (70) can similarly be expressed in matrix notation as

$$\begin{aligned} d \ln X &= \mathbf{H} d \ln w + \mathbf{J} d \ln X + \mathbf{K} d \ln \pi + \mathbf{L} d \ln \tau \\ &= [\mathbf{I} - \mathbf{J}]^{-1} [\mathbf{H} + \mathbf{K}\mathbf{F}] d \ln w + [\mathbf{I} - \mathbf{J}]^{-1} [\mathbf{L} + \mathbf{K}\mathbf{G}] d \ln \tau \\ &= \mathbf{M} d \ln w + \mathbf{N} d \ln \tau, \end{aligned}$$

where $\mathbf{M} = [\mathbf{I} - \mathbf{J}]^{-1} [\mathbf{H} + \mathbf{K}\mathbf{F}]$ and $\mathbf{N} = [\mathbf{I} - \mathbf{J}]^{-1} [\mathbf{L} + \mathbf{K}\mathbf{G}]$. Finally the labor market clearing (or trade balance) under reciprocity (i.e. $d \ln w = 0$) can be expressed as

$$d \ln w = \mathbf{O} d \ln X + \mathbf{P} d \ln \pi - \mathbf{P} d \ln \tau.$$

Using the above expression we get

$$\begin{aligned} d \ln w &= [\mathbf{O}\mathbf{M} + \mathbf{P}\mathbf{F}] d \ln w + [\mathbf{O}\mathbf{N} + \mathbf{P}\mathbf{G} - \mathbf{P}] d \ln \tau \\ &= \mathbf{T} d \ln \tau, \end{aligned}$$

with $\mathbf{T} = \mathbf{Q}^{-1}\mathbf{R}$, and where $\mathbf{Q} = [\mathbf{I} - (\mathbf{OM} + \mathbf{PF})]^{-1}$ and $\mathbf{R} = [\mathbf{ON} + \mathbf{PG} - \mathbf{P}]$. Therefore, reciprocity satisfies

$$\mathbf{T}d\ln\tau = 0.$$

We next impose that $d\ln w = 0$ for all n and solve for the null space. Let $N^* \times J^*$ be the number of instruments allowed to vary (for instance, sectoral MFN tariffs). The number of linearly independent vectors that span the solution space is given by

$$(N^* \times J^*) - (N - 1)$$

and there exists at least one solution if and only if

$$(N^* \times J^*) - (N - 1) > 0.$$

We can now summarize with:

Proposition A6. *In a many-(N)-country many-(J)-sector Eaton and Kortum (2002) world, changes in tariffs that satisfy multilateral reciprocity for all countries are characterized by $\mathbf{T}d\ln\tau = 0$ with $\mathbf{T} = \mathbf{Q}^{-1}\mathbf{R}$ where $\mathbf{Q} = [\mathbf{I} - (\mathbf{OM} + \mathbf{PF})]^{-1}$ and $\mathbf{R} = [\mathbf{ON} + \mathbf{PG} - \mathbf{P}]$. Moreover, with $N^* \times J^*$ denoting the number of tariffs allowed to vary, there exists at least one set of tariff changes that delivers multilateral reciprocity for all countries only if $(N^* \times J^*) > (N - 1)$.*

A.5 The Revenue-Maximizing Tariff for Fixed Terms of Trade in a Two-Country Eaton and Kortum World

In this Appendix section, we derive the formula for the revenue-maximizing tariff for fixed terms of trade in the two-country Eaton and Kortum (2002) model. We begin with the expression for tariff revenue,

$$\frac{(\tau_{ni} - 1) \pi_{ni}}{\tau_{ni}} X_n,$$

which can be written as

$$\frac{(\tau_{ni} - 1) \pi_{ni}}{\tau_{ni}} \frac{w_n \tau_{ni}}{1 + (\tau_{ni} - 1) \pi_{nn}} = \frac{w_n (\tau_{ni} - 1) (1 - \pi_{nn})}{1 + (\tau_{ni} - 1) \pi_{nn}}.$$

Taking logs and totally differentiating, we obtain

$$\frac{d\tau_{ni}}{\tau_{ni} - 1} - \frac{d\pi_{nn}}{1 - \pi_{nn}} - \frac{d\tau_{ni}\pi_{nn} + (\tau_{ni} - 1) d\pi_{nn}}{1 + (\tau_{ni} - 1) \pi_{nn}} = 0,$$

where we use that under reciprocity $d\ln w_n = 0$. Arranging the terms

$$\left(\frac{1}{\tau_{ni} - 1} - \frac{\pi_{nn}}{1 + (\tau_{ni} - 1) \pi_{nn}} \right) d\tau_{ni} = \left(\frac{(\tau_{ni} - 1)}{1 + (\tau_{ni} - 1) \pi_{nn}} + \frac{1}{1 - \pi_{nn}} \right) d\pi_{nn},$$

we obtain

$$\left(\frac{1}{(\tau_{ni} - 1)} \right) \frac{d\tau_{ni}}{\tau_{ni}} = \left(\frac{\pi_{nn}}{1 - \pi_{nn}} \right) \frac{d\pi_{nn}}{\pi_{nn}},$$

and using $d\ln\pi_{ii} = \pi_{ii}\theta(d\ln w_n - d\ln w_i) + (1 - \pi_{ii})\theta d\ln\tau_{in}$ we get

$$\left(\frac{1}{(\tau_{ni} - 1)} \right) d\ln\tau_{ni} = \left(\frac{\pi_{nn}}{1 - \pi_{nn}} \right) (1 - \pi_{nn}) \theta d\ln\tau_{ni},$$

to finally arrive at the formula for the revenue-maximizing tariff for fixed terms of trade in the two-country Eaton and Kortum (2002) model:

$$(\tau_{ni} - 1) = \frac{1}{\pi_{nn}\theta},$$

as reported in the main text.

