Reciprocity and the China Shock*

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Abstract

The principle of reciprocity plays a central role in GATT/WTO market access negotiations. Motivated by the "China Shock" experienced by the United States with the large loss of manufacturing jobs after China's WTO accession, and by the widespread belief that China has not abided by the norm of reciprocity since joining the WTO in 2001, 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. We do this in a sequence of formal models, beginning from the canonical two-good two-country neoclassical trade model that has helped to illuminate the economic logic of many of GATT's design features, and culminating in a number of workhorse quantitative trade models. We then apply our theoretical results to guide a quantitative analysis of the extent to which reciprocity was achieved in the context of China's WTO accession negotiations. We assess how deviations from reciprocity may have impacted the extent of employment dislocation in the United States and globally. Our findings indicate that China did indeed fail to deliver reciprocity, but that in fact the tariff reductions that it implemented after its 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 contributed to 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.

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1 Introduction

When China joined the WTO in 2001, it secured from the United States a promise of Permanent Normal Trade Relations. This promise implied a grant to China on a permanent basis of the US tariff reductions embodied in the on-going phase-ins of market access commitments that had been agreed at the 1995 conclusion of the Uruguay Round of GATT negotiations. In exchange, as the core of its protocol of accession China agreed to a set of 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 investigate the link between reciprocity in tariff negotiations and the magnitude of the *labor-market adjustments* that can be expected to arise with the implementation of the outcomes of negotiations that abide by reciprocity. We do this in a sequence of formal models, beginning from the canonical two-good two-country neoclassical trade model that has helped to illuminate the economic logic of many of GATT's design features, and culminating in a number of workhorse quantitative trade models. We then use the results of this investigation to guide a quantitative analysis of the extent to which reciprocity was achieved between the United States and China – and more broadly between China and the existing WTO membership – in the context of China's WTO accession negotiations. And we assess how deviations from reciprocity in these negotiations may have impacted the "China Shock" experienced by the United States, as embodied in the large loss of US manufacturing jobs after China joined the WTO as first documented by Autor, Dorn and Hanson (2013), as well as how these deviations may have impacted the extent of employment dislocation globally.

We are not the first to point out 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

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

> 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 in the context of the China Shock and also for labor markets globally.

China's accession to the WTO provides a natural case study for the importance of the link between reciprocity in tariff negotiations and the magnitude of the labor-market adjustments that those tariff negotiations will engender, 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 because China's economic size makes its ability to hew to reciprocity in tariff negotiations potentially highly consequential for its trading partners. But the basic issue that 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 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 the implication of reciprocity for the terms of trade. As Bagwell and Staiger (1999, 2002) have argued, adopting a natural formalization of the notion of reciprocity as it occurs in GATT practice leads to the conclusion that (MFN) tariff changes that conform to reciprocity will leave the terms of trade unchanged. Bagwell and Staiger emphasize the terms-of-trade-fixing properties of reciprocity for the implied ability of reciprocity to eliminate inefficient international cost-shifting incentives from each country's tariff choices. We emphasize instead the terms-of-trade-fixing properties of reciprocity for the implied ability of reciprocity to potentially moderate the relative price movements *within* a country that would be expected as the result of negotiated tariff changes, and hence to potentially moderate the size of the labor market reallocations implied by these relative price movements.

We first work out the implications of reciprocity for labor market dislocation in the simplest of settings, the canonical two-good two-country neoclassical trade model. We argue that in the two-good two-country Ricardo-Viner model with labor the mobile factor across sectors, but also in other versions of the neoclassical trade model under appropriate conditions, deviations from reciprocity have implications for the size of labor-market disruption associated with tariff liberalization. In particular, we show that 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.

The intuition for this finding is simple. Since reciprocal tariff cuts leave the terms of trade unchanged, it follows that when the foreign country reciprocates the home-country's tariff cut the relative price of the import-competing good

in the home country declines by exactly the percentage of the home-country's tariff cut. A tariff cut by the foreign country that falls short of (exceeds) this level leads to a decline (improvement) in the home country's terms of trade, and hence – with the relative world price of its import good now higher (lower) – to a decline in the relative price of the import-competing good in the home country that is smaller (larger) in magnitude than would occur under reciprocity. And in the Ricardo-Viner model with labor mobile across sectors that we are considering (and also in other versions of the neoclassical trade model under appropriate conditions), the magnitude of the loss of home-country import-competing jobs due to imports that comes with any negotiated tariff cuts is monotonically increasing in the magnitude of the drop in the relative price of the import-competing good in the home country that those tariff cuts engender.

We also confirm in this setting that 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. This finding is of special interest because of what it implies for assessing the expected labor-market dislocation from tariff negotiations. In particular, it implies that, as long as a country is confident that the outcome of the tariff negotiations it is engaged in will satisfy the reciprocity norm, the country 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 next show how these findings translate into 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 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 analogue of Bagwell and Staiger's (1999, 2002) 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 then characterize reciprocal tariff cuts and interpret their features. And we introduce 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 empirical measure of the labor-market dislocation associated with tariff liberalization.

We derive closed form expressions for this measure of labor-market dislocation in these models 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 nego-

tiated 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 our results confirm 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 our findings from the canonical neoclassical model to the multi-country multi-sector Ricardian trade model.

Finally, we 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 in this setting our earlier results on reciprocity must be qualified, because while it is still true that tariff changes that fix the relative costs of input bundles and hence relative world prices across countries sector-by-sector will satisfy reciprocity, it is now also possible that other 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. Whether these additional ways to satisfy reciprocity exist, and if they do exist what implications they might have for the negotiating countries, will depend on the underlying details of the world economy, and this is an issue we confront in our quantitative analysis.

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. And using the loss of jobs in the tradable sector as our empirical measure 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 findings indicate that China did indeed fail to deliver reciprocity, but that in fact the tariff reductions that it implemented after its 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 for the United Sates the contribution of deviations from reciprocity to changes in the US's tradable sector employment as a result of the Uruguay Round US tariff cuts together with the implementation of China's accession commitments was roughly comparable in magnitude to the contribution of the US's own tariff cuts over this period. And compared with the results with no intermediate goods, we find that the presence of intermediate goods magnified these effects. In this sense, our quantitative results confirm 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 the United States.

Finally, it is important to keep in mind that our quantitative analysis makes two key assumptions with respect to China: first, we assume that China actually implemented the tariff cuts that were specified in its Protocol of Accession; second, we assume that China's economy responded to those tariff cuts as would any market economy. The first assumption is beyond controversy, given the lack of WTO violation complaints against China with claims that China violated its tariff bindings. The second assumption, however, 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.[2] 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.

The remainder of the paper proceeds as follows. In section 2 we provide institutional background on the role of reciprocity in the GATT/WTO, and a brief discussion of the relationship between China, the GATT/WTO, and the more general problem of accommodating non-market economies in trade agreements. In section 3 we illustrate the basics of the link between reciprocity and labor market dislocation in the two-country two-good neoclassical trade model. In section 4 we extend our analytical results to the Ricardian settings of Eaton and Kortum (2002) and its multi-sector extension contained in Costinot, Donaldson and Komunjer (2012), while in section 5 we show how our analytical results can be extended to a world that features intermediate goods and input-output linkages across sectors as in Caliendo and Parro (2015). In section 6 we present our quantitative results. Section 7 offers a brief conclusion. A pair of Appendices present supporting material not included in the body of the paper.

[2] Even 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 where terms-of trade neutral, our results would go through.

2 Institutional Background

In this section we provide institutional background on the role of reciprocity in the GATT/WTO, and a brief discussion of the relationship between China, the GATT/WTO, and the more general problem of accommodating non-market economies in trade agreements.

Reciprocity in 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 value of each country's imports that are roughly equal to changes in the value 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.

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 "retaliation" to preserve 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 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. 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, a focus of our attention 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.[4]

China and GATT/WTO China was a signatory to the original GATT in 1947. Following the communist revolution in 1949, however, China withdrew from GATT, and as a non-member was not legally entitled to the reduced MFN tariff rates that had been negotiated among GATT members. Several GATT members, however, including the United States, eventually afforded China ac-

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

[4] As 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 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.

cess to the MFN GATT rates voluntarily on a temporary basis, subject to periodic renewal. By acceding to GATT in 2001, China put an end to the uncertainty associated with these periodic renewals and, as noted above, established "Permanent Normal Trade Relations" with the entire WTO membership.

China's accession followed a multi-year, complex negotiation regarding the commitments that China would make in return, which were memorialized in its Protocol of Accession. During that process, China's negotiators professed a commitment to achieving a balance of rights and obligations, and thus to the norm of reciprocity. Important aspects of the negotiations were bilateral, as China had to persuade a supermajority of the membership to go along with its admission.

Notwithstanding its nominal commitment to reciprocity, however, various commentators question China's fidelity to this principle. They typically focus on the enormous growth in China's exports of goods and services over the period since its accession (over 14-fold between 2000 and 2021 according to the World Bank) and China's persistent global trade surpluses. A common refrain among the critics is the suggestion that China remains in many respects a non-market economy where government policy dictates the allocation of resources in key sectors rather than market forces. Accordingly, the market access commitments that ensure enhanced export opportunities to market economies – such as tariff reductions – are said to be ineffective in sectors where the Chinese government resists the growth of imports.

The worry that conventional market access commitments will 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. Hungary was allowed to accede on terms more closely resembling those afforded to market economies, by contrast, but only after its government made a commitment to use tariffs as the primary means for controlling import flows. See Kostecki (1974).

Interestingly, China's 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 problem does not lie to any great extent with a violation of specific commitments in the protocol.[5] Rather, as suggested above, it is because China has not evolved toward a market economy as its trading partners expected.

In the quantitative analysis to follow, we will examine in detail the claim that China has failed to achieve reciprocity in its trade relations. In line with the theoretical literature on reciprocity and the theory section of this paper to follow, the effect of China's accession on the terms of trade will be a central focus, along with the attendant implications for labor market dislocation in China's trading partners.

3 Reciprocity and Labor Market Dislocation: Basics

We begin by illustrating the basics of the implications of reciprocity for labor market dislocation in the simplest of settings, the canonical two-good two-country neoclassical trade model. In this model, a country's production in its import-competing sector falls as the country's relative price of the import-competing good falls. Hence, it is natural in this setting to associate labor market dislocation in a country with the loss of import-competing jobs that would be implied by the fall in the country's relative price of the import competing good, an implication that would follow explicitly in a Ricardo-Viner model with labor the mobile factor across sectors but which would also arise in other versions of the neoclassical trade model under the right conditions. To fix ideas, we will focus on the Ricardo-Viner model in the discussion that follows.

3.1 The two-good two-country Ricardo-Viner model

We suppose that the home country imports manufactured goods m from the foreign country and exports services s to the foreign country. All foreign-country variables will be denoted with a "*". The terms of trade between the two countries is given by $\frac{p_m^w}{p_s^w}$, where p_s^w is the "world" (exporter) price of services and p_m^w is the world price of manufactured goods: when $\frac{p_m^w}{p_s^w}$ falls the home country's terms of trade improves and the foreign country's terms of trade worsens, while when $\frac{p_m^w}{p_s^w}$ rises the home country's terms of trade worsens and the foreign country's terms of trade improves.

Our starting point is the implication of reciprocity for the terms of trade $\frac{p_m^w}{p_s^w}$. As Bagwell and Staiger (1999, 2002) have argued, adopting a natural formalization of the notion of reciprocity as it occurs in GATT practice leads to

[5] As Wu (2016) notes, violations of the specific commitments agreed to by China as part of its WTO Protocol of Accession (see WTO, 2001b) can be and have been litigated successfully in the WTO. On China's record of compliance with WTO rulings against it, see Webster (2014) and Zhou (2019).

the conclusion that (MFN) tariff changes that conform to reciprocity will leave the terms of trade unchanged.

More specifically, in the two-good two-country setting considered here, according to Bagwell and Staiger tariff changes conform to GATT's notion of reciprocity if, for each country, these tariff changes would lead to changes in the volume of the country's imports which are equal to the change in the volume of its exports, where imports and exports are converted to common units using the initial world prices. Hence, adopting the home country's perspective for purposes of illustration, the tariff cut offered by the foreign country in its tariff negotiations with the home country would reciprocate the home-country tariff cut if and only if

$$\left(\frac{p_m^w}{p_s^w}\right)^0 \times [M^1 - M^0] = [E^1 - E^0], \tag{1}$$

where the superscript 0 denotes an equilibrium magnitude under the initial tariffs and the superscript 1 denotes an equilibrium magnitude under the new tariffs, and where M denotes the home-country import volume of manufactured goods and E denotes the home-country export volume of services.

As Bagwell and Staiger demonstrate, under the trade balance condition that must hold both under the initial tariffs and under the new tariffs, the reciprocity condition in (1) implies

$$\left[\left(\frac{p_m^w}{p_s^w}\right)^1 - \left(\frac{p_m^w}{p_s^w}\right)^0\right] \times M^1 = 0,$$

and therefore $\left(\frac{p_m^w}{p_s^w}\right)^1 = \left(\frac{p_m^w}{p_s^w}\right)^0$ as long as $M^1 > 0$: the terms of trade $\frac{p_m^w}{p_s^w}$ will not be impacted by these tariff negotiations as long as the tariff cuts agreed to by the two countries conform to reciprocity.[6] And as long as the Lerner Paradox is ruled out, it then also follows that $\frac{p_m^w}{p_s^w}$ must rise and the foreign country's terms of trade improve if the foreign country's tariff cut falls short of the level that would be required to reciprocate the home country's tariff cuts, while $\frac{p_m^w}{p_s^w}$ must fall and the foreign country's terms of trade worsen if the foreign country's tariff cut exceeds the level that would be required to reciprocate the home country's tariff cuts.

[6] We have illustrated this result in the context of a 2-good general equilibrium model in which there is only one relative price, and in this context the implications of reciprocity are particularly stark. Bagwell and Staiger (1999, note 16; and 2016 Online Appendix) extend these implications of reciprocity to a many-good setting where there are many relative prices, and they show that in the many-good setting reciprocity no longer implies that relative world prices must be fixed good by good, but reciprocity does imply that relative world prices must still be fixed in an imported-weighted and export-weighted average sense that defines each country's overall terms of trade in the many-good setting. We will revisit this point in sections 4 and 5 when we present our analytical results in the context of the Eaton and Kortum (2002) and Caliendo and Parro (2015) models. Also, Bagwell and Staiger (2016, p 481) show that these results carry through in the presence of trade imbalances, as long as the size of the trade imbalance does not change. Below we generalize the reciprocity definition in (1) to accommodate changes in trade imbalances.

Bagwell and Staiger (1999, 2002) emphasize the terms-of-trade-fixing properties of reciprocity for the implied ability of reciprocity to eliminate terms-of-trade manipulation and the associated inefficient international cost-shifting incentives from each country's tariff choices. We emphasize here the terms-of-trade-fixing properties of reciprocity for the implied ability of reciprocity to potentially moderate the relative price movements *within* a country that can be expected as the result of negotiated tariff changes, and hence to potentially moderate the size of the labor market dislocation that a country can expect when it engages in tariff negotiations with its trading partners.

In particular, to illustrate the implications that reciprocity has for the magnitude of labor market dislocation associated with tariff negotiations in this setting, we note that the relative price of manufactured goods to services within the home country is given by

$$\frac{p_m}{p_s} = (1+\tau_m) \times \frac{p_m^w}{p_s^w}, \tag{2}$$

where τ_m is the ad valorem tariff imposed by the home country on imports of manufactured goods. And in the Ricardo-Viner model with labor mobile across sectors that we are considering (and also in other versions of the neoclassical trade model under appropriate conditions), the magnitude of the loss of home-country manufacturing jobs that comes with any negotiated tariff cuts is monotonically increasing in the magnitude of the drop in $\frac{p_m}{p_s}$ that accompanies the tariff cuts that the two countries agree to in their negotiations.

With regard to the foreign country's response to the tariff cut agreed to by the home country, there are then three mutually exclusive and exhaustive scenarios: the foreign country's agreed tariff cut satisfies reciprocity (Scenario 1), the foreign country's agreed tariff cut falls short of reciprocity (Scenario 2), or the foreign country's agreed tariff cut exceeds reciprocity (Scenario 3). We consider each scenario in turn.

Scenario 1: The foreign country's tariff cut satisfies reciprocity Suppose first that the foreign country's tariff cut exactly reciprocates the home-country tariff cut. Then $\frac{p_m^w}{p_s^w}$ is left unchanged by the agreed tariff cuts, and using (2) the relative price of manufactured goods to services within the home country changes according to

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

which is negative because of the assumed home-country tariff cut. So in this case, the percentage fall in the relative price of manufactured goods to services in the home country is equal to the percentage reduction in the tariff that the home country agreed to in its negotiations with the foreign country.

We can conclude that under Scenario 1, the home-country loss of manufacturing jobs that accompanies the tariff agreement, as implied by the fall in

the relative price of manufactured goods to services in the home country, is completely determined by the home country's *own* tariff liberalization.

Scenario 2: The foreign country's tariff cut falls short of reciprocity Suppose next that the foreign country's tariff cut falls short of what would be required to reciprocate the home-country tariff cut. Then $\frac{p_m^w}{p_s^w}$ rises with the agreed tariff cuts, and using (2) the relative price of manufactured goods to services within the home country changes according to

$$\begin{aligned} d\log\left(\frac{p_m}{p_s}\right) &= d\log\left(1+\tau_m\right) + d\log\left(\frac{p_m^w}{p_s^w}\right) \\ &> d\log\left(1+\tau_m\right), \end{aligned}$$

which implies that the fall in the relative price of manufactured goods to services within the home country is *dampened* by the foreign country's deviation from reciprocity from what it would be if reciprocity had prevailed. So in this case, the percentage fall in the relative price of manufactured goods to services in the home country is *less than* the percentage reduction in the tariff on home-country imports of manufactured goods that the home country agreed to.

We can conclude that under Scenario 2, the home-country loss of manufacturing jobs that accompanies the tariff agreement, as implied by the fall in the relative price of manufactured goods to services in the home country, is *dampened* by the shortfall of the foreign country's agreed tariff cut relative to the norm of reciprocity, while the home country's terms of trade is *worsened* – and hence aggregate home-country real income is reduced – by this shortfall.

Scenario 3: The foreign country's tariff cut exceeds reciprocity Finally, suppose that the foreign country's tariff cut exceeds what would be required to reciprocate the home-country tariff cut. Then $\frac{p_m^w}{p_s^w}$ falls with the agreed tariff cuts, and using (2) the relative price of manufactured goods to services within the home country changes according to

$$\begin{aligned} d\log\left(\frac{p_m}{p_s}\right) &= d\log\left(1+\tau_m\right) + d\log\left(\frac{p_m^w}{p_s^w}\right) \\ &< d\log\left(1+\tau_m\right), \end{aligned}$$

which implies that the fall in the relative price of manufactured goods to services within the home country is *amplified* by this deviation from reciprocity from what it would be if reciprocity had prevailed. So in this case, the percentage fall in the relative price of manufactured goods to services in the home country is *more than* the percentage reduction in the tariff on home-country imports of manufactured goods that the home country agreed to.

We can conclude that under Scenario 3, the home-country loss of manufacturing jobs that accompanies the tariff agreement, as implied by the fall in the relative price of manufactured goods to services in the home country, is *amplified* by the excessive nature of the foreign country's agreed tariff cut relative to

the norm of reciprocity, while the home country's terms of trade is *improved* – and hence aggregate home-country real income is increased – by this excess.

We can now summarize the implications of reciprocity for labor market dislocation in this setting:

Proposition 1 *In the two-good two-country Ricardo-Viner model with labor the mobile factor across sectors, 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 two-good two-country Ricardo-Viner model with labor the mobile factor across sectors, 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.*

And as we have noted, while we have developed the results recorded in Proposition 1 and its Corollary in the specific context of the Ricardo-Viner model with labor mobile across sectors, these results will also hold in other versions of the neoclassical trade model under appropriate conditions.

The Corollary to Proposition 1 is of special 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 satisfy the reciprocity norm, the country 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 will show that this feature of reciprocity is robust to the variety of extended models of the world economy that we consider below.[7]

3.2 Trade imbalances

Anticipating our exploration of possible deviations from reciprocity as a contributing factor to the magnitude of the China Shock experienced by the United

[7] Interestingly, unlike the implications of reciprocity highlighted by Bagwell and Staiger (1999, 2002) which are preserved in a many country world only when reciprocity is paired with MFN, the particular implication that we emphasize here does not require MFN to hold in a many-country world, provided only that a country can be confident that the negotiated tariff changes will lead to changes in import and export volumes that satisfy (bilateral) reciprocity between it and at least one of its trading partners. This is because in this two-good neoclassical setting, there can only be one relative local price in a country, and if the relative world price between it and one of its trading partners is unchanged by the tariff negotiations, then the country's local relative price change will be pinned down by the change in the country's tariff on imports from that trading partner.

States after China's 2001 accession to the WTO, in this section we extend our analysis of reciprocity to accommodate changes in a country's trade surplus, an important feature of the US-China relationship in the post-China-WTO-accession era. We treat any changes in trade balances 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. We demonstrate that a simple extension of the definition of reciprocity originally proposed by Bagwell and Staiger (1999, 2002) for a world of balanced trade will preserve the world-price-stabilizing consequences of reciprocity in a world where trade imbalances change through time. After presenting our quantitative analysis in section 6 under a notion of reciprocity that mirrors (1), we will return to discuss this extended notion of reciprocity, and consider whether it might resonate with GATT/WTO practice when applied to non-market economies such as China.

For simplicity, throughout this section we maintain our earlier focus on the tariff cuts of a home and a foreign country, with the understanding that in this section we have in mind that the foreign country would represent China and the tariff cuts that we consider would arise in the context of China's WTO accession negotiations.

An extended notion of reciprocity Suppose that the tariff cuts offered by the foreign country would be said to reciprocate the tariff cuts offered by the home country if and only if

$$\left(\frac{p_m^w}{p_s^w}\right)^0 \times [M^1 - M^0] = \left([E^1 - E^0] - [TB^1 - TB^0]\right), \tag{3}$$

where $TB \equiv E - \frac{p_m^w}{p_s^w} M$ denotes the trade balance (surplus if positive, deficit if negative, but no longer restricted to zero) of the home country measured at (contemporaneous) world prices in units of services. To see what the extended notion of reciprocity in (3) implies, consider the case of a rising home-country trade deficit (or, what is the same thing, a rising foreign-country trade surplus); that is, suppose $0 > TB^0 > TB^1$. According to (3), when the home- and foreign-country tariff cuts satisfy this extended notion of reciprocity, the home country's import volume must rise by more than its export volume (where imports and exports are again converted to common units using the initial world prices) to the extent that its trade deficit rises (and in fact by exactly the amount $-[TB^1 - TB^0]$).

Making use of the definitions of TB^0 and TB^1 and substituting these expressions into (3), it is direct to confirm that (3) again implies

$$\left[\left(\frac{p_m^w}{p_s^w}\right)^1 - \left(\frac{p_m^w}{p_s^w}\right)^0\right] \times M^1 = 0,$$

and therefore $\left(\frac{p_m^w}{p_s^w}\right)^1 = \left(\frac{p_m^w}{p_s^w}\right)^0$ as long as $M^1 > 0$. Hence, even if the home

country's trade balance were to change for exogenous reasons after the negotiated agreement were implemented, it would still be true that the terms of trade $\frac{p_m^w}{p_s^w}$ would not change subsequent to the implementation of the agreement as long as, in light of the home country's agreed tariff cuts, the foreign country's tariff cuts conform to the extended notion of reciprocity defined by (3).

Bagwell and Staiger (2016, p 481) observe that the terms-of-trade-stabilizing property of reciprocity as defined by Bagwell and Staiger (1999, 2002) under balanced trade – as recorded in (1) above – generalizes to the case of trade imbalances, provided that the size of the new trade imbalance, measured at the new equilibrium world prices, is the same as the size of the initial trade imbalance, measured at initial equilibrium world prices. This condition would correspond to the requirement that $TB^1 = TB^0$, and comparing (1) with (3) when $TB^1 = TB^0$ confirms Bagwell and Staiger's observation. What (3) provides in addition is the generalization of the reciprocity condition that would preserve the terms-of-trade-stabilizing property even when the size of the trade balance changes.[8]

4 Reciprocity and Labor Market Dislocation: The Eaton and Kortum Model

In the previous section we explored the link between reciprocity in tariff negotiations and labor market dislocation in the two-good two-country neoclassical trade model. 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 6, 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). This is a special case of the technologies proposed by Dornbusch, Fischer, Samuelson (1977) and Wilson (1980). For the interested reader, in Appendix I 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 on N countries which we index by i, and there is a constant mass of households denoted by $L = (L_1, \ldots, L_N)$ in each country. Goods are produced with a constant-returns-to-scale technology using labor, and we denote by $w = (w_1, \ldots, w_N)$ the vector of wages paid in each country. Traded 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

[8] To be clear, the terms of trade being referred to here are the intratemporal terms of trade between manufactured goods and services that can be manipulated with a classic Johnson (1953-54) optimal tariff. See Costinot, Lorenzoni and Werning (2014) on the incentive to manipulate *inter*temporal terms of trade with capital controls that alter trade imbalances through time.

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 $\kappa_{in} > 1$ for $i \neq n$ and $\kappa_{in} \equiv 1$ for $i = n$. Below we will extend this setup to multiple sectors that we index by j and to the presence of a non-tradable sector, and in section 5 we allow for intermediate goods.

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

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

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

$$p_{in}^w(z) \equiv \frac{p_i(z)}{\tau_{in}} = \frac{w_n \kappa_{in}}{z_n} \tag{4}$$

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 $\phi(z) = \prod_i^N A_i exp\left(\sum_i A_i z_i\right)$ is the joint density of z.

We now proceed to define tariff changes that conform to reciprocity in this setting, and to solve for the implications of reciprocity for changes in world prices. We first do so in the special case of a two-country world, and then extend the analysis to a multi-country world.

4.1 Reciprocity in a two-country world

We consider first a two-country 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. To

define reciprocity, we first define $\hat{p}_{in}^{w0}(z) \equiv \frac{w_n^0 \kappa_{in}}{z_n}$ 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. 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

$$\int_{B_{in}^1} \hat{p}_{in}^{w0}(z) D_i^1(z) \phi(z) dz - \int_{B_{in}^0} \hat{p}_{in}^{w0}(z) D_i^0(z) \phi(z) dz = \int_{B_{ni}^1} \hat{p}_{ni}^{w0}(z) D_n^1(z) \phi(z) dz - \int_{B_{ni}^0} \hat{p}_{ni}^{w0}(z) D_n^0(z) \phi(z) dz. \quad (5)$$

The left-hand side of the reciprocity condition (5) 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 $(\tau_{in}^0, \tau_{ni}^0)$ had these goods initially been sourced from country n. The right-hand side of the reciprocity condition (5) 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 $(\tau_{in}^0, \tau_{ni}^0)$ had these goods initially been sourced from the 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 (5) in a more compact form. In particular, denoting by

$$D_{in} \equiv \int_{B_{in}} \frac{\kappa_{in} D_i(z)}{z} \phi(z) dz \quad (6)$$

the labor content of the volume of country $i's$ imports from country n inclusive of trade costs, we can use (6) and $\hat{p}_{in}^{w0}(z) \equiv \frac{w_n^0 \kappa_{in}}{z_n}$ to express the reciprocity condition (5) equivalently as

$$w_n^0 \left(D_{in}^1 - D_{in}^0 \right) = w_i^0 \left(D_{ni}^1 - D_{ni}^0 \right). \quad (7)$$

According to (7), 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 2 *In a two-country Eaton and Kortum (2002) 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.*

4.1.1 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,

$$\int_{B_{in}^0} p_{in}^{w0}(z) D_i^0(z) \phi(z) dz = \int_{B_{ni}^0} p_{ni}^{w0}(z) D_n^0(z) \phi(z) dz$$

$$\int_{B_{in}^1} p_{in}^{w1}(z) D_i^1(z) \phi(z) dz = \int_{B_{ni}^1} p_{ni}^{w1}(z) D_n^1(z) \phi(z) dz.$$

As with the reciprocity condition, these trade balance conditions can be written in the more compact form using (6) and the definition of $p_{in}^{w0}(z)$:

$$w_n^0 D_{in}^0 = w_i^0 D_{ni}^0, \tag{8}$$

$$w_n^1 D_{in}^1 = w_i^1 D_{ni}^1. \tag{9}$$

As (8) and (9) 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 (8) that must hold under the initial tariffs $(\tau_{in}^0, \tau_{ni}^0)$ into the reciprocity condition (7) and defining $\omega_i \equiv w_i/w_n$ we obtain

$$\omega_i^0 D_{ni}^1 = D_{in}^1. \tag{10}$$

And substituting the trade balance condition (9) that must hold under the new tariffs $(\tau_{in}^1, \tau_{ni}^1)$ into the right-hand side of (10) yields

$$\left(\omega_i^1 - \omega_i^0\right) D_{ni}^1 = 0. \tag{11}$$

Since $D_{ni}^1 > 0$ given that in any country there is a lowest cost supplier under the properties of the Frechet distribution, it follows from (11) 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 3 *In a two-country Eaton and Kortum (2002) world, relative wages are unchanged by reciprocal tariff changes, namely,* $\omega_i^1 - \omega_i^0 = 0$.

In the Ricardian framework considered here, for given iceberg costs and productivities, world (exporter) prices are pinned down by wages as (4) 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 considered in section 3. 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 analogue of the reciprocity-fixes-the-terms-of-trade result that was derived by Bagwell and Staiger (1999, 2002) in the context of a neoclassical trade model.

We therefore may also state:

Corollary *In a two-country Eaton and Kortum (2002) world, the terms of trade is unchanged by reciprocal tariff changes.*

The result in Proposition 3 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 the result in Proposition 3 generalizes to other neoclassical trade models with product differentiation as in Armington (1969).

4.1.2 Reciprocity and the terms of trade with many sectors

Does the result of Proposition 3 extend to a two-country Eaton and Kortum (2002) world with many sectors? Here we extend the analysis to a world with many sectors as in Costinot, Donaldson and Komunjer (2012), and we show that the result extends without qualification.