A.6 Labor Market Dislocation in an Eaton and Kortum World with Sector-Specific Labor

In this section of the Appendix, we derive the labor market dislocation effects of reciprocity and deviation from reciprocity in an Eaton and Kortum (2002) economy with sector-specific labor. As before, the labor market clearing condition in the non-tradable sector is given by

$$w_n^{NT} L_n^{NT} = X_n^{NT},$$

where total expenditure in the non-tradable sector can be written as

$$X_n^{NT} = (1 - \alpha) \left(X_n^T \frac{(\tau_{ni} - 1)(1 - \pi_{nn}^T)}{\tau_{ni}} \right).$$

$$X_n^T = \alpha \left(w_n^{NT} L_n^{NT} + w_n^T L_n^T + X_n^T \frac{(\tau_{ni} - 1)(1 - \pi_{nn}^T)}{\tau_{ni}} \right).$$

Using the fact that $X_n^{NT}/X_n^T = (1 - \alpha)/\alpha$ we get,

$$X_n^{NT} = (1 - \alpha) \left(w_n^{NT} L_n^{NT} + w_n^T L_n^T + X_n^{NT} \frac{\alpha}{1 - \alpha} \frac{(\tau_{ni} - 1)(1 - \pi_{nn}^T)}{\tau_{ni}} \right),$$

or

$$X_n^{NT} = \frac{(1 - \alpha)(w_n^{NT} L_n^{NT} + w_n^T L_n^T)}{\left(1 - \frac{\alpha(\tau_{ni} - 1)(1 - \pi_{nn}^T)}{\tau_{ni}}\right)}.$$

Combining these equations and normalizing, we get

$$w_n^{NT} L_n^{NT} = \frac{(1 - \alpha)(w_n^{NT} L_n^{NT} + w_n^T L_n^T)}{\left(1 - \frac{\alpha(\tau_{ni} - 1)(1 - \pi_{nn}^T)}{\tau_{ni}}\right)}$$

$$w_n^T L_n^T = \pi_{nn}^T X_n^T + \frac{\pi_{in}^T X_i^T}{\tau_{in}}.$$

Using the trade balance condition

$$w_n^T L_n^T = X_n^T \left(\frac{1 + \pi_{nn}^T(\tau_{ni} - 1)}{\tau_{ni}} \right),$$

we therefore have

$$\frac{X_n^T}{X_n^{NT}} = \frac{w_n^T L_n^T}{w_n^{NT} L_n^{NT} \left(\frac{1 + \pi_{nn}^T(\tau_{ni} - 1)}{\tau_{ni}} \right)} = \frac{\alpha}{1 - \alpha}.$$

Hence

$$d\ln \frac{w_n^T}{w_n^{NT}} = d\ln \left(\frac{1 + \pi_{nn}^T (\tau_{ni} - 1)}{\tau_{ni}} \right)$$

implies

$$d\ln \frac{w_n^T}{w_n^{NT}} = \frac{(\tau_{ni} - 1) \pi_{nn}^T}{1 + \pi_{nn}^T (\tau_{ni} - 1)} d\ln \pi_{nn}^T + \frac{\pi_{nn}^T - 1}{1 + \pi_{nn}^T (\tau_{ni} - 1)} d\ln \tau_{ni}$$

or

$$d\ln \frac{w_n^{NT}}{w_n^T} = -\frac{(\tau_{ni} - 1) \pi_{nn}^T}{1 + \pi_{nn}^T (\tau_{ni} - 1)} d\ln \pi_{nn}^T + \frac{1 - \pi_{nn}^T}{1 + \pi_{nn}^T (\tau_{ni} - 1)} d\ln \tau_{ni}$$

Finally, using the total differential for the bilateral expenditure shares

$$d\ln \pi_{nn}^T = - (1 - \pi_{nn}^T) \theta d\ln \omega_n + (1 - \pi_{nn}^T) \theta d\ln \tau_{ni},$$

we arrive at

$$d\ln \frac{w_n^{NT}}{w_n^T} = \frac{(1 - \pi_{nn}^T)}{1 + \pi_{nn}^T (\tau_{ni} - 1)} ((\tau_{ni} - 1) \pi_{nn}^T \theta d\ln \omega_n + (1 - (\tau_{ni} - 1) \pi_{nn}^T \theta) d\ln \tau_{ni}),$$

as reported in note 6.

A.7 Employment Dislocation in an Eaton and Kortum World with Many Countries and Sectors

In this Appendix section we derive an expression for labor market dislocation in a many-country multi-sector Eaton and Kortum (2002) world as in Costinot, Donaldson and Komunjer (2012). Total expenditure in country n and sector j is given by

$$X_n^j = \alpha^j w_n L_n + X_n^j \sum_{i=1}^N \sum_{s=1}^J \alpha^s (\tau_n^s - 1) \frac{\pi_{ni}^s}{\tau_{ni}^s},$$

which can be written as

$$X_n^j = \alpha^j w_n L_n \left[1 - \sum_{i=1}^N \sum_{s=1}^J \alpha^s (\tau_n^s - 1) \frac{\pi_{ni}^s}{\tau_{ni}^s} \right]^{-1}.$$