To this end, we now index 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 $(\tau^0_{in1}, \tau^0_{in2}, ...\tau^0_{inJ}, \tau^0_{ni1}, \tau^0_{ni2}, ...\tau^0_{niJ})$ and $(\tau^1_{in1}, \tau^1_{in2}, ...\tau^1_{inJ}, \tau^1_{ni1}, \tau^1_{ni2}, ...\tau^1_{niJ})$ satisfies reciprocity for country i if and only if

$$\sum_j \int_{B^1_{inj}} \hat{p}^{w0}_{inj}(z) D^1_{ij}(z)\phi(z)dz - \sum_j \int_{B^0_{inj}} \hat{p}^{w0}_{inj}(z) D^0_{ij}(z)\phi(z)dz =$$
$$\sum_j \int_{B^1_{nij}} \hat{p}^{w0}_{nij}(z) D^1_{nj}(z)\phi(z)dz - \sum_j \int_{B^0_{nij}} \hat{p}^{w0}_{nij}(z) D^0_{nj}(z)\phi(z)dz$$

which using $\hat{p}^{w0}_{inj}(z) \equiv \frac{w^0_n \kappa_{inj}}{z_{nj}}$ and

$$D_{inj} \equiv \int_{B_{inj}} \frac{\kappa_{inj} D_{ij}(z)}{z} \phi(z)dz$$

can be rewritten as

$$w_n^0 \left(\sum_j D_{in,j}^1 - \sum_j D_{in,j}^0 \right) = w_i^0 \left(\sum_j D_{ni,j}^1 - \sum_j D_{ni,j}^0 \right).$$

Similarly, the trade balance conditions for country i at the initial tariff schedules $(\tau_{in1}^0, \tau_{in2}^0, ...\tau_{inJ}^0, \tau_{ni1}^0, \tau_{ni2}^0, ...\tau_{niJ}^0)$ and the new tariff schedules $(\tau_{in1}^1, \tau_{in2}^1, ...\tau_{inJ}^1, \tau_{ni1}^1, \tau_{ni2}^1, ...\tau_{niJ}^1)$ are given respectively by,

$$\sum_j \int_{B_{inj}^0} p_{inj}^{w0}(z) D_{ij}^0(z) \phi(z) dz = \sum_j \int_{B_{nij}^0} p_{nij}^{w0}(z) D_{nj}^0(z) \phi(z) dz$$

$$\sum_j \int_{B_{inj}^1} p_{inj}^{w1}(z) D_{ij}^1(z) \phi(z) dz = \sum_j \int_{B_{nij}^1} p_{nij}^{w1}(z) D_{nj}^1(z) \phi(z) dz,$$

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

$$w_n^0 \sum_j D_{in,j}^0 = w_i^0 \sum_j D_{ni,j}^0$$

$$w_n^1 \sum_j D_{in,j}^1 = w_i^1 \sum_j D_{ni,j}^1.$$

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

$$\omega_i^0 \sum_j D_{ni,j}^1 = \sum_j D_{in,j}^1.$$

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

$$\left(\omega_i^1 - \omega_i^0 \right) \sum_j D_{ni,j}^1 = 0 \tag{12}$$

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

Proposition 4 *In a two-country Eaton and Kortum (2002) world with many sectors, relative wages are unchanged by reciprocal tariff changes, namely,* $\omega_i^1 - \omega_i^0 = 0$.

And recalling that, for given iceberg costs and productivities, world prices for each sector are pinned down by wages according to (4), we therefore may also state:

Corollary *In a two-country Eaton and Kortum (2002) world with many sectors, tariff changes that satisfy reciprocity leave the terms of trade unchanged, sector by sector.*

The Corollary to Proposition 4 is notable in part because, unlike in a many-good extension of the neoclassical model considered in section 3 (see note 6), in the Eaton and Kortum (2002) model with many 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-sector case as it is when there is only a single 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-sector case as in the neoclassical model.

4.1.3 Reciprocal tariff changes

We next characterize reciprocal tariff changes in the two-country Eaton and Kortum (2002) model. Armed with this characterization, in Appendix I we then show that a reciprocal reduction in tariffs in this world is Pareto improving as long as both tariffs remain non-negative, and we also characterize reciprocal tariff changes for the many-country many-sector case.

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 in the previous section, 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

$$\pi_{in} = \frac{A_n \left(w_n \tau_{in}\right)^{-\theta}}{A_i \left(w_i\right)^{-\theta} + A_n \left(w_n \kappa_{in} \tau_{in}\right)^{-\theta}}. \tag{13}$$

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

$$\frac{\pi_{in}}{\tau_{in}} X_i = \frac{\pi_{ni}}{\tau_{ni}} X_n. \tag{14}$$

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

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

We can then rewrite total expenditure as

$$X_i = \frac{w_i L_i \tau_{in}}{1 + \pi_{ii}\left(\tau_{in} - 1\right)}. \tag{15}$$

Taking the total differential of the expression for total expenditure in (15) yields

$$dlnX_i = dlnw_i + dln\tau_{in} - \left(\frac{\pi_{ii}\left(\tau_{in} - 1\right) dln\pi_{ii} + \pi_{ii}\tau_{in} dln\tau_{in}}{1 + \pi_{ii}\left(\tau_{in} - 1\right)}\right).$$

Similarly, the total differential of the domestic expenditure share in country i, namely equation (13) when $i = n$, is given by

$$dln\pi_{ii} = (1 - \pi_{ii})\theta \left(dlnw_n - dlnw_i\right) + (1 - \pi_{ii})\, \theta dln\tau_{in}.$$

And taking the total differential of the trade balance condition (14) yields

$$dlnX_i - \frac{\pi_{ii}}{1 - \pi_{ii}} dln\pi_{ii} - dln\tau_{in} = dlnX_n - \frac{\pi_{nn}}{1 - \pi_{nn}} dln\pi_{nn} - dln\tau_{ni}.$$

Using the expressions for total expenditure and domestic expenditure shares in country i, and defining $dln\omega_i = dlnw_i - dlnw_n$, we then obtain

$$dln\omega_i - \left(\frac{\pi_{ii}\left(\tau_{in} - 1\right)}{1 + \pi_{ii}\left(\tau_{in} - 1\right)} + \frac{\pi_{ii}}{1 - \pi_{ii}}\right) dln\pi_{ii} - \left(\frac{\pi_{ii}\tau_{in}}{1 + \pi_{ii}\left(\tau_{in} - 1\right)}\right) dln\tau_{in} =$$
$$- \left(\frac{\pi_{nn}\left(\tau_{ni} - 1\right)}{1 + \pi_{nn}\left(\tau_{ni} - 1\right)} + \frac{\pi_{nn}}{1 - \pi_{nn}}\right) dln\pi_{nn} - \left(\frac{\pi_{nn}\tau_{ni}}{1 + \pi_{nn}\left(\tau_{ni} - 1\right)}\right) dln\tau_{ni}.$$

And using the expressions for $dln\pi_{ii}$ and $dln\pi_{nn}$ 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

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

With Proposition 3 establishing that reciprocal tariff changes leave relative wages unchanged, it follows that such tariff changes must leave the left-hand side of (16) unchanged, leading to the characterization of reciprocal tariff changes that we record in the following proposition:

Proposition 5 *In a two-country Eaton and Kortum (2002) world, reciprocal changes in tariffs between country i and country n must satisfy*

$$\frac{dln\tau_{in}}{dln\tau_{ni}} = \frac{\tilde{\pi}_{nn}}{\tilde{\pi}_{ii}}.$$

The result in Proposition 5 shows that the reciprocal change 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 $\tilde{\pi}_{nn}$. In other words, if country i is larger or less open than country n, then $\tilde{\pi}_{ii} > \tilde{\pi}_{nn}$, and therefore the required change in tariff applied by country i to achieve reciprocity is smaller that that applied by country n. The intuition follows from the fact that a larger country has a greater possibility to affect the terms of trade from a given change in tariffs than a smaller country. Hence, the smaller country needs a bigger change in tariffs to neutralize the terms-of-trade effects from the change in the larger country's tariffs. The same logic applies to the initial level of trade openness. A change in tariffs in an initially more open country will have a smaller impact on its wage, hence requires a bigger change in tariffs to neutralize the terms-of-trade change due to the change in tariffs in the other (less

open) country. It also follows that if countries i and n are symmetric, achieving reciprocity requires the same change in tariffs between both countries, as Proposition 5 implies when $\tilde{\pi}_{ii} = \tilde{\pi}_{nn}$.

Finally, the same logic can be used to explain the fact that there is a continuum set of tariff changes between country i and n that achieve reciprocity; namely, 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 world prices. 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 some good, hence the country can always exploit its "monopoly power" to move its terms of trade. In Appendix I we show (Proposition A4) that a reciprocal reduction in tariffs in this world is Pareto improving as long as both tariffs remain non-negative. We also extend the characterization of reciprocal tariff changes in Proposition 5 to a setting of many countries and many sectors (Proposition A5).

4.1.4 Reciprocity and labor market dislocation in a two-country world

We turn now to discuss the labor market dislocation effects of reciprocity and deviations from reciprocity in the two-country Eaton and Kortum (2002) setting. To this end, we assume that each country has two sectors, a tradable sector modeled as above that we will interpret as the "manufacturing" sector, and a non-tradable sector that we will interpret as the "services" sector, with a constant final consumption share in the tradable sector given by α. We will associate 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.[9] This differs somewhat from the notion of labor market dislocation we considered in section 3 in the context of the two-good two-country neoclassical trade model, and we will return to

[9] We 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. Our measure of labor-market dislocation does not accommodate the possibility of exit from work as emphasized by Autor, Dorn and Hanson, and in this sense it is more compatible with the observation of Feenstra and Sasahara. That said, our measure does not count as dislocated a worker who is displaced by imports but continues to work in the tradable sector as emphasized by Feenstra and Sasahara. But as we discuss further at the end of this section, our measure in the neoclassical analysis of section 3 does count such workers as dislocated, and our analysis of the Dornbusch, Fischer and Samuelson (1977) model in Appendix I adopts an alternative measure of labor-market dislocation that is also more consistent with the Feenstra and Sasahara observation, and there, analogous analytical results to those we derive here are obtained.

discuss this difference at the end of the section.[10]

The labor market clearing condition in the non-tradable sector is given by

$$w_n L_n^{NT} = X_n^{NT}, \tag{17}$$

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

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

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

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

Combining these equations yields

$$\frac{L_n^{NT}}{L_n} = (1-\alpha)\left[1 - \frac{\alpha\,(\tau_{ni}-1)\left(1-\pi_{nn}^T\right)}{\tau_{ni}}\right]^{-1}. \tag{18}$$

Taking the total differential of (18), we obtain

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

Using the total differential for the bilateral expenditure shares

$$dln\pi_{nn}^T = \theta(1-\pi_{nn}^T)\,(dlnw_i - dlnw_n) + \theta\left(1-\pi_{nn}^T\right) dln\tau_{ni},$$

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

$$\begin{aligned} dlnL_n^T = &-\frac{L_n^{NT}}{L_n^T}\frac{L_n^{NT}}{L_n}\frac{1}{(1-\alpha)}\left[\frac{\alpha\left(1-\pi_{nn}^T\right)\pi_{nn}^T\,(\tau_{ni}-1)\,\theta}{\tau_{ni}}\right] dln\omega_n \\ &-\frac{L_n^{NT}}{L_n^T}\frac{L_n^{NT}}{L_n}\frac{1}{(1-\alpha)}\left[\frac{\alpha\left(1-\pi_{nn}^T\right)\left(1-\pi_{nn}^T\,(\tau_{ni}-1)\,\theta\right)}{\tau_{ni}}\right] dln\tau_{ni}. \end{aligned} \tag{19}$$

Equation (19) describes the employment effect in the tradable sector that arises from changes in tariffs. In particular, it describes how deviations from reciprocity that result in changes in the world prices, as reflected by changes

[10] We did not include a non-tradable sector in our two-good two-country neoclassical model of section 3, but if we had done so and had continued to adopt the notion of labor market dislocation considered there, the key findings of section 3 would be preserved under appropriate assumptions that rule out Metzler-Paradox type outcomes (see, e.g., Batra and Naqvi, 1989).

in the relative wage $dln\omega_n$, impact the employment in the tradable sector L_n^T. The coefficient on $dln\omega_n$ 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.[11]

In light of our result in Proposition 4, we can also extend the expression for the employment dislocation in the tradable sector given in (19) to the case of many tradable sectors. For the many-sector case, the analogous expression is given by

$$d\ln L_n^T = -\frac{L_n^{NT}}{L_n^T}\frac{L_n^{NT}}{L_n}\frac{1}{\alpha_n^{NT}}\left[\sum_{s=1}^{J}\frac{\alpha_n^s\left(1-\pi_{nn}^s\right)\pi_{nn}^s\left(\tau_{ni}^s-1\right)\theta^s}{\tau_{ni}^s}\right]d\ln\omega_n^s \qquad (20)$$
$$-\frac{L_n^{NT}}{L_n^T}\frac{L_n^{NT}}{L_n}\frac{1}{\alpha_n^{NT}}\left[\sum_{s=1}^{J}\left[\frac{\alpha_n^s\left(1-\pi_{nn}^s\right)\left(1-\pi_{nn}^s\left(\tau_{ni}^s-1\right)\theta^s\right)}{\tau_{ni}^s}\right]d\ln\tau_{ni}^s\right].$$

This has the same interpretation as (19).

We summarize with:

Proposition 6 *In a two-country Eaton and Kortum (2002) world with a non-tradable sector and many tradable sectors, 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 (2002) world with a non-tradable sector and many tradable sectors, 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.*

[11] As we note, the coefficient on $dln\omega_n$ 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 $dln\omega_n > 0$), 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 (17) 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 6 is intuitive. If country i falls short of (exceeds) reciprocating country $n's$ tariff cuts and as a result country n experiences a deterioration (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 $dln\tau_{ni}$ in (19) – or the coefficient on $dln\tau^s_{ni}$ in (20) – 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 $\frac{1}{\theta\pi^T_{nn}}$, which we show in Appendix I 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 6, the coefficient on $dln\tau_{ni}$ 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^T_n. 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 (17). 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^{NT}_n – changes in the same direction as the change in its tariff revenue. And (17) implies that with w_n held fixed L^{NT}_n 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.

Finally, it is worth noting that our focus 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. An alternative and complementary measure might 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. Simply put, these 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 focus here; 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 never-

theless non-traded at the new tariffs). This alternative measure of labor-market dislocation is closer in spirit to the measure we considered in section 3 in the context of the two-good two-country neoclassical trade model. In Appendix I, we consider this alternative measure in our analysis of the Dornbusch, Fischer and Samuelson (1977) model, and there we show (Proposition A3) that the analogue of the results reported in Proposition 6 and its Corollary continue to apply.

4.2 Reciprocity in a many-country world

We now extend our analysis to a many-country world. We begin by considering a world of three countries, and then extend our results to the N-country case.

4.2.1 Multilateral reciprocity in a three-country world

We first consider a world of three countries, indexed by i, n and r. In what follows we choose the wage of the third country r as the numeraire.

As we observed in section 2, 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 (see also Bagwell, Staiger and Yurukoglu, 2020, who document the importance of multilateral reciprocity as a GATT bargaining norm). We will therefore focus on multilateral reciprocity in this three-country world. 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.

Formally, we say that the change in tariffs implied by the tariff schedules $(\tau^0_{in}, \tau^0_{ir}, \tau^0_{ni}, \tau^0_{nr}, \tau^0_{ri}, \tau^0_{rn})$ and $(\tau^1_{in}, \tau^1_{ir}, \tau^1_{ni}, \tau^1_{nr}, \tau^1_{ri}, \tau^1_{rn})$ satisfies multilateral reciprocity for country i if and only if

$$\begin{aligned}
&\left[\int_{B^1_{in}} \hat{p}^{w0}_{in}(z) D^1_i(z)\phi(z)dz + \int_{B^1_{ir}} \hat{p}^{w0}_{ir}(z) D^1_i(z)\phi(z)dz\right] \\
&\qquad - \left[\int_{B^0_{in}} \hat{p}^{w0}_{in}(z) D^0_i(z)\phi(z)dz + \int_{B^0_{ir}} \hat{p}^{w0}_{ir}(z) D^0_i(z)\phi(z)dz\right] \\
&\qquad\qquad = \\
&\left[\int_{B^1_{ni}} \hat{p}^{w0}_{ni}(z) D^1_n(z)\phi(z)dz + \int_{B^1_{ri}} \hat{p}^{w0}_{ri}(z) D^1_r(z)\phi(z)dz\right] \\
&\qquad - \left[\int_{B^0_{ni}} \hat{p}^{w0}_{ni}(z) D^0_n(z)\phi(z)dz + \int_{B^0_{ri}} \hat{p}^{w0}_{ri}(z) D^0_r(z)\phi(z)dz\right]
\end{aligned}$$

which, using (6) and $\hat{p}_{in}^{w0}(z) \equiv \frac{w_n^0 \kappa_{in}}{z_n}$ can be expressed equivalently as

$$w_n^0 \left(D_{in}^1 - D_{in}^0\right) + w_r^0 \left(D_{ir}^1 - D_{ir}^0\right) = w_i^0([D_{ni}^1 + D_{ri}^1] - [D_{ni}^0 + D_{ri}^0]). \quad (21)$$

Multilateral reciprocity and the terms of trade To see the relative wage implications of tariff changes that conform to multilateral reciprocity in this three-country world, we consider tariff changes that satisfy the multilateral reciprocity condition in (21) for all three countries and proceed as before. In particular, using (21) applied to each country together with each country's (multilateral) trade balance condition at the initial tariff schedules $(\tau_{in}^0, \tau_{ir}^0, \tau_{ni}^0, \tau_{nr}^0, \tau_{ri}^0, \tau_{rn}^0)$ and at the new tariff schedules $(\tau_{in}^1, \tau_{ir}^1, \tau_{ni}^1, \tau_{nr}^1, \tau_{ri}^1, \tau_{rn}^1)$, we obtain the following condition on changes in wages that must hold:

$$\begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix} = \begin{pmatrix} D_{ni}^1 + D_{ri}^1 & -D_{in}^1 & -D_{ir}^1 \\ -D_{ni}^1 & D_{in}^1 + D_{rn}^1 & -D_{nr}^1 \\ -D_{ri}^1 & -D_{rn}^1 & D_{ir}^1 + D_{nr}^1 \end{pmatrix} \begin{pmatrix} w_i^1 - w_i^0 \\ w_n^1 - w_n^0 \\ w_r^1 - w_r^0 \end{pmatrix}.$$

Imposing the numeraire in the system (e.g., $w_r^1 = w_r^0$), it follows that we have two independent conditions

$$\left(D_{ni}^1 + D_{ri}^1\right)(w_i^1 - w_i^0) = D_{in}^1(w_n^1 - w_n^0)$$

$$\left(D_{in}^1 + D_{rn}^1\right)(w_n^1 - w_n^0) = D_{ni}^1(w_i^1 - w_i^0)$$

which require that

$$sign[w_i^1 - w_i^0] = sign[w_n^1 - w_n^0]$$

given that each of the $D^{1\prime}s$ is strictly positive. Finally, adding both conditions together yields

$$\sum_{m=i,n} D_{rm}^1(w_m^1 - w_m^0) = 0, \quad (22)$$

implying that the only solution is $w_m^1 = w_m^0$ for $m = i, n$.

We may therefore state

Proposition 7 *In a three-country Eaton and Kortum (2002) world, relative wages are unchanged by tariff changes that deliver multilateral reciprocity for each country.*

It should be clear from the above that the same steps that allowed us to generalize Proposition 3 to a setting with many sectors in a two-country world will also deliver this generalization in a three-country world. Therefore, we may also state the following:

Corollary *In a three-country Eaton and Kortum (2002) world with many sectors, relative wages are unchanged by tariff changes that deliver multilateral reciprocity for each country.*

4.2.2 Multilateral reciprocity in a many-country world

We now consider the case of N countries, and suppose that country i must satisfy reciprocity multilaterally, with all trading partners, with this condition holding for each country i. As with the three-country case considered above, we say that multilateral reciprocity is satisfied for country i in the case of N countries if the change in the volume of country $i's$ *aggregate* imports, measured at initial world prices, is equal in magnitude to the change in the volume of country $i's$ *aggregate* exports, measured at initial world prices. Following the same steps as above which led to (21) for the three-country case, the condition for multilateral reciprocity for country i in the case of N countries can be written as

$$\sum_{n=1}^{N} w_n^0 \left(D_{in}^1 - D_{in}^0 \right) = w_i^0 \sum_{n=1}^{N} \left(D_{ni}^1 - D_{ni}^0 \right),$$

the analogue of (21) for the N-country case. This multilateral reciprocity condition must hold for all countries.

Trade balance for country i at the initial and new tariffs is given respectively by

$$\sum_{n=1}^{N} w_n^0 D_{in}^0 = w_i^0 \sum_{n=1}^{N} D_{ni}^0$$

$$\sum_{n=1}^{N} w_n^1 D_{in}^1 = w_i^1 \sum_{n=1}^{N} D_{ni}^1.$$

Then, proceeding as before, substituting the trade balance condition at initial tariffs into the condition for multilateral reciprocity yields

$$\sum_{n=1}^{N} \frac{w_n^0}{w_i^0} D_{in}^1 = \sum_{n=1}^{N} D_{ni}^1,$$

while substituting the trade balance condition at new tariffs into the above expression and rearranging yields

$$\sum_{n=1}^{N} D_{in}^1 \left(\frac{w_n^1}{w_i^1} - \frac{w_n^0}{w_i^0} \right) = 0,$$

which is the analogue of (22) for the N-country case.

We may therefore state

Proposition 8 *In a many-country Eaton and Kortum (2002) world, relative wages are unchanged by tariff changes that deliver multilateral reciprocity for each country.*

Again it should be clear from the above that the same steps that allowed us to generalize Proposition 3 to a setting with many sectors in a two-country world will also deliver this generalization in a many-country world, hence we also have:

Corollary *In a many-country Eaton and Kortum (2002) world with many sectors, relative wages are unchanged by tariff changes that deliver multilateral reciprocity for each country.*

4.2.3 Multilateral reciprocity and labor market dislocation in a many-country world

The same steps that led to (20) in the context of our two-country analysis allow us derive an expression for labor market dislocation in a many-country world for an Eaton and Kortum (2002) environment with many countries, many tradable sectors and a non-tradable sector. For this case, the analogous expression to (20) is given by

$$d\ln L_n^T = -\frac{L_n^{NT}}{L_n^T}\frac{L_n^{NT}}{L_n}\frac{1}{\alpha_n^{NT}}\left[\sum_{i=1}^{N}\sum_{s=1}^{J}\frac{\alpha_n^s\pi_{ni}^s\left(\tau_{ni}^s-1\right)\theta^s}{\tau_{ni}^s}\right]d\ln\omega_{ni}^s$$
$$-\frac{L_n^{NT}}{L_n^T}\frac{L_n^{NT}}{L_n}\frac{1}{\alpha_n^{NT}}\left[\sum_{i=1}^{N}\sum_{s=1}^{J}\left[\theta^s\pi_{ni}^s\sum_{m=1}^{N}\frac{\alpha_n^s\pi_{nm}^s\left(\tau_{nm}^s-1\right)}{\tau_{nm}^s}+\frac{\alpha_n^s\pi_{ni}^s\left[1-\theta^s\left(\tau_{ni}^s-1\right)\right]}{\tau_{ni}^s}\right]d\ln\tau_{ni}^s\right]. \tag{23}$$

Armed with (23) and the Corollary to Proposition 8, we may now state:

Proposition 9 *In a many-country Eaton and Kortum (2002) world with a non-tradable sector and many tradable sectors, 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 Eaton and Kortum (2002) world with a non-tradable sector and many tradable sectors, 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.*

5 Reciprocity and Labor Market Dislocation: The Caliendo and Parro Model

In this section we extend the analysis to incorporate intermediate goods as in Caliendo and Parro (2015). 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 $z = (z_1, \ldots, z_N)$ is now available in country i at unit prices

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

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

$$c_i = w_i^{\beta} P_i^{1-\beta}. \tag{24}$$

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

$$p_{in}^w(z) \equiv \frac{p_i(z)}{\tau_{in}} = \frac{c_n \kappa_{in}}{z_n} \tag{25}$$

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. For simplicity, in what follows we focus our attention on a two-country world and only briefly discuss extensions to a many-country world. We also begin by focusing on a world with a single tradable sector, before considering a world with many tradable sectors and input-output linkages across sectors.

5.1 Reciprocity and the terms of trade with intermediate goods

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 (25) and (4) 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 (5), with the only difference that now world prices include the price of intermediate materials. In analogy with (7), therefore, we can write the reciprocity condition in the more compact form

$$c_n^0 \left(D_{in}^1 - D_{in}^o\right) = c_i^0 \left(D_{ni}^1 - D_{ni}^o\right)$$

where the only difference with (7) 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

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

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

Proposition 10 *In a two-country Caliendo and Parro (2015) world, relative input-bundle costs are unchanged by reciprocal tariff changes, namely,* $\tilde{\omega}_i^1 - \tilde{\omega}_i^0 = 0$.

With world prices pinned down by input bundles for given iceberg costs and productivities as (25) reflects, we can also state the following:

Corollary *In a two-country Caliendo and Parro (2015) world, 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 10 and its Corollary extend without qualification to a many-country world. We next move to discuss the implications of reciprocity in a world with intermediate goods and many sectors.

5.2 Reciprocity and the terms of trade with many sectors and intermediate goods

We now consider a world with intermediate goods and also many sectors that we 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

$$c_{i,j} = w_i^{\gamma^j} \prod_k \left(P_i^{kj}\right)^{\gamma^{kj}},$$

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

$$\sum_j \left(c_{n,j}^0 D_{in,j}^1 - c_{n,j}^0 D_{in,j}^0\right) = \sum_j \left(c_{i,j}^0 D_{ni,j}^1 - c_{i,j}^0 D_{ni,j}^0\right).$$

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

$$\sum_j c_{n,j}^0 D_{in,j}^0 = \sum_j c_{i,j}^0 D_{ni,j}^0,$$

$$\sum_j c_{n,j}^1 D_{in,j}^1 = \sum_j c_{i,j}^1 D_{ni,j}^1.$$

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

$$\sum_j \left(c_{n,j}^1 - c_{n,j}^0\right) D_{in,j}^1 - \sum_j \left(c_{i,j}^1 - c_{i,j}^0\right) D_{ni,j}^1 = 0. \tag{26}$$

Notice from (24) that, in the absence of intermediates, we would have $c_{n,j} = w_n$ and $c_{i,j} = w_i$. And with w_n chosen as the numeraire, in this case (26)

would collapse to (12), ensuring that reciprocity fixes the relative wage and therefore the terms of trade sector by sector, as Proposition 4 and its Corollary record. In the presence of intermediates and many sectors and hence input-output linkages across sectors, (26) implies that tariff changes that fix $c_{n,j}$ and $c_{i,j}$ for all j – and hence by (25) fix the terms of trade sector by sector – will satisfy reciprocity. But in the presence of intermediates, much as in the many-good case of the neoclassical model developed in section 3 (see note 6), it is now possible that additional solutions to (26) may also exist in which tariff changes satisfy reciprocity even while leading to changes in $c_{n,j}$ and $c_{i,j}$ 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. Whether these additional solutions to (26) exist, and if they do exist what implications they might have for the negotiating countries, will depend on the underlying details of the world economy, and this is an issue we will confront in our quantitative analysis of section 6.

For now we simply state:

Proposition 11 *In a two-country Caliendo and Parro (2015) world with many sectors and hence input-output linkages across sectors, tariff changes that preserve the terms of trade sector by sector, namely, that ensure* $c_{m,j}^1 - c_{m,j}^0 = 0$ *for* $m = i, n$ *and for all* j*, satisfy reciprocity.*

5.3 Reciprocal tariff changes with intermediate goods

In this section, we characterize reciprocal tariff changes in a world with intermediate goods. To provide a sharp illustration of the role of intermediate goods, we maintain our focus on a world with two countries that as before we denote by i, n, and we return our focus to a single-sector economy.

The bilateral trade shares π_{in} with intermediate goods is given by

$$\pi_{in} = \frac{A_n \left(c_n \tau_{in}\right)^{-\theta}}{A_i \left(c_i\right)^{-\theta} + A_n \left(c_n \kappa_{in} \tau_{in}\right)^{-\theta}}. \tag{27}$$

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

$$\frac{\pi_{in}}{\tau_{in}} X_i = \frac{\pi_{ni}}{\tau_{ni}} X_n. \tag{28}$$

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

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

Using the trade balance condition (28), we express total expenditure in country i as

$$X_i = \frac{w_i L_i \tau_{in}}{\beta \left(1 + \pi_{ii} \left(\tau_{in} - 1\right)\right)}. \tag{29}$$

Taking the total differential of total expenditure (29) yields

$$dlnX_i = dlnw_i + dln\tau_{in} - \left(\frac{\pi_{ii}\left(\tau_{in}-1\right) dln\pi_{ii} + \pi_{ii}\tau_{in} dln\tau_{in}}{1+\pi_{ii}\left(\tau_{in}-1\right)} \right).$$

Similarly, the total differential of the domestic expenditure share (equation 27 when $i = n$) in country i is given by

$$dln\pi_{ii} = \theta\left(1-\pi_{ii}\right)(d\ln c_n - dlnc_i) + \theta\left(1-\pi_{ii}\right) dln\tau_{in}. \tag{30}$$

Taking the total differential of the trade balance condition (28) yields

$$dlnX_i - \frac{\pi_{ii}}{1-\pi_{ii}} dln\pi_{ii} - dln\tau_{in} = dlnX_n - \frac{\pi_{nn}}{1-\pi_{nn}} dln\pi_{nn} - dln\tau_{ni}.$$

Finally, using the total differential equations for total expenditure (29) we obtain,

$$dlnw_i - \left(\frac{\pi_{ii}\left(\tau_{in}-1\right)}{1+\pi_{ii}\left(\tau_{in}-1\right)} + - \frac{\pi_{ii}}{1-\pi_{ii}} \right) dln\pi_{ii} - \left(\frac{\pi_{ii}\tau_{in}}{1+\pi_{ii}\left(\tau_{in}-1\right)} \right) dln\tau_{in} =$$
$$dlnw_n - \left(\frac{\pi_{nn}\left(\tau_{ni}-1\right)}{1+\pi_{nn}\left(\tau_{ni}-1\right)} + - \frac{\pi_{nn}}{1-\pi_{nn}} \right) dln\pi_{nn} - \left(\frac{\pi_{nn}\tau_{ni}}{1+\pi_{nn}\left(\tau_{ni}-1\right)} \right) dln\tau_{ni}$$

and, using the expression for $dln\pi_{ii}$ and $dln\pi_{nn}$ in (30), we arrive at

$$\frac{dlnw_i}{1+\theta} - \frac{\theta}{1+\theta} \left(\frac{\pi_{ii}\left(\tau_{in}-1\right)}{1+\pi_{ii}\left(\tau_{in}-1\right)} + - \frac{\pi_{ii}}{1-\pi_{ii}} \right) \left[\left(1-\pi_{ii}\right)\left(dlnc_n - dlnc_i\right) \right] - \tilde{\pi}_{ii} dln\tau_{in} =$$
$$\frac{dlnw_n}{1+\theta} - \frac{\theta}{1+\theta} \left(\frac{\pi_{nn}\left(\tau_{ni}-1\right)}{1+\pi_{nn}\left(\tau_{ni}-1\right)} + - \frac{\pi_{nn}}{1-\pi_{nn}} \right) \left[\left(1-\pi_{nn}\right)\left(dlnc_i - dlnc_n\right) \right] - \tilde{\pi}_{nn} dln\tau_{ni}$$

where recall that $\tilde{\pi}_{ii} = \frac{\pi_{ii}\tau_{in}}{1+\pi_{ii}(\tau_{in}-1)}$.