Market clearing condition in the non-tradable sector is given by

$$w_n L_n^{NT} = X_n^{NT},$$

which can be expressed as

$$w_n L_n^{NT} = w_n L_n \alpha^{NT} \left[1 - \sum_{i=n}^N \sum_{s=1}^J \alpha^s (\tau_{ni}^s - 1) \frac{\pi_{ni}^s}{\tau_{ni}^s} \right]^{-1}.$$

Hence we have

$$\frac{L_n^{NT}}{L_n} = \alpha^{NT} \left[1 - \sum_{i=n}^N \sum_{s=1}^J \alpha^s (\tau_{ni}^s - 1) \frac{\pi_{ni}^s}{\tau_{ni}^s} \right]^{-1},$$

and taking the total differential we get

$$d \ln L_n^{NT} = \frac{L_n^{NT}}{L_n \alpha^{NT}} \left[\sum_{i=1}^N \sum_{s=1}^J \frac{\alpha^s \pi_{ni}^s (\tau_{ni}^s - 1)}{\tau_{ni}^s} d \ln \pi_{ni}^s + \sum_{i=1}^N \sum_{s=1}^J \frac{\alpha^s \pi_{ni}^s}{\tau_{ni}^s} d \ln \tau_{ni}^s \right].$$

Using the following expressions

$$d \ln \pi_{ni}^s = \sum_{m=1}^N \theta^s \pi_{nm}^s d \ln w_m - \theta^s d \ln w_i + \sum_{m=1}^N \theta^s \pi_{nm}^s d \ln \tau_{nm}^s - \theta^s d \ln \tau_{ni}^s,$$

$$d \ln \omega_{ni}^s = \sum_{m=1}^N \pi_{nm}^s d \ln w_m - d \ln w_i,$$

we get

$$\begin{aligned} d \ln L_n^{NT} &= \frac{L_n^{NT}}{L_n} \frac{1}{\alpha_n^{NT}} \left[\sum_{i=1}^N \sum_{s=1}^J \frac{\alpha^s \pi_{ni}^s (\tau_{ni}^s - 1) \theta^s}{\tau_{ni}^s} d \ln \omega_{ni}^s \right] \\ &+ \frac{L_n^{NT}}{L_n} \frac{1}{\alpha_n^{NT}} \left[\sum_{i=1}^N \sum_{s=1}^J \left[\theta^s \pi_{ni}^s \sum_{m=1}^N \frac{\alpha^s \pi_{nm}^s (\tau_{nm}^s - 1)}{\tau_{nm}^s} + \frac{\alpha^s \pi_{ni}^s [1 - \theta^s (\tau_{ni}^s - 1)]}{\tau_{ni}^s} \right] d \ln \tau_{ni}^s \right]. \end{aligned}$$

Finally, using the fact that $d \ln L_n^T = -\frac{L_n^{NT}}{L_n^T} d \ln L_n^{NT}$, we arrive at

$$\begin{aligned} d \ln L_n^T &= -\frac{L_n^{NT}}{L_n^T} \frac{L_n^{NT}}{L_n} \frac{1}{\alpha_n^{NT}} \left[\sum_{i=1}^N \sum_{s=1}^J \frac{\alpha^s \pi_{ni}^s (\tau_{ni}^s - 1) \theta^s}{\tau_{ni}^s} d \ln \omega_{ni}^s \right] \\ &- \frac{L_n^{NT}}{L_n^T} \frac{L_n^{NT}}{L_n} \frac{1}{\alpha_n^{NT}} \left[\sum_{i=1}^N \sum_{s=1}^J \left[\theta^s \pi_{ni}^s \sum_{m=1}^N \frac{\alpha^s \pi_{nm}^s (\tau_{nm}^s - 1)}{\tau_{nm}^s} + \frac{\alpha^s \pi_{ni}^s [1 - \theta^s (\tau_{ni}^s - 1)]}{\tau_{ni}^s} \right] d \ln \tau_{ni}^s \right], \end{aligned}$$

which is the expression reported in the text.

A.8 Within-Sector Employment Dislocation in a Many-Country Eaton and Kortum World

In this Appendix section we derive a formula for the within-sector employment dislocation in a many-country Eaton and Kortum (2002) world. The labor market clearing condition is given by

$$w_n L_n = \pi_{nn} X_n + \sum_{i \neq n} \frac{\pi_{in}}{\tau_{in}} X_i.$$

We then write down the labor market clearing for the subset of varieties that are sold domestically, and the subset of varieties that are exported, namely

$$\begin{aligned} w_n L_{nn} &= \pi_{nn} X_n, \\ \sum_{i \neq n} w_n L_{in} &= \sum_{i \neq n} \frac{\pi_{in}}{\tau_{in}} X_i. \end{aligned}$$

The trade balance condition implies

$$\sum_{i \neq n} \frac{\pi_{in}}{\tau_{in}} X_i = \sum_{i \neq n} \frac{\pi_{ni}}{\tau_{ni}} X_n,$$

and it also implies that

$$\begin{aligned} w_n L_n &= \pi_{nn} X_n + \sum_{i \neq n} \frac{\pi_{in}}{\tau_{in}} X_i \\ &= \pi_{nn} X_n + \sum_{i \neq n} \frac{\pi_{ni}}{\tau_{ni}} X_n, \end{aligned}$$

or

$$w_n L_n = X_n \left(\pi_{nn} + \sum_{i \neq n} \frac{\pi_{ni}}{\tau_{ni}} \right).$$

Hence,

$$L_{nn} = \pi_{nn} \frac{X_n}{w_n} = \frac{\pi_{nn} L_n}{\pi_{nn} + \sum_{i \neq n} \frac{\pi_{ni}}{\tau_{ni}}},$$

and the share of total labor used to produce goods that are sold domestically is given by

$$\frac{L_{nn}}{L_n} = \frac{\pi_{nn}}{\pi_{nn} + \sum_{i \neq n} \frac{\pi_{ni}}{\tau_{ni}}}.$$