Therefore, using the result of Proposition 10 and its Corollary, reciprocal changes in tariffs between country i and country n (i.e., the tariff changes that satisfy $dlnc_n = dlnc_i = 0$) are characterized by

$$\frac{dlnw_i}{1+\theta} - \tilde{\pi}_{ii} dln\tau_{in} = \frac{dlnw_n}{1+\theta} - \tilde{\pi}_{nn} dln\tau_{ni}.$$

Notice that this expression is similar to the expression for reciprocal tariffs with no intermediate goods in Proposition 5, 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 (25). In particular, taking the total differential of the price index in country i we get,

$$dlnP_i = \pi_{ii} dlnc_i + \pi_{in}\left(dlnc_n + dln\tau_{in}\right),$$

where the total differential of the input bundle cost is given by

$$dlnc_i = \beta dlnw_i + \left(1-\beta\right) dlnP_i.$$

Hence the changes in relative wages in country i and country n that preserve the input bundle costs must satisfy

$$dlnw_i - dlnw_n = \frac{(1-\beta)}{\beta}\left(\pi_{ni} dln\tau_{ni} - \pi_{in} dln\tau_{in}\right).$$

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 (2015) world, reciprocal changes in tariffs between country i and country n must satisfy*

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

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 I we show (Proposition A6) that a reciprocal reduction in tariffs in this world is Pareto improving as long as both country's tariffs remain non-negative. But we also establish that with intermediate goods, a small reciprocal reduction in tariffs will remain Pareto improving even when one country has reached free trade, due to the positive effect on wages that increases welfare in this case.

5.4 Reciprocity and labor market dislocation with intermediate goods

We turn now to discuss the labor market dislocation effects of reciprocity and deviations from reciprocity in the two-country Caliendo and Parro (2015) setting, maintaining our focus on the case of one tradable sector and a non-tradable sector.

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

$$w_n L_n^T = \beta\left(\frac{\pi_{in}^T}{\tau_{in}} X_i^T + \pi_{nn}^T X_n^T\right) \tag{31}$$

$$w_n L_n^{NT} = \beta X_i^{NT}. \tag{32}$$

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

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

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

$$X_n^{NT} = \frac{(1-\alpha)}{\beta}\left(w_n L_n + X_n^T \frac{(\tau_{ni}-1)\left(1-\pi_{nn}^T\right)}{\tau_{ni}}\right). \tag{33}$$

It follows that the relative sectoral expenditures can be expressed as

$$\frac{X_n^T}{X_n^{NT}} = \frac{\frac{\alpha\beta}{(1-\alpha)}}{\left(1-(1-\beta)\left(\frac{1+\pi_{nn}^T(\tau_{in}-1)}{\tau_{in}}\right)\right)}. \tag{34}$$

Plugging (34) into the expression for non-tradable expenditure in (33), we obtain

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

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

Using the labor market clearing condition (32) we get

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

And taking the total differential in the tradable sector we get

$$dlnL_n^{NT} =$$
$$-\frac{L_n^{NT}}{L_n^T}\frac{L_n^{NT}\alpha}{(1-\alpha)L_n}\left\{\frac{\beta\tau_{in}(\tau_{ni}-1)\pi_{nn}^T}{(\tau_{in}-(1-\beta)(1+\pi_{nn}^T(\tau_{ni}-1)))^2} dln\pi_{nn}^T + \frac{\tau_{ni}\beta\left(1-\pi_{nn}^T\right)}{(\tau_{ni}-(1-\beta)(1+\pi_{nn}^T(\tau_{ni}-1)))^2}\right\} dln\tau_{ni}.$$

Finally using the total differential of the expenditure shares

$$dln\pi_{nn}^{T} = \theta(1-\pi_{nn}^{T})\left(dlnc_i - dlnc_n\right) + \theta\left(1-\pi_{nn}^{T}\right) dln\tau_{ni},$$

and defining $dln\tilde{\omega}_n \equiv dlnc_n - dlnc_i$, we obtain

$$dlnL_n^T = -\frac{L_n^{NT}}{L_n^T}\frac{L_n^{NT}}{L_n}\frac{\beta}{(1-\alpha)}\left[\frac{\alpha\left(1-\pi_{nn}^{T}\right)\pi_{nn}^{T}\left(\tau_{ni}-1\right)\theta\tau_{ni}}{\left(\tau_{ni}-(1-\beta)\left(1+\left(\tau_{ni}-1\right)\pi_{nn}^{T}\right)\right)^2}\right] dln\tilde{\omega}_n \tag{35}$$

$$-\frac{L_n^{NT}}{L_n^T}\frac{L_n^{NT}}{L_n}\frac{\beta}{(1-\alpha)}\left[\frac{\alpha\left(1-\pi_{nn}^{T}\right)\left(1-\pi_{nn}^{T}\left(\tau_{ni}-1\right)\theta\right)\tau_{ni}}{\left(\tau_{ni}-(1-\beta)\left(1+\left(\tau_{ni}-1\right)\pi_{nn}^{T}\right)\right)^2}\right] dln\tau_{ni}.$$

The expression in (35) extends the expression in (19) 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 (2015) 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 Caliendo and Parro (2015) 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.*

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 tariff cuts satisfy multilateral reciprocity for all countries. But as with our discussion leading up to Proposition 11, 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. As we noted earlier, whether these additional ways to satisfy reciprocity are indeed possible, and if they are possible what implications they might have for the negotiating countries, will depend on the underlying details of the world economy, and this is an issue we will confront in our quantitative analysis of section 6.

6 Quantitative Analysis

We now turn to the quantitative analysis. On December 11, 2001, China joined the WTO. Consequently, the member countries of the WTO granted China Most

Favoured Nation (MFN) status. As a new WTO member, China was required to apply non-discriminatory tariffs and achieve reciprocity with other WTO members. As a consequence of China's accession to the WTO, obvious questions arise: 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?

6.1 Reciprocity and the China Shock

To answer these questions, we first abstract from intermediate goods and employ a many-sector version of the Eaton and Kortum (2002) model along the lines of the model of Costinot, Donaldson and Komunjer (2012). We take the model to the data at the end of the year 2000, and study whether the changes in tariffs applied between China and the rest of the world from 1990 to 2007 were reciprocal or not. The rationale to consider the changes in tariffs from 1990 is to account for the tariff changes that were negotiated at the time of the Uruguay round as preparation for China's accession to the WTO. We obtain trade flows between China and the rest of the world from the World Input-Output Database (WIOD). We aggregate agricultural, mining, and manufacturing industries into a tradable sector, and the rest of the industries into a non-tradable sector. We obtain bilateral sectoral tariffs across countries from Caliendo et al. (2023). The authors 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. We aggregate tariff rates across sectors and countries using 1995 trade shares. In Appendix II we also present quantitative results using unweighted tariffs, as well as quantitative results for different initial years, and time frames for tariff changes. Finally, 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 the 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), Caliendo and Parro (2015)). In particular, we evaluate the reciprocity of the actual changes in

bilateral tariffs while holding other economic fundamentals constant. To do so, 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 make 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.

Figure 1 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.

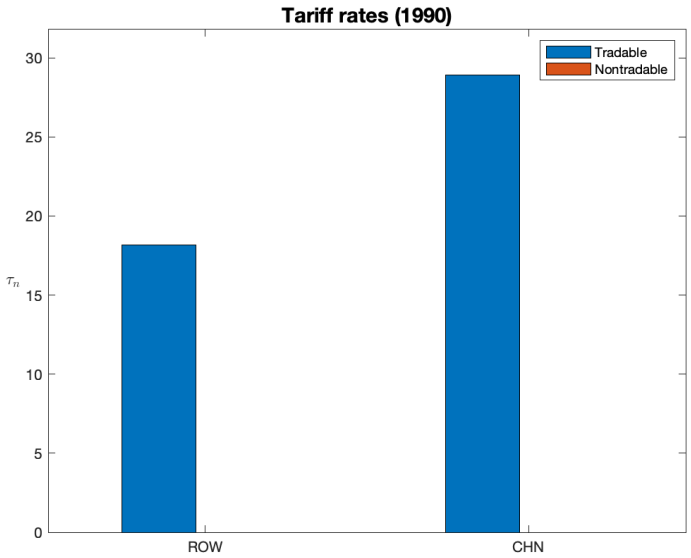


Figure 1: Initial Tariffs 1990

Note: The figure presents 1990 trade-weighted tariffs between China and the rest of the world constructed with the tariff dataset from Caliendo et al. (2023).

We then 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 5 (extended to include a non-tradable sector) to compute the corresponding reciprocal tariff changes applied by China. Figure 2 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 tariffs 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.

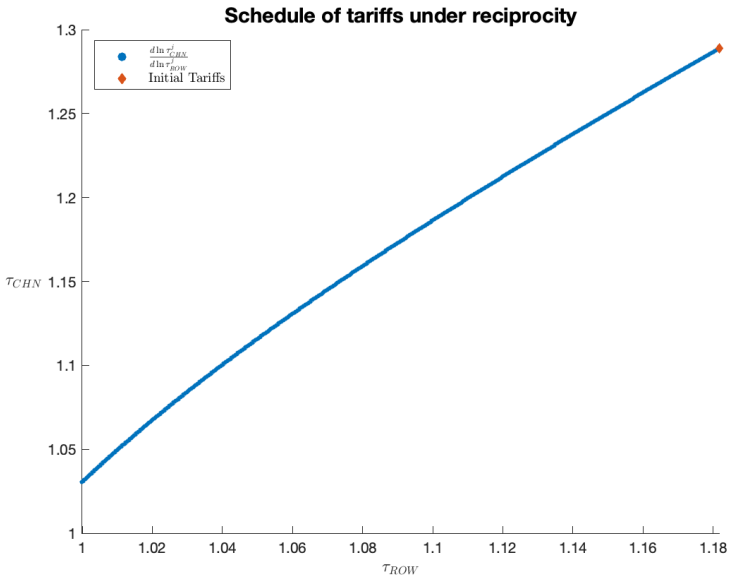


Figure 2: Tariff schedules under reciprocity

Note: The figure presents the schedule of reciprocal tariff changes applied between China and the rest of the world starting from the initial equilibrium in 1990. The axes show the reciprocal ad-valorem tariff applied between China and the rest of the world.

In Figure 3, we display the welfare 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 three percent. Notably, these reciprocal tariffs are Pareto improving as welfare increases for both China and the rest of the world when 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.

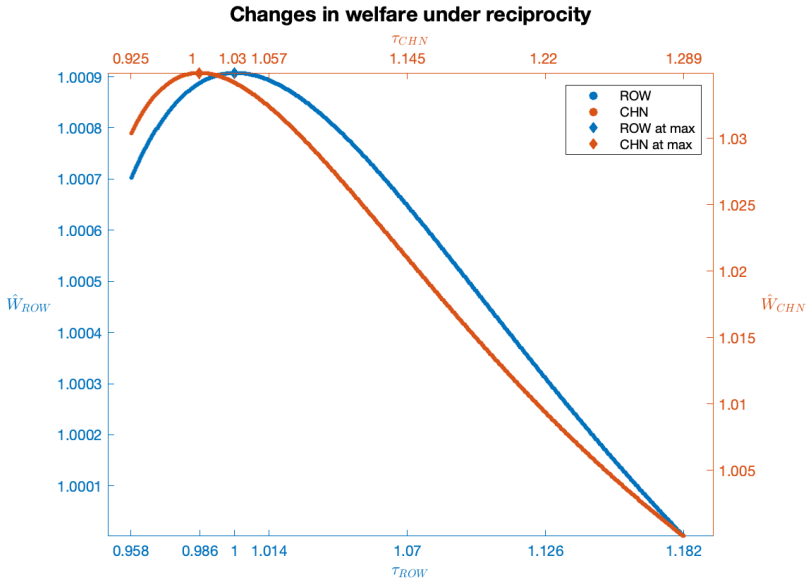


Figure 3: Welfare effects of reciprocity

Note: The figure 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 figures for China. The axes show the ad-valorem tariff applied between China and the rest of the world.

To further quantitatively illustrate our theoretical results, Figure 4 displays the shifts in terms of trade resulting from hypothetical deviations from reciprocity. Specifically, the figure shows that, as anticipated, world prices remain unchanged under reciprocity. The middle bars illustrate that if China were to set tariffs at a level twenty percentage points above reciprocity, its terms of trade would improve, while the U.S. terms of trade would worsen. The bars on the right of the figure demonstrate that the converse occurs if China were to exceed reciprocity and apply a tariff level twenty percentage points lower than the reciprocal ones.

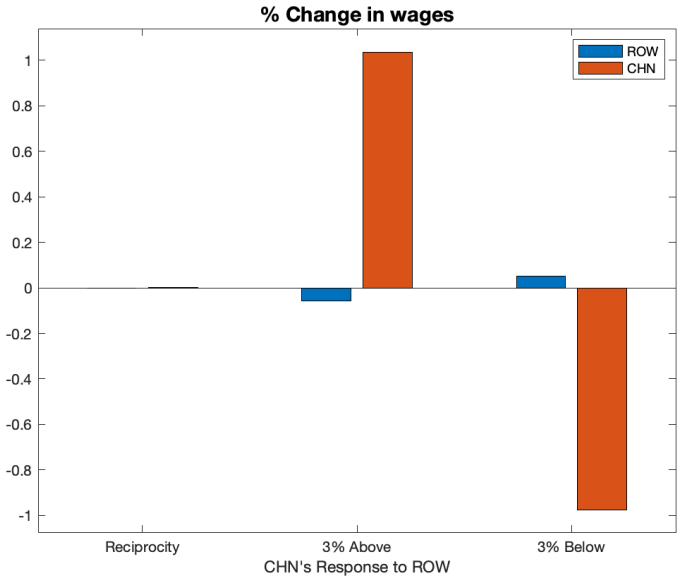


Figure 4: Terms of trade effects

Note: The figure presents the changes in relative wages for different scenarios, under reciprocity, and with China imposing a twenty percentage points change in tariffs above and below reciprocal tariffs from the rest of the world.

In the left panel in Figure 5, the reciprocal tariff schedule between China and the rest of the world is once again illustrated. The diamond marker on the schedule indicates that the reciprocal tariff applied by China in response to the rest of the world's tariffs is approximately twenty percent. However, a second 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. The right panel explores the welfare effects of China's reciprocal tariff adjustments in response to changes in the world tariffs. A vertical line marks the actual tariff level achieved by 2007. The figure demonstrates that both China and the rest of the world would 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.

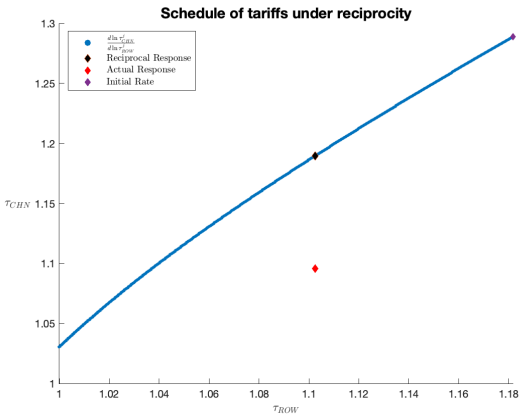


Figure 5a: Reciprocal and actual tariff changes



Figure 5b: Welfare under reciprocal and actual tariff changes

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 turn 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 6 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.

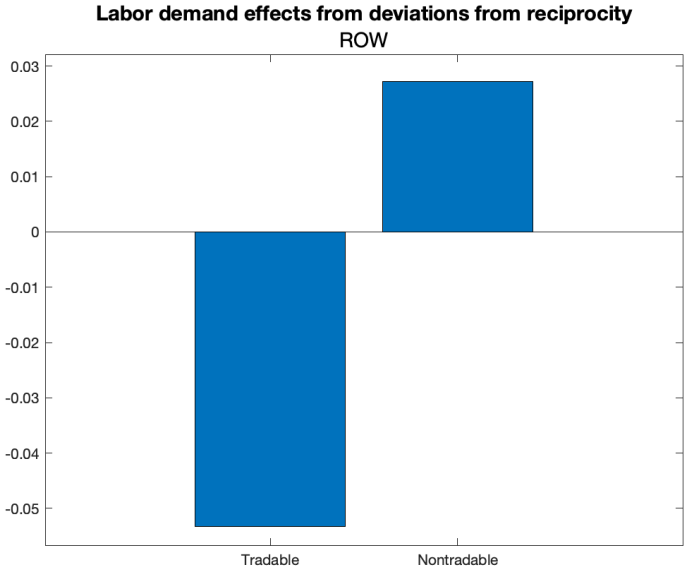


Figure 6: Employment effects across sectors in the rest of the world

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 the change in wages due to the actual changes in tariffs between China and the rest of the world over the period 1990-2007.

In Appendix II, 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.

Finally, we quantify the employment effects across individual countries in a world with multiple countries and sectors. As discussed in the theoretical section, in a world with multiple countries and sectors there is a dimensionality problem to find a unique set of reciprocal tariffs that preserve world prices, and therefore, we cannot derive closed-form formulas for reciprocal tariff changes as we did for the two country case. Hence, in order to compute the employment dislocation in a world with multiple countries and sectors, we rely on the total differential of the employment effects derived in (23). In particular, we use the equation to calculate how much of the employment effects, resulting from actual

changes in each country's tariffs, can be attributed to the influence of terms of trade on employment in the non-tradable sector.

Figure 7 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 (23). Hence, 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.

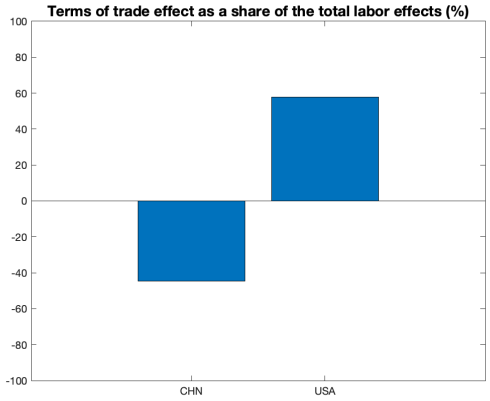


Figure 7a: Employment dislocation from bilateral tariff changes

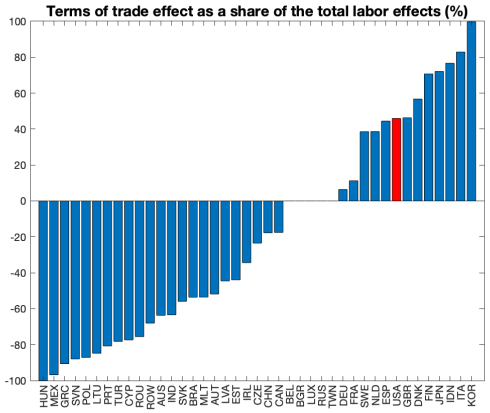


Figure 7b: Employment dislocation from multilateral tariff changes

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 (23).

On the left panel, we compute 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 (23), the left panel can be interpreted as showing for the United Sates that the contribution of deviations from reciprocity to changes in the US's tradable sector employment as a result of the Uruguay Round US tariff cuts plus implementation of China's accession commitments is roughly comparable in magnitude to the contribution of the US's own tariff cuts over this 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 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, like Mexico or India, which resulted in employment moving into the tradable sector in those countries.

6.2 Reciprocity with Intermediate Goods

We next extend our quantitative analysis to incorporate intermediate goods as in Caliendo and Parro (2015). To do so, we start by applying our reciprocal tariff formula with intermediate goods derived in Proposition 12 (extended to include a non-tradable sector as we did before). 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 5.2, in the presence of intermediate goods and multiple sectors, it is possible that specific movements in the input bundle costs across sectors might satisfy the reciprocity condition (26). To rule out these cases, we focus on conducting the quantitative analysis in a two-country world with a tradable and a non-tradable sector. This approach ensures that the reciprocal tariffs are unique and keep the input bundle cost in the tradable sector unchanged. Of course, the input bundle cost in the non-tradable sector can still vary due to changes in wages.

Figure 8, left panel, 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. Different from our analysis of reciprocity with no intermediate goods, but consistent with our theoretical results, the right panel in Figure 8 shows that under reciprocity welfare for the rest of the world is maximized beyond free trade, and that subsidizing imports from China at the maximizing welfare point is Pareto improving, as it also increases welfare for China.

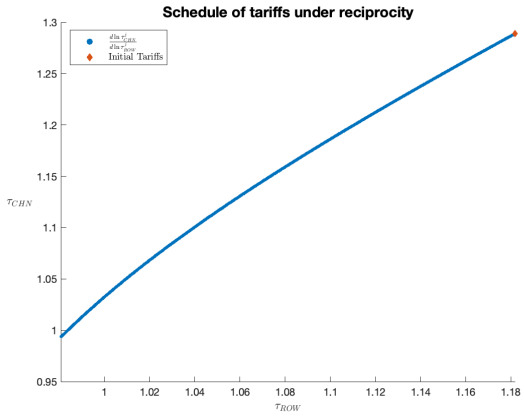


Figure 8a: Tariff schedules under reciprocity with intermediate goods



Figure 8b: Welfare under reciprocity with intermediate goods

Note: The left panel presents the schedule of reciprocal tariff changes applied between China and the rest of the world starting from the initial equilibrium in 1990. The axes show the reciprocal 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 figures for China.

In the left panel in Figure 9, we can see 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, similar to our results with no intermediate goods, we also find that China exceeded reciprocity with respect to the rest of the world.

The right panel in Figure 9, 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 with the results with no intermediate goods, we find that intermediate goods magnified such employment dislocation.

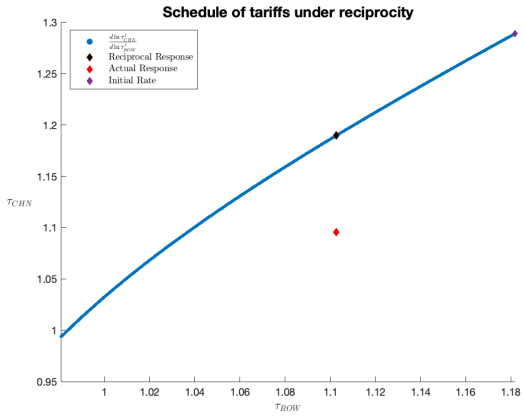


Figure 9a: Reciprocal and actual tariff changes

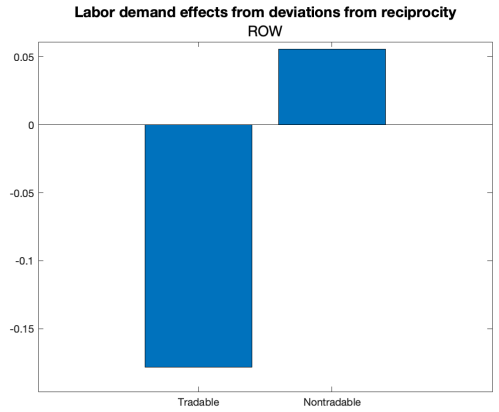


Figure 9b: Employment effects across sectors in the rest of the world

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 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.

As we did before, in Appendix II 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.

6.3 Discussion

These results are surprising, given US government claims that China has not lived up to its WTO commitments regarding reciprocity (e.g., USTR 2020). Our quantitative evidence has found that China's market access commitments *exceeded* those that would be required to reciprocate the market access commitments it received from other WTO members with its 2001 WTO accession. As a result, we find that China's particular deviation from reciprocity worsened its own terms of trade and improved the terms of trade of the United States and other major industrialized economies. While China's deviation from reciprocity therefore raised the aggregate real income of the United States through these terms-of-trade improvements, it also *amplified* the magnitude of the US manufacturing-sector dislocation, increasing the size of the China Shock experienced by the United States relative to what the United States could have

expected based on its tariff cuts alone in the presence of reciprocal tariff cuts from China. Some discussion of this counterintuitive result is in order.

One puzzle involves why the United States did not implement a stronger policy in response to China's failure to reciprocate US tariff cuts and instead expand its export volumes beyond those consistent with reciprocity. A partial explanation may point to the insufficiency of WTO rules for dealing with such circumstances. In particular, existing WTO rules may have provided the United States with effective avenues to address only *some* of the local injury that arose from the manufacturing-sector dislocation that it experienced.

For example, under GATT Article XXVIII the United States could have sought to raise its MFN tariff bindings directly. But to do this it would have had to enter into negotiations with trading partners (like China) adversely impacted by any US tariff increase to allow them to raise their tariffs in response. The trading partners' tariff increase would be limited itself by reciprocity; as indicated earlier, this has the effect of fixing the terms of trade. Thus, in principle such a policy response would have allowed the United States to both "lock in" its higher level of aggregate welfare (arising from the improved terms of trade associated with China's deviation from reciprocity) and then negotiate reciprocal tariff increases to reduce the magnitude of its manufacturing-sector dislocation.

But the United States did not use this Article XXVIII renegotiations approach in response to the China Shock, perhaps because it wanted to avoid the reciprocal withdrawal of market access concessions from its trading partners that Article XXVIII allows.[12] Instead the United States mostly turned to its antidumping and countervailing duty laws to raise tariffs (often to prohibitive levels) on imports from China, actions that are admissible under WTO rules without triggering the right of reciprocal actions by trading partners.[13] The United States response here 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 eventually reaching over 7 percent by 2017 (Bown 2018).[14]

[12] A similar explanation may apply for why the United States did not make use of temporary "escape clause" provisions afforded to GATT/WTO member countries (see Sykes, 2003, on the various problems with the WTO Agreement on Safeguards).

[13] Under its domestic regulations, the United States could not begin imposing countervailing duties on imports from China until it reversed a 1986 decision whereby it had decided against imposing CVDs against non-market economies like China and the former Soviet Union. The Commerce Department eventually reversed the *Georgetown Steel* decision in 2007, at which point it began imposing CVDs in addition to the antidumping duties it was applying, often on the same products, from China. Note that in a separate example, upon expiration of the Multi-Fibre Arrangement in 2005, the United States negotiated an agreement whereby China agreed to voluntarily restrain exports of clothing and textiles for an additional two years (WTO 2006, pp. 60-61).

[14] Also interesting is that, with one exception, the US 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; here, 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

Then, of course, beginning in 2018, the United States imposed a variety of import restrictions on China under new rationales and exceptions, including for the protection of national security (imports of steel and aluminum) and the trade war. By the end of 2019, roughly two-third of US imports from China were covered by some form of special tariffs and were then sustained even under the US-China "Phase One" agreement (Bown 2021). But even if these broader import restrictions had been specifically designed to address injury from the China Shock, such US policy actions would have been insufficient to address the local injury arising from excessive Chinese exports in those sectors where the United States and China are competing exporters in third markets. In these cases, the only possible WTO legal recourse would be under formal WTO dispute settlement and the threats of US import restrictions applied to *other* imports from China. If it were clear that the cause of China's excessive exports was not excessive import liberalization but, say, WTO-illegal subsidies, then the United States could make the case that China had violated the rules of the WTO Agreement on Subsidies and Countervailing Measures (SCM). The real-world challenge for the SCM Agreement, however, has been defining "subsidies" for the case of a nonmarket economy like China.[15]

Our quantitative results also point to a second puzzle, which in some sense reflects the tension between, on the one hand, claims that China has not opened its own markets to imports sufficiently, and on the other hand claims that China has taken actions that unduly stimulate its exports. If it is accepted that the policies typically addressed in the context of WTO commitments are not the kinds of policies that have first-order implications for a country's trade imbalances, then both of these claims cannot simultaneously be correct: for a fixed trade balance, a country's trade policies either restrict both its imports and its exports, or they stimulate both its imports and its export, a version of Lerner Symmetry.

Put differently, recall that our baseline model does not allow for changes in trade imbalances by assumption, on the grounds that trade imbalances are historically outside the scope of trade commitments taken under the GATT/WTO and are typically handled instead by international macroeconomic institutions such as the IMF. Hence, in our model the only policy explanation for the excessive Chinese exports - which worsened its terms of trade - arises from excessive Chinese imports that result from China lowering its import tariffs below the level implied by reciprocity. While introducing into the model additional policy instruments, such as (export) subsidies, could similarly deliver a worsening of China's terms of trade, Lerner symmetry necessarily implies that Chinese imports would have also increased.

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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 rule.

[15] A final alternative is for the United States to have brought forward a nonviolation nullification and impairment (NVNI) WTO dispute against China under Article XXIII - arguing that it had expected, but been denied, the economic benefits of China satisfying reciprocal market access treatment in those third markets. It is well-known that such claims are exceptionally difficult to bring against WTO members, but see Hillman (2018) and Staiger (2022) on how such claims might work in the context of US-China trade relations.

A potential resolution of this second puzzle leads us back to a consideration of the extended notion of reciprocity discussed in section 3 and presented in (3). The restrictions in (1) and (3) represent alternative approaches to mitigating terms-of-trade changes that might otherwise occur subsequent to the implementation of negotiated tariff cuts and the market access commitments that they imply. As long as trade imbalances are not changing through time, these two restrictions are identical. But if trade imbalances change after the exchange of market access commitments, the two restrictions have distinct implications.

In particular, the extended reciprocity restriction in (3) describes tariff cuts that would preserve the existing terms of trade even in the presence of changing trade imbalances, something that the reciprocity restriction in (1) does not attempt to do.[16] That is, (1) requires a balanced change in the home country's export and import volumes over the period when market access commitments are implemented even as exogenous changes in trade imbalances are also occurring; the trade volume restrictions in (3), by contrast, net out the volume changes that would have to occur to accommodate the trade balance changes.

Which restriction captures most closely the spirit of the rules of the multilateral trading system as applied to market economies? Focussing narrowly on GATT/WTO rules, it would seem that (1) is the most fitting representation, and that is the restriction on which our paper has heretofore focused. But if we consider more broadly not only the GATT/WTO but also the IMF, then it might be argued that it is (3) that most closely captures the combined effect of the rules of the multilateral trading system: abstracting from changes in trade imbalances, (1) captures the GATT/WTO norm of reciprocity in market access concessions; and the augmentation of (1) embodied in (3) that kicks in when trade imbalances change through time could be said to then represent the role of the IMF in ensuring that countries do not run global trade imbalances that have a disruptive impact on the global economy, where here the disruptive impact could be gauged by the extent to which the changes in trade imbalances cause substantial changes in world prices (and hence substantial changes in local prices given fixed tariffs).

Adopting the view that market economies abide by (3) via tariff bindings and the code of conduct embodied in GATT/WTO Articles together with their IMF obligations, it might then be reasonable for China to abide by (3) through the meeting of quantitative targets (along the lines of Poland's protocol of accession to GATT in 1967 as discussed in section 2), on the grounds that China must conform to quantitative targets that mirror the commitments accepted by market economies because the rules that work to discipline market economies along these lines may not work to discipline a non-market economy such as China. With this motivation in mind, we next present quantitative results under the

[16] Whether or not (3) would require additional tariff adjustments that are not implied by (1) in the presence of changing trade imbalances would depend on the resolution of the classic "transfer problem," and in particular on whether or not the international transfer implied by the changing trade imbalance would, at the new tariffs described by (1), induce a secondary burden or blessing through terms-of-trade movements required to re-establish international equilibrium in the presence of the transfer.

extended definition of reciprocity in (3).

6.4 Changing trade imbalances and an extended notion of reciprocity

[TBA]

7 Conclusion

[TBA]

8 Appendix I

8.1 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 4, 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

$$wa(\tilde{z}) = \frac{w^* a^*(\tilde{z})}{g}(1+\tau) \Rightarrow \omega = \frac{A(\tilde{z})}{g}(1+\tau) \tag{36}$$

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

$$w^* a^*(\tilde{z}^*) = \frac{wa(\tilde{z}^*)}{g}(1+\tau^*) \Rightarrow \omega = gA(\tilde{z}^*)\frac{1}{(1+\tau^*)}. \tag{37}$$

In the absence of transport costs and tariffs (i.e., for $g = 1$ and $\tau = 0 = \tau^*$), (36) and (37) 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 (36) and (37) 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 (36) and (37) 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.[17]

We are now ready to define reciprocity in the context of this model. As embodied in (1) above, 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

[17] We 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 $\hat{p}(z)$.

the new tariffs (τ_1, τ_1^*), tariff changes that conform to reciprocity for the US must then satisfy

$$\int_{\bar{z}_1}^{1} \hat{p}_0^*(z) D_1(z) dz - \int_{\bar{z}_0}^{1} \hat{p}_0^*(z) D_0(z) dz = \int_0^{\bar{z}_1^*} \hat{p}_0(z) D_1^*(z) dz - \int_0^{\bar{z}_0^*} \hat{p}_0(z) D_0^*(z) dz. \tag{38}$$

The left-hand side of (38) 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 (38) 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 (38) is satisfied so that reciprocity holds for the US, then reciprocity must also hold for China.