Taking the total differential we get

$$d \ln \frac{L_{nn}}{L_n} = d \ln \pi_{nn} - \left(\frac{\pi_{nn} d \ln \pi_{nn} + \sum_{i \neq n} \frac{\pi_{ni}}{\tau_{ni}} (d \ln \pi_{ni} - d \ln \tau_{ni})}{\pi_{nn} + \sum_{i \neq n} \frac{\pi_{ni}}{\tau_{ni}}} \right).$$

Rearranging this expression we obtain

$$d \ln \frac{L_{nn}}{L_n} = \left(\frac{\sum_{i \neq n} \frac{\pi_{ni}}{\tau_{ni}}}{\pi_{nn} + \sum_{i \neq n} \frac{\pi_{ni}}{\tau_{ni}}} \right) (d \ln \pi_{nn} - d \ln \pi_{ni}) + \frac{\sum_{i \neq n} \frac{\pi_{ni}}{\tau_{ni}}}{\pi_{nn} + \sum_{i \neq n} \frac{\pi_{ni}}{\tau_{ni}}} d \ln \tau_{ni}.$$

Using

$$\frac{\pi_{nn}}{\pi_{ni}} = \frac{A_n (w_n)^{-\theta}}{A_i (w_i \kappa_{ni} \tau_{ni})^{-\theta}},$$

where we denote $\omega_{in} = w_i/w_n$ we get

$$\frac{\pi_{nn}}{\pi_{ni}} = \frac{A_n}{A_i (\omega_{in} \kappa_{ni} \tau_{ni})^{-\theta}}.$$

Hence, we have that

$$d \ln \pi_{nn} - d \ln \pi_{ni} = \theta (d \ln \tau_{ni} + d \ln \kappa_{ni} + d \ln \omega_{in}).$$

Therefore, using this expression we get

$$d \ln \frac{L_{nn}}{L_n} = - \frac{\theta}{\pi_{nn} + \sum_{i \neq n} \frac{\pi_{ni}}{\tau_{ni}}} \sum_{i \neq n} \frac{\pi_{ni}}{\tau_{ni}} d \ln \omega_{ni} + \frac{(1 + \theta)}{\pi_{nn} + \sum_{i \neq n} \frac{\pi_{ni}}{\tau_{ni}}} \sum_{i \neq n} \frac{\pi_{ni}}{\tau_{ni}} d \ln \tau_{ni},$$

as reported in the text.

A.9 The Welfare Effects of Reciprocal Tariff Changes in a Two-Country Caliendo and Parro World

In this Appendix section, we show that a reciprocal reduction in tariffs in a two-country world with intermediate goods is Pareto improving as long as both country's tariffs remain non-negative. To establish this, we start from the observation that welfare is impacted by the effects of the change in reciprocal tariffs on prices and tariff revenue. However, as discussed in section 5, with intermediate goods wages can also change to preserve the input bundle costs, and these wage changes will have an additional impact on welfare that needs to be accounted for.

In particular, the change in welfare from the reciprocal change in tariffs in country n is given by

$$d\ln W_n = \frac{w_n L_n}{w_n L_n + R_n} d\ln w_n + \frac{R_n}{w_n L_n + R_n} d\ln R_n - d\ln P_n.$$

Taking the total differential of tariff revenue, the price index, and using the change in wages in country n that preserves the input bundle costs, namely $d\ln w_n = -\frac{(1-\beta)}{\beta} (1 - \pi_{nn}) d\ln \tau_{ni}$, we obtain

$$\frac{d\ln W_n}{d\ln \tau_{ni}} = - \left(\frac{(1 - \pi_{nn}) (\tau_{ni} - 1)}{\beta + (1 - (1 - \beta) \pi_{nn}) (\tau_{ni} - 1)} \right) \left(\frac{\pi_{nn} (1 + \theta)}{1 + \pi_{nn} (\tau_{ni} - 1)} \tau_{ni} + \frac{(1 - \beta)}{\beta} (1 - \pi_{nn}) \right).$$

Therefore, given that to achieve reciprocity countries need to change tariffs proportionally, reducing tariffs starting from any positive tariff levels increases welfare in both countries; that is, reducing tariffs in a reciprocal way is Pareto improving. This elasticity changes sign at free trade, which leads us to establish the following proposition.

Proposition A7. *In a two-country Caliendo and Parro (2015) world, a reciprocal change in tariffs is Pareto improving up to the point that at least one country achieves free trade.*

A.10 Employment Dislocation in a Two-Country Caliendo and Parro World

In this Appendix section we compute an expression for labor market dislocation in the tradable sector in a two country world with intermediate goods.

The labor market clearing conditions in the tradable and non-tradable sectors, respectively, are given by

$$\begin{aligned} w_n L_n^T &= \beta \left(\frac{\pi_{in}^T}{\tau_{in}} X_i^T + \pi_{nn}^T X_n^T \right), \\ w_n L_n^{NT} &= \beta X_i^{NT}. \end{aligned}$$

Total expenditure in the tradable sector is given by

$$X_n^T = (1 - \beta) \left(\frac{\pi_{in}^T}{\tau_{in}} X_i^T + X_n^T \pi_{nn}^T \right) + \alpha \left(w_n L_n + (\tau_{ni} - 1) X_n^T \frac{\pi_{ni}^T}{\tau_{ni}} \right),$$

which applying trade balance can be expressed as

$$X_n^T = \frac{\alpha \left(w_n L_n + (\tau_{ni} - 1) X_n^T \frac{(1 - \pi_{ni}^T)}{\tau_{ni}} \right)}{\left(1 - (1 - \beta) \left(\frac{1 + \pi_{nn}^T (\tau_{in} - 1)}{\tau_{in}} \right) \right)}.$$

The total expenditure in the non-tradable sector is given by

$$X_n^{NT} = \frac{(1-\alpha)}{\beta} \left(w_n L_n + X_n^T \frac{(\tau_{ni} - 1)(1 - \pi_{nn}^T)}{\tau_{ni}} \right).$$

It follows that the relative sectoral expenditures can be expressed as

$$\frac{X_n^T}{X_n^{NT}} = \frac{\frac{\alpha\beta}{(1-\alpha)}}{\left(1 - (1-\beta) \left(\frac{1+\pi_{nn}^T(\tau_{in}-1)}{\tau_{in}} \right) \right)}.$$

Plugging this expression in the non-tradable expenditure function we obtain

$$X_n^{NT} = \frac{(1-\alpha)}{\beta} \left(w_n L_n + X_n^{NT} \frac{\frac{\alpha\beta}{(1-\alpha)} \frac{(\tau_{ni}-1)(1-\pi_{nn}^T)}{\tau_{ni}}}{\left(1 - (1-\beta) \left(\frac{1+\pi_{nn}^T(\tau_{ni}-1)}{\tau_{ni}} \right) \right)} \right),$$

or

$$X_n^{NT} = \frac{\frac{(1-\alpha)}{\beta} w_n L_n}{1 - \frac{\alpha \frac{(\tau_{ni}-1)(1-\pi_{nn}^T)}{\tau_{ni}}}{\left(1 - (1-\beta) \left(\frac{1+\pi_{nn}^T(\tau_{in}-1)}{\tau_{in}} \right) \right)}}.$$

Using the labor market clearing condition for non-tradables we get

$$L_n^{NT} = L_n (1-\alpha) \left[1 - \frac{\alpha (\tau_{ni} - 1) (1 - \pi_{nn}^T)}{(\tau_{ni} - (1-\beta) (1 + \pi_{nn}^T (\tau_{in} - 1)))} \right]^{-1}.$$

Taking the total differential in the tradable sector we obtain

$$\begin{aligned} d\ln L_n^{NT} = & -\frac{L_n^{NT}}{L_n} \frac{\alpha}{(1-\alpha)} \left[\frac{\beta \tau_{in} (\tau_{ni} - 1) \pi_{nn}^T}{(\tau_{in} - (1-\beta) (1 + \pi_{nn}^T (\tau_{in} - 1)))^2} \right] d\ln \pi_{nn}^T \\ & + \frac{L_n^{NT}}{L_n} \frac{\alpha}{(1-\alpha)} \left[\frac{\tau_{ni} \beta (1 - \pi_{nn}^T)}{(\tau_{ni} - (1-\beta) (1 + \pi_{nn}^T (\tau_{ni} - 1)))^2} \right] d\ln \tau_{ni}. \end{aligned}$$

Finally using the total differential of the expenditure shares $d\ln \pi_{nn}^T = (1 - \pi_{nn}^T) \theta (d\ln c_i - d\ln c_n) + (1 - \pi_{nn}^T) \theta d\ln \tau_{ni}$, and defining $d\ln \tilde{\omega}_n = d\ln c_n - d\ln c_i$ we obtain

$$\begin{aligned} d\ln L_n^T = & -\frac{L_n^{NT}}{L_n^T} \frac{\alpha L_n^{NT} \beta}{(1-\alpha) L_n} \left[\frac{(\tau_{ni} - 1) \pi_{nn}^T \tau_{ni} (1 - \pi_{nn}^T) \theta}{(\tau_{ni} - (1-\beta) (1 + (\tau_{ni} - 1) \pi_{nn}^T))^2} \right] d\ln \tilde{\omega}_n \\ & - \frac{L_n^{NT}}{L_n^T} \frac{\alpha L_n^{NT} \beta}{(1-\alpha) L_n} \left[\frac{\tau_{ni} (1 - \pi_{nn}^T) (1 - (\tau_{ni} - 1) \pi_{nn}^T) \theta}{(\tau_{ni} - (1-\beta) (1 + (\tau_{ni} - 1) \pi_{nn}^T))^2} \right] d\ln \tau_{ni}, \end{aligned}$$

as reported in the text.

A.11 Reciprocal Tariffs in an Eaton and Kortum World with Sector-Specific Labor

In this section of the Appendix, we derive the formula for reciprocal tariffs in a two-country Eaton and Kortum (2002) world with sector-specific labor and with a tradable and a non-tradable sector.

Total expenditure in the tradable sector in country n is given by

$$X_n^T = \alpha \left(w_n^T L_n^T + w_n^{NT} L_n^{NT} + (\tau_{ni} - 1) X_n^T \frac{\pi_{ni}^T}{\tau_{ni}} \right),$$

and in the non-tradable sector is given by

$$X_n^{NT} = (1 - \alpha) \left(w_n^T L_n^T + w_n^{NT} L_n^{NT} + (\tau_{ni} - 1) X_n^T \frac{\pi_{ni}^T}{\tau_{ni}} \right).$$

Hence, we have that

$$X_n^{NT} = \frac{1 - \alpha}{\alpha} X_n^T,$$

and therefore, total expenditure in the tradable sector can be re-expressed as

$$X_n^T = w_n^T L_n^T \frac{\tau_{ni}}{1 + \pi_{nn}^T (\tau_{ni} - 1)}.$$

Substituting into the trade balance condition we obtain,

$$w_n^T L_n^T \frac{1 - \pi_{nn}^T}{1 + \pi_{nn}^T (\tau_{ni} - 1)} = w_i^T L_i^T \frac{1 - \pi_{ii}^T}{1 + \pi_{ii}^T (\tau_{in} - 1)}.$$

Total differentiating this trade balance condition and imposing the reciprocity condition $d \ln w_i^T = 0$, we arrive at the formula of reciprocal tariff changes,

$$\frac{d \ln \tau_{ni}}{d \ln \tau_{in}} = \frac{\tilde{\pi}_{ii}^T}{\tilde{\pi}_{nn}^T},$$

which is the same formula as that presented in Proposition 3 for the one-sector case.