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:

$$\begin{aligned} \int_{\bar{z}_0}^{1} p_0^*(z) D_0(z) dz &= \int_0^{\bar{z}_0^*} p_0(z) D_0^*(z) dz \\ \int_{\bar{z}_1}^{1} p_1^*(z) D_1(z) dz &= \int_0^{\bar{z}_1^*} p_1(z) D_1^*(z) dz. \end{aligned} \tag{39}$$

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 (39) into the reciprocity condition (38), 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 $\hat{p}_0(z)$,

$$\int_{\bar{z}_1}^{1} a^*(z) D_1(z) dz = \bar{\omega}_0 \int_0^{\bar{z}_1^*} a(z) D_1^*(z) dz. \tag{40}$$

And rewriting the bottom line of (39) 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 (40) yields

$$[\bar{\omega}_1 - \bar{\omega}_0] \int_0^{\bar{z}_1^*} a(z) D_1^*(z) dz = 0. \tag{41}$$

Hence, according to (41), as long as trade volumes remain positive, tariff changes that satisfy the reciprocity condition (38) will hold fixed $\bar{\omega}$, the relative wage between the US and China. From here, it is straightforward to confirm using (38) that if China's tariff cuts fall short of reciprocating the US tariff cuts so that the left-hand side of (38) 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 (38) 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 (36) and (37), 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

$$b(z) = \frac{p_0(z) D_0(z)}{I_0} = \frac{w_0 a(z) D_0(z)}{I_0} \quad \text{for } z \in (\bar{z}_1, \bar{z}_0)$$

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

revenue under the initial tariffs is given by

$$I_0 = \frac{w_0 L}{1 - \frac{\tau_0}{1+\tau_0}[1 - \gamma(\bar{z}_0)]}$$

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,

$$\mathcal{L}(\bar{z}_1) \equiv \frac{1}{1 - \frac{\tau_0}{1+\tau_0}[1 - \gamma(\bar{z}_0)]} \int_{\bar{z}_1}^{\bar{z}_0} b(z)dz, \tag{42}$$

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 $\bar{z}_1$.[18] We summarize with:

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 $L(\bar{z}_1) \equiv$*

[18] Of 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

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

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.

$\frac{1}{1-\frac{\tau_0}{1+\tau_0}[1-\gamma(\bar{z}_0)]} \int_{\bar{z}_1}^{\bar{z}_0} b(z)dz$. *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 (36) to obtain

$$A(\bar{z}) = \bar{\omega}(\tau, \tau^*)\frac{g}{(1+\tau)}. \tag{43}$$

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 (43) to assess what deviations from reciprocity imply for labor reallocation in the US.

In particular, it follows from (43) 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 (43) 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.*

As with the Corollary to Proposition 1, the Corollary to Proposition A3 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 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. And as we demonstrate in section 4, this result extends without qualification to a many-country many-good Ricardian trade model setting as long as tariffs are non-discriminatory (i.e., conform to the GATT/WTO MFN principle).

Trade Imbalances As with the 2-good neoclassical trade model, it is also interesting to consider an extension of reciprocity in the model of Dornbusch, Fischer and Samuelson (1977) that accommodates changes in trade imbalances. To this end, we now consider the following extension of the definition of reciprocity considered in (38):

$$\int_{\bar{z}_1}^{1} \hat{p}_0^*(z) D_1(z) dz - \int_{\bar{z}_0}^{1} \hat{p}_0^*(z) D_0(z) dz = \left[\int_0^{\bar{z}_1^*} \hat{p}_0(z) D_1^*(z) dz - \int_0^{\bar{z}_0^*} \hat{p}_0(z) D_0^*(z) dz \right] + \left[TB_1^* - TB_0^* \right], \quad (44)$$

where TB^* is the foreign country trade balance (positive if surplus, negative if deficit) defined by

$$TB^* \equiv \int_{\bar{z}}^{1} p^*(z) D(z) dz - \int_0^{\bar{z}^*} p(z) D^*(z) dz.$$

As with (38), the left-hand side of (44) 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. And as with (38), the term in the first set of square brackets on the right-hand side of (44) 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. Finally, the term in the second set of square brackets on the right-hand side of (44) is the change in China's trade balance measured at (contemporaneous) world prices: this term will be positive (negative) if China's trade surplus grows (shrinks) in the period when the new tariffs are implemented. Again, it is intuitive and easy to show that if (44) is satisfied so that reciprocity holds for the US, then reciprocity must also hold for China.

Substituting the definition of the trade balance term TB^* into (44) and using the price definitions, it is direct to show that (44) implies

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

Hence, as long as trade volumes remain positive, a commitment to tariff changes that satisfy the extended reciprocity condition (44) would hold fixed $\bar{\omega}$, the relative wage between the US and China, regardless of any changes in China's trade balance, and would thereby ensure that the own-tariff changes of the US are a sufficient statistic for calculating the labor-market dislocation the US would experience as a result of negotiated tariff liberalization with China, regardless of any change in China's trade surplus that occurs after the tariff negotiations are completed.

At this point, our interpretive discussion of this extended notion of reciprocity in section 6.3 applies, and we do not repeat that discuss here. The one point to add here is that, as discussed by Dornbusch, Fischer and Samuelson (1977) in their treatment of trade imbalances, the presence of non-traded goods created by trade impediments in the model ensures that the Keynes case of the transfer problem obtains, and this means that China would need to restrict access to its markets and/or cut its export subsidies to accommodate its growing trade surplus while satisfying (44), that is, in order to stabilize the terms of trade in the presence of its growing trade surplus.

8.2 The welfare effects of reciprocal tariff changes in the two-country Eaton and Kortum model

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 3 that this implies that relative wages and hence world prices are preserved. Welfare in country n is defined as the real income, given by

$$W_n = \frac{w_n L_n + R_n}{P_n}, \tag{45}$$

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. Taking the total differential of equation (45) under reciprocity, we obtain

$$dlnW_n = \frac{R_n}{(w_n L_n + R_n)} dlnR_n - logP_n.$$

Taking the total differential of tariff revenue and the price index, it follows that the change in welfare in country n from a reciprocal change in tariff is given by

$$\frac{d\ln W_n}{d\ln \tau_{ni}} = -\left(1+\theta\right)\frac{\left(1-\pi_{nn}\right)\pi_{nn}\left(\tau_{ni}-1\right)}{1+\pi_{nn}\left(\tau_{ni}-1\right)}. \tag{46}$$

As (46) 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 A4. *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.*

8.3 Reciprocal tariff changes in the many-country many-sector Eaton and Kortum model

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

$$d\ln P_n^k = \sum_{i=1}^{N} \pi_{ni}^k d\ln \tau_{ni}^k, \tag{47}$$

the total differential of the bilateral trade shares is given by

$$d\ln \pi_{in}^k = \theta^k \ln P_i^k - \theta^k d\ln \tau_{in}^k. \tag{48}$$

The total differential of the sectoral total expenditure is

$$d\ln X_n^j = \sum_{k=1}^{J}\sum_{i=1}^{N} \frac{\alpha_n^j \left(\tau_{ni}^j - 1\right) X_n^k \pi_{ni}^k}{X_n^j \tau_{ni}^k} d\ln X_n^k + \sum_{k=1}^{J}\sum_{i=1}^{N} \frac{\alpha_n^j \left(\tau_{ni}^j - 1\right) X_n^k \pi_{ni}^k}{X_n^j \tau_{ni}^k} d\ln \pi_{ni}^k + \sum_{k=1}^{J}\sum_{i=1}^{N} \frac{\alpha_n^j X_n^k \pi_{ni}^k}{X_n^j \tau_{ni}^k} d\ln \tau_{ni}^k. \tag{49}$$

Finally the labor market clearing condition is given by

$$d\ln w_n = \sum_{k=1}^{J}\sum_{i=1}^{N} \frac{X_i^k \pi_{in}^k}{w_n L_n \tau_{in}^k} d\ln X_i^k + \sum_{k=1}^{J}\sum_{i=1}^{N} \frac{X_i^k \pi_{in}^k}{w_n L_n \tau_{in}^k} d\ln \pi_{in}^k - \sum_{k=1}^{J}\sum_{i=1}^{N} \frac{X_i^k \pi_{in}^k}{w_n L_n \tau_{in}^k} d\ln \tau_{in}^k. \tag{50}$$

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 (47) we obtain,

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

Similarly, we express bilateral trade shares (48) 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

$$\begin{aligned} d\ln \pi &= \left[\mathbf{CA} - \mathbf{D}\right] d\ln w + \left[\mathbf{CB} - \mathbf{E}\right] d\ln \tau \\ &= \mathbf{F} d\ln w + \mathbf{G} d\ln \tau, \end{aligned}$$

with $\mathbf{F} = \mathbf{CA} - \mathbf{D}$ and $\mathbf{G} = \mathbf{CB} - \mathbf{E}$. The equilibrium condition for total expenditure (49) can similarly be expressed in matrix notation as

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

where $\mathbf{M} = \left[\mathbf{I} - \mathbf{J}\right]^{-1} \left[\mathbf{H} + \mathbf{KF}\right]$and $\mathbf{N} = \left[\mathbf{I} - \mathbf{J}\right]^{-1} \left[\mathbf{L} + \mathbf{KG}\right]$. 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

$$\begin{aligned} d\ln w &= \left[\mathbf{OM} + \mathbf{PF}\right] d\ln w + \left[\mathbf{ON} + \mathbf{PG} - \mathbf{P}\right] d\ln \tau \\ &= \mathbf{T} d\ln \tau, \end{aligned}$$

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

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

We can now summarize with:

Proposition A5. *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 $\mathbf{T} = \mathbf{Q^{-1}R}$ 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* $(N^* \times J^*) > (N-1)$.

8.4 The revenue-maximizing tariff for fixed terms of trade in the two-country Eaton and Kortum model

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

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

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

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

where we use that under reciprocity $dlnw_n = 0$. Arranging 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 use $dln\pi_{ii}=\pi_{ii}\theta\left(dlnw_n-dlnw_i\right)+\left(1-\pi_{ii}\right)\theta dln\tau_{in}$ which implies

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

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:

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

8.5 The welfare effects of reciprocal tariff changes in the two-country Caliendo and Parro model

In this Appendix section, we show that a reciprocal reduction in tariffs in a two-country Caliendo and Parro (2015) world is Pareto improving as long as both country's tariffs remain non-negative, and that a small reciprocal reduction in tariffs will remain Pareto improving even when one country has reached free trade.

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

$$dlnW_n=\frac{w_nL_n}{(w_nL_n+R_n)}dlnw_n+\frac{R_n}{(w_nL_n+R_n)}dlnR_n-logP_n.$$

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 $dlnw_n=-\frac{(1-\beta)}{\beta}\left(1-\pi_{nn}\right)d\ln\tau_{ni}$, we obtain,

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

Hence, similar to the case with no intermediate goods, we have 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 starting from any positive tariff levels increases welfare in both countries; that is, reducing tariffs in a reciprocal way is Pareto

improving . However, with intermediate goods, this elasticity is still negative at free trade ($\tau_{ni} = 1$). At free trade reducing tariffs further (i.e., offering a small import subsidy) results in a negative revenue effect that exactly offsets the price effect, as in the case with no intermediate goods, but there is still a positive effect on wages that increases welfare. The next proposition summarizes:

Proposition A6. I*n 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. Moreover, a small reciprocal reduction in tariffs will remain Pareto improving even when one country has reached free trade.*

9 Appendix II

In this appendix, we present alternative robustness exercises. First, we recompute our baseline results for a two-country world in the quantitative analysis described in the main text, using unweighted bilateral sectoral tariffs for China and the rest of the world. Figure A1 displays the unweighted tariffs applied between China and the rest of the world in the year 1990. The unweighted initial tariff applied by China to the rest of the world is approximately forty percent, while the unweighted tariff applied by the rest of the world to China is around thirteen percent.

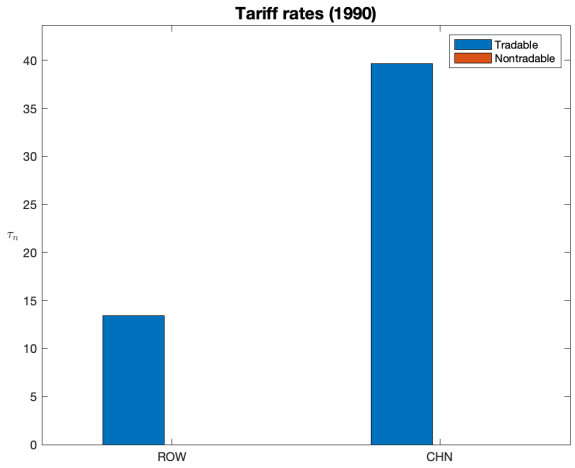


Figure A1: Initial unweighted tariffs in 1990

Note: The figure presents 1990 unweighted tariffs between China and the rest of the world constructed from tariff dataset from Caliendo et al. (2023).

Figure A2 displays the welfare effects from the reciprocal tariff schedule. We can see that when the rest of the world reaches free trade (zero tariffs), the

reciprocal tariff applied by China is about twenty percent.

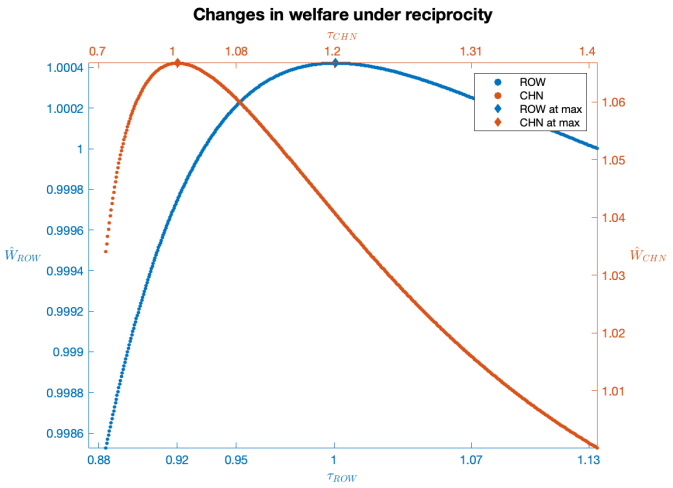


Figure A2: Welfare effects of reciprocity

Note: The figure 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 figures for China. The axes show the ad-valorem tariff applied between China and the rest of the world.

Finally, Figure A3 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 1990-2007. As in the main text, the figure shows that employment shifts to the non-tradable sector in the rest of the world.

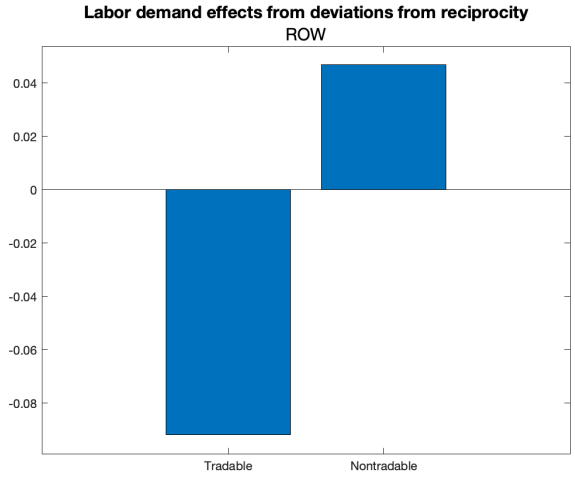


Figure A3: Employment effects across sectors in the rest of the world

Note: The figure 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 figures for China. The axes show the ad-valorem tariff applied between China and 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. Figure A4 displays the weighted tariffs applied between China and the rest of the world in the year 1995. The weighted initial tariff applied by China to the rest of the world is about twenty four percent while the weighted tariff applied by the rest of the world to China is around sixteen percent.