A.12 Proof of Proposition 15

Proof of Proposition 15 To prove Proposition 15, we consider the following extension of the definition of reciprocity for country i :

$$w_i^0 (D_{ni}^1 - D_{ni}^0) - w_n^0 (D_{in}^1 - D_{in}^0) = (TB_i^1 - TB_i^0),$$

where TB_i is the trade balance in country i (positive if trade surplus, negative if trade deficit). The trade balance condition in country i at any moment in time is given by

$$w_i^0 D_{ni}^0 - w_n^0 D_{in}^0 = TB_i^0,$$

$$w_i^1 D_{ni}^1 - w_n^1 D_{in}^1 = TB_i^1.$$

Substituting the trade balanced condition at 0 on the reciprocity condition we obtain

$$w_i^0 D_{ni}^1 - w_n^0 D_{in}^1 = TB_i^1,$$

or

$$D_{in}^1 = \frac{w_i^0}{w_n^0} D_{ni}^1 - \frac{TB_i^1}{w_n^0}.$$

Substituting this expression in the other trade balance condition at 1 yields

$$TB_i^1 \left(\frac{1}{w_n^1} - \frac{1}{w_n^0} \right) = \left(\frac{w_i^1}{w_n^1} - \frac{w_i^0}{w_n^0} \right) D_{ni}^1.$$

Finally, normalizing $w_n = 1$, without loss of generality we obtain,

$$\left(\frac{w_i^1}{w_n^1} - \frac{w_i^0}{w_n^0} \right) D_{ni}^1 = 0.$$

Proposition 15 then follows.

B Appendix: Robustness Exercises

In this Appendix, we present alternative robustness exercises. In particular, we recompute the tradable sector employment dislocation effects using alternative measures of tariff rates and base years. We focus on the employment dislocation effects to highlight that under all the alternative measures of tariff rates and base years we consistently find that China exceeded reciprocity. Consequently, this deviation from reciprocity contributed to employment dislocation out of the tradable sector in the rest of the world, as we have discussed in the main text.²⁴

First, we recompute our baseline results using unweighted bilateral sectoral tariffs for China and the rest of the world. The unweighted initial tariff applied by China to the rest of the world in the year 1990 was approximately forty percent, while the unweighted tariff applied by the rest of the world to China was around thirteen percent.

Figure B.1 displays the employment effects in the non-tradable sector of the rest of the world due to the movement in terms of trade resulting from the actual changes in tariffs between China and the rest of the world over the period 1990-2007. Similar to our benchmark result in the main text, the figure shows that employment shifts to the non-tradable sector in the rest of the world.

We then present results taking the model to the year 1995, and evaluating reciprocity using the actual tariff change between China and the rest of the world over the period 1995-2007. The weighted tariffs applied by China to the rest of the world in the year 1995 is approximately twenty four percent while the weighted tariff applied by the rest of the world to China is around sixteen percent.

Figure B.2 displays the employment effects in the non-tradable sector of the rest of the world due to the movement in terms of trade resulting from the actual changes in tariffs between China and the rest of the world over the period 1995-2007. Consistent with our results in the main text, the figure shows that employment shifts to the non-tradable sector in the rest of the world.

We also present results taking the model to the year 1995, and evaluating reciprocity using the actual tariff change between China and the rest of the world over the period 1995-2007, using unweighted bilateral sectoral tariffs applied between China and the rest of the world. The unweighted

²⁴ Additional results on reciprocal tariff schedules and welfare effects using these alternative tariff measures and base years are available upon request.

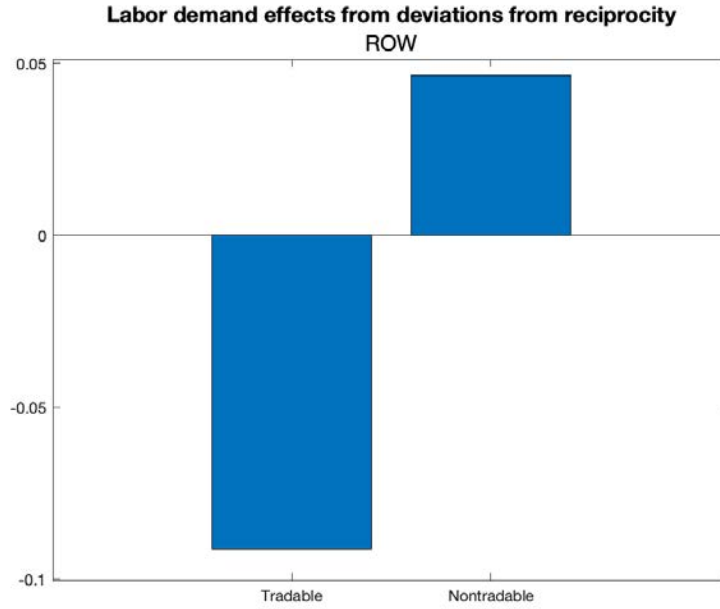


Figure B.1: Employment effects across sectors in the rest of the world

Note: The figure presents the employment effects in the tradable sector and in the non-tradable sector in the rest of the world resulting from deviations from reciprocity due to the actual changes in tariffs between China and the rest of the world over the period 1990-2007. Results are computed using unweighted bilateral sectoral tariffs for China and the rest of the world.

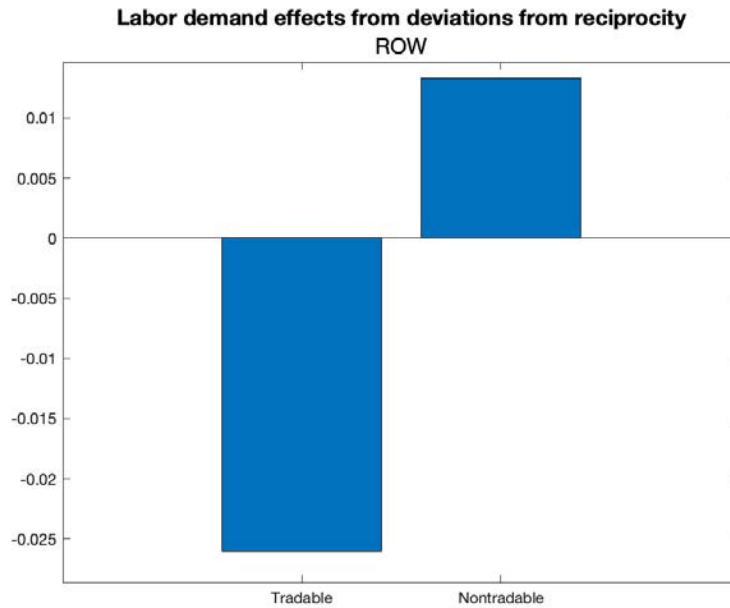


Figure B.2: Employment effects across sectors in the rest of the world

Note: The figure presents the employment effects in the tradable sector and in the non-tradable sector in the rest of the world resulting from deviations from reciprocity due to the actual changes in tariffs between China and the rest of the world over the period 1995-2007. Results are computed using weighted bilateral sectoral tariffs for China and the rest of the world.

tariffs applied by China to the rest of the world is about thirty two percent in the year 1995 while the weighted tariff applied by the rest of the world to China is around thirteen percent.

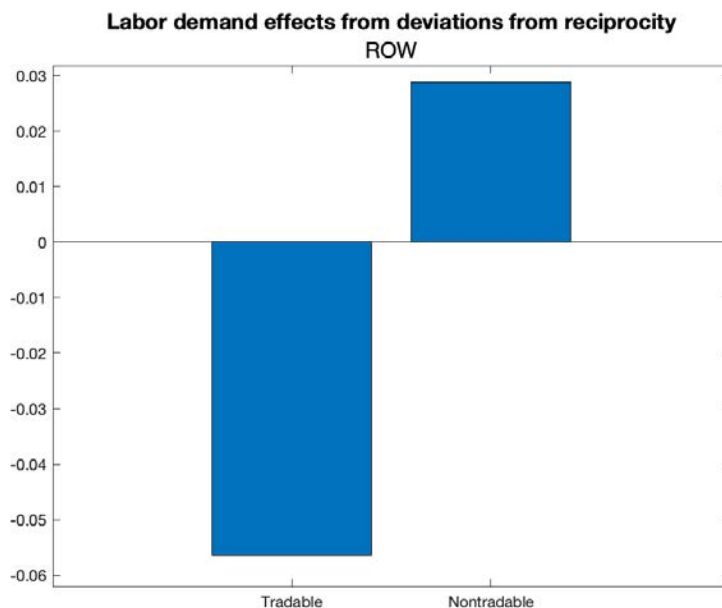


Figure B.3: Employment effects across sectors in the rest of the world

Note: The figure presents the employment effects in the tradable sector and in the non-tradable sector in the rest of the world resulting from deviations from reciprocity due to the actual changes in tariffs between China and the rest of the world over the period 1995-2007. Results are computed using unweighted bilateral sectoral tariffs for China and the rest of the world.

Finally, Figure B.3 displays the employment effects in the non-tradable sector in the rest of the world due to the movement in terms of trade resulting from the actual changes in tariffs between China and the rest of the world over the period 1995-2007, computing unweighted bilateral sectoral tariffs. As in the main text, the figure shows that employment shifts to the non-tradable sector in the rest of the world.

B.1 Additional Results with Intermediate Goods

In this section the Appendix, we present alternative results with intermediate goods. We first recompute our results with intermediate goods using unweighted tariffs. Figure B.4 presents the employment effects of deviation from reciprocity across sectors in the rest of the world. Consistent with our results in the main text, we find that China exceeded reciprocity with respect to the rest of the world, which resulted in employment reallocation to the non-tradable sector in the rest of the world.

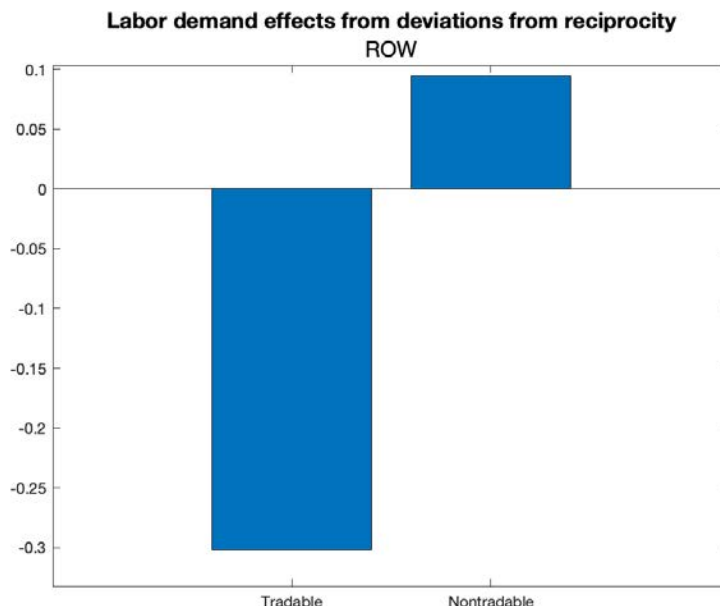


Figure B.4: Employment effects across sectors in the rest of the world

Note: The figure presents the employment effects in the tradable sector and in the non-tradable sector in the rest of the world resulting from deviations from reciprocity due to the actual changes in tariffs between China and the rest of the world over the period 1990-2007. Results are computed in the framework with intermediate goods using unweighted bilateral sectoral tariffs for China and the rest of the world.

We then present the results using the model for the year 1995, and evaluating reciprocity over the period from 1995 to 2007. We first do this using weighted tariffs. Figure B.5 shows the employment effects of deviation from reciprocity across sectors in the rest of the world. Consistent again with our previous results, we find employment reallocated to the non-tradable sector in the rest of the world as a consequence of China exceeding reciprocity.

Finally, we present results using unweighted tariffs, again taking the model to the year 1995 and evaluating reciprocity over the period 1995-2007. Analogously to the previous set of figures, Figure B.6 reports the employment effects of deviation from reciprocity across sectors in the rest of the world. We again find that employment reallocated to the non-tradable sector in the rest of the world as a consequence of China's exceeding reciprocity.

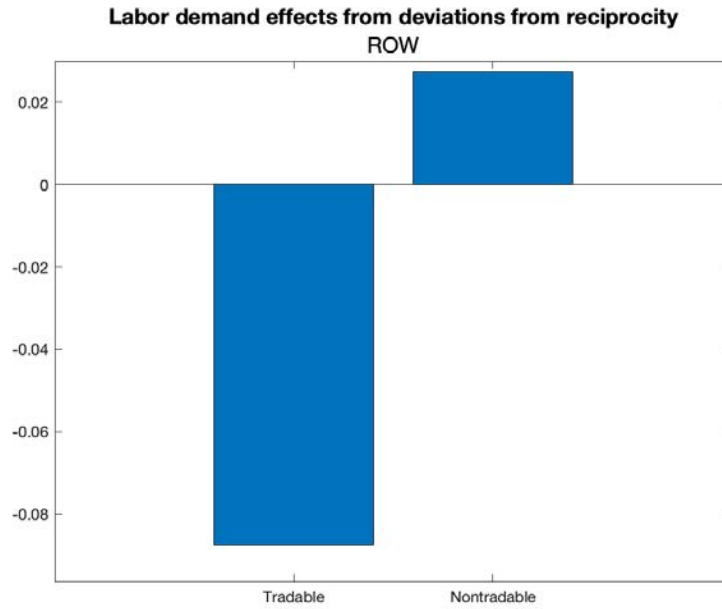


Figure B.5: Employment effects across sectors in the rest of the world

Note: The figure presents the employment effects in the tradable sector and in the non-tradable sector in the rest of the world resulting from deviations from reciprocity due to the actual changes in tariffs between China and the rest of the world over the period 1995-2007. Results are computed in the framework with intermediate goods using weighted bilateral sectoral tariffs for China and the rest of the world.

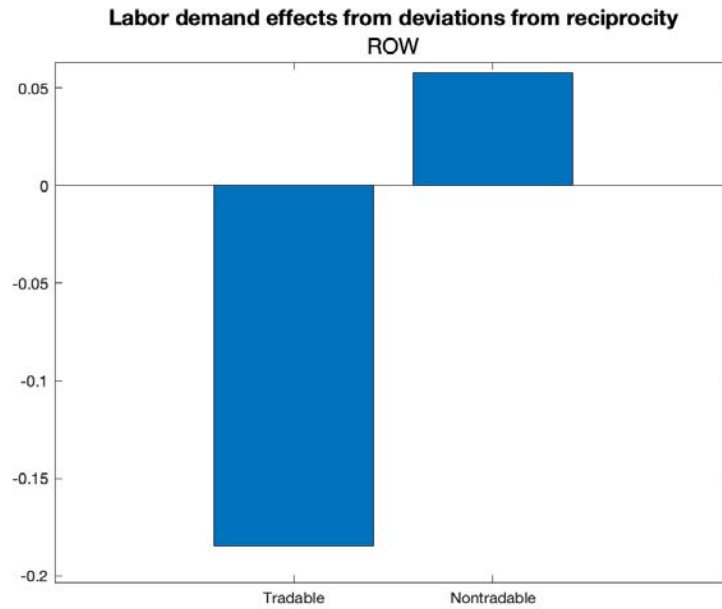


Figure B.6: Employment effects across sectors in the rest of the world

Note: The figure presents the employment effects in the tradable sector and in the non-tradable sector in the rest of the world resulting from deviations from reciprocity due to the actual changes in tariffs between China and the rest of the world over the period 1995-2007. Results are computed in the framework with intermediate goods using unweighted bilateral sectoral tariffs for China and the rest of the world.