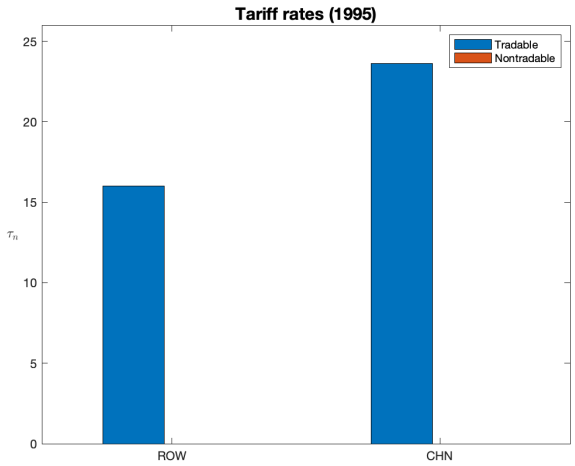


Figure A4: Initial weighted tariffs in 1995

Note: The figure presents 1995 weighted tariffs between China and the rest of the world constructed from tariff dataset from Caliendo et al. (2023).

Figure A5 displays the welfare effects from the reciprocal tariff schedule. We can see that when the rest of the world reaches free trade (zero tariffs), the reciprocal tariff applied by China is about two percent.

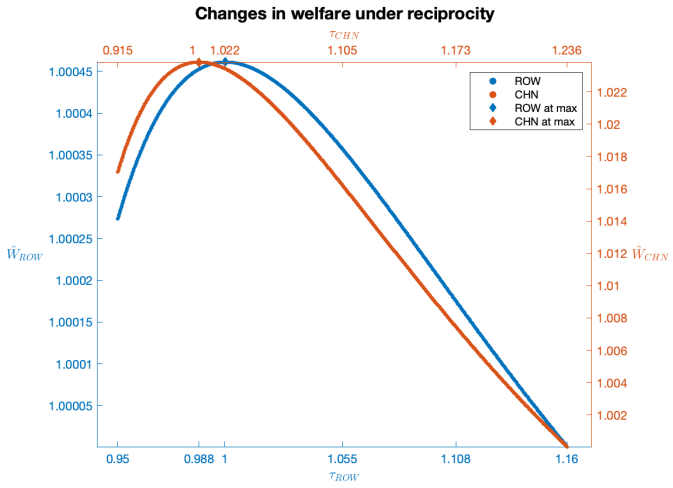


Figure A5: Welfare effects of reciprocity

Note: The figure presents the welfare effects of the reciprocal tariff schedule between

China and the rest of the world when the initial year is 1995. 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 figures for China. The axes show the ad-valorem tariff applied between China and the rest of the world.

Finally, Figure A6 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. As in the main text, the figure shows that employment shifts to the non-tradable sector in the rest of the world.

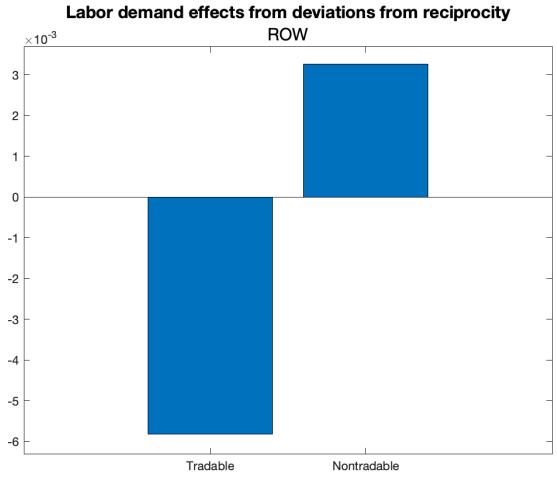


Figure A6: Employment effects across sectors in the rest of the world

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 1995-2007.

The next set of figures 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. Figure A7 displays the unweighted tariffs applied between China and the rest of the world in the year 1995. The unweighted initial tariff applied by China to the rest of the world is about thirty two percent while the weighted tariff applied by the rest of the world to China is around thirteen percent.

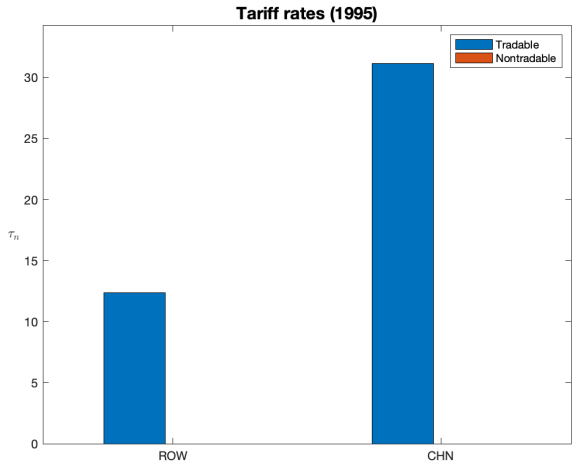


Figure A7: Initial unweighted tariffs in 1995

Note: The figure presents 1995 unweighted tariffs between China and the rest of the world constructed from tariff dataset from Caliendo et al. (2023).

Figure A8 displays the welfare effects from the reciprocal tariff schedule. We can see that when the rest of the world reaches free trade (zero tariffs), the reciprocal tariff applied by China is about fourteen percent.

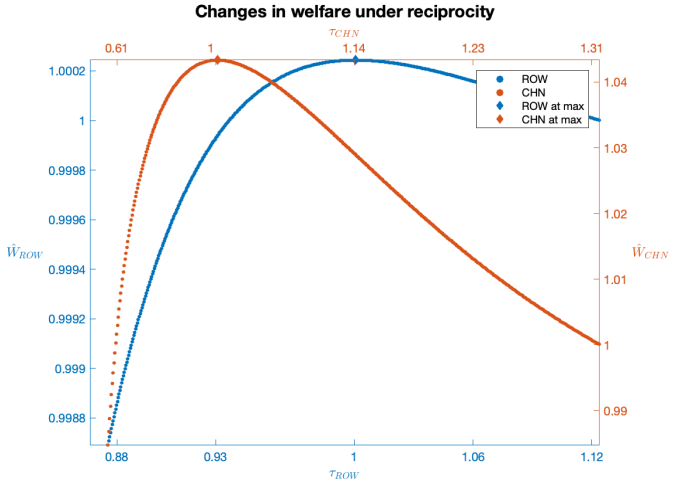


Figure A8: Welfare effects of reciprocity

Note: The figure presents the welfare effects of the reciprocal tariff schedule between

China and the rest of the world when the initial year is 1995. 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 figures for China. The axes show the ad-valorem tariff applied between China and the rest of the world.

Finally, Figure A9 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.

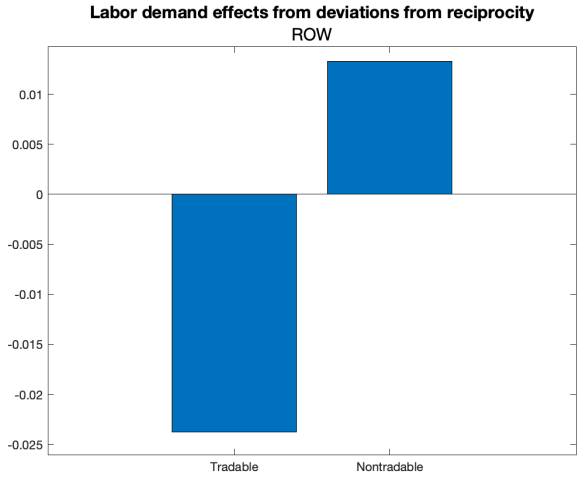


Figure A9: Employment effects across sectors in the rest of the world

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 1995-2007.

9.1 Additional Results with Intermediate Goods

In this section of Appendix II, we present alternative results with intermediate goods. We first recompute our results with intermediate goods using unweighted tariffs. Figure A10 shows the schedule of reciprocal tariffs between China and the rest of the world with intermediate goods in the left panel, and the welfare effects of reciprocal tariffs in the right panel. The left panel in Figure A11 displays the actual tariff applied by China to the rest of the world by 2007 compared with the reciprocal tariff schedule. The right panel of the figure shows 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.

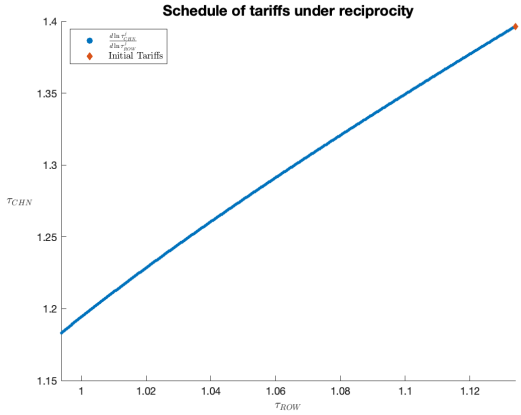


Figure A10a: Tariff schedule under reciprocity with intermediate goods

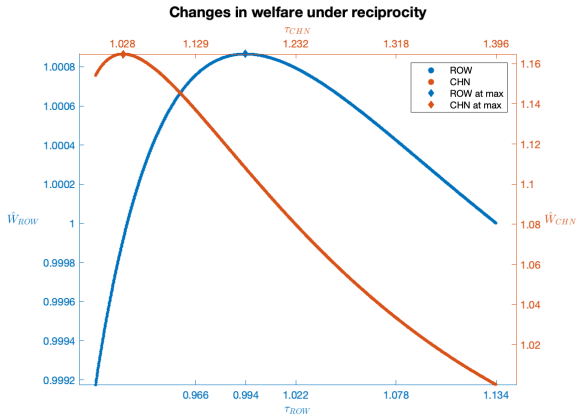


Figure A10b: Welfare effects of reciprocity

Note: The left panel presents the schedule of reciprocal tariff schedule applied between China and the rest of the world starting from the initial equilibrium in 1990. The axes show the reciprocal 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 figures for China.

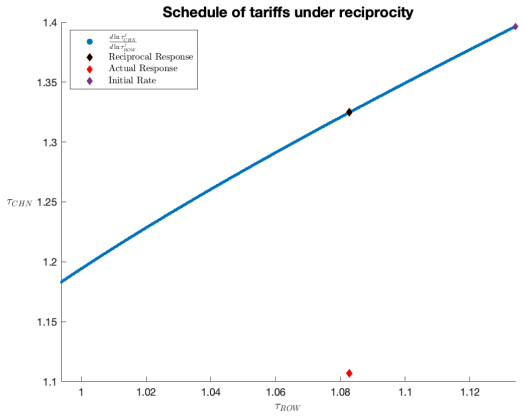


Figure A11a: Reciprocal and actual tariff changes

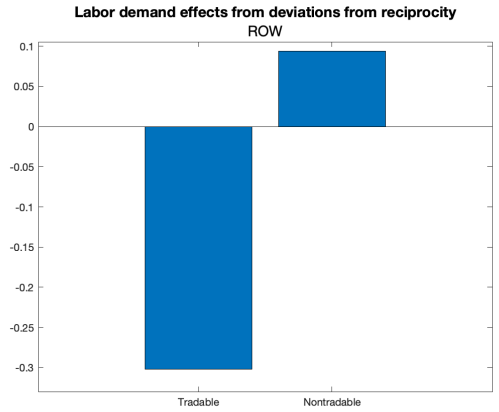


Figure A11b: Employment effects across sectors in the rest of the world

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 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.

We then present 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. As before, Figure A12 shows the schedule of reciprocal tariffs between China and the rest of the world with intermediate goods in the left panel, and the welfare effects of reciprocal tariffs on the right panel. The left panel in Figure A13 displays the actual tariff applied by China to the rest of the world by 2007 compared with the reciprocal tariff schedule. The right panel of the figure shows the employment effects of deviation from reciprocity across sectors in the rest of the world. Consistent 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.

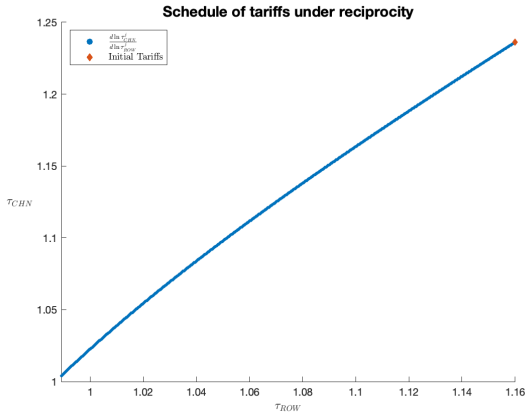


Figure A12a: Tariff schedule under reciprocity with intermediate goods

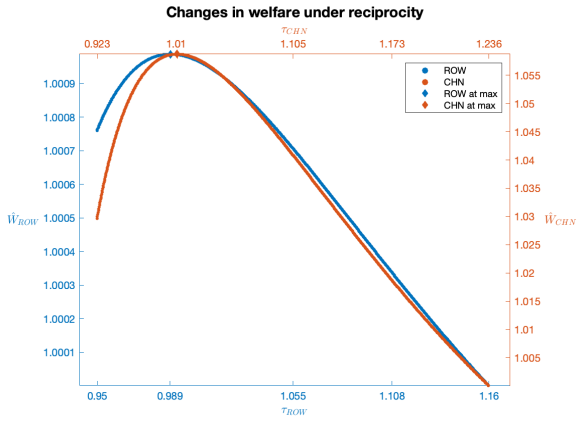


Figure A12b: Welfare effects of reciprocity

Note: The left panel presents the schedule of reciprocal tariff schedule applied between China and the rest of the world starting from the initial equilibrium in 1995. The axes show the reciprocal 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 figures for China.

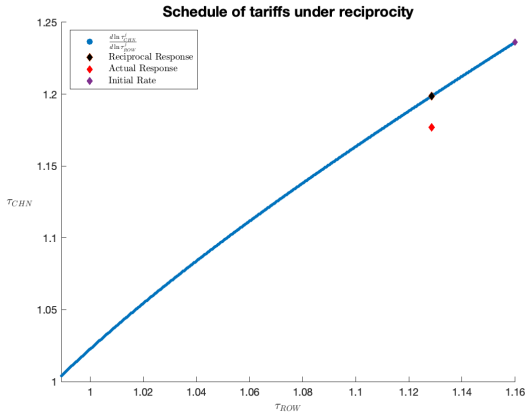


Figure A13a: Reciprocal and actual tariff changes

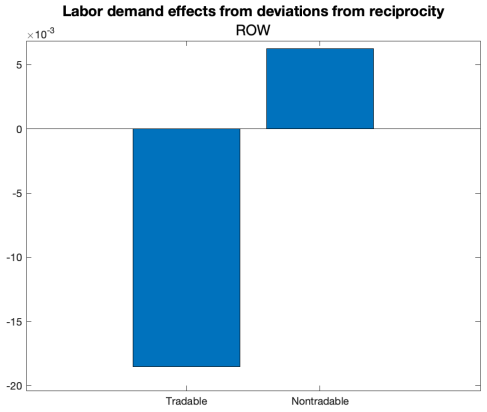


Figure A13b: Employment effects across sectors in the rest of the world

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 1995, 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 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 1995-2007.

Finally, we present results using unweighted tariffs. In the next set of figures, we also take the model the year 1995, and evaluating reciprocity over the period 1995-2007. Analogously to the previous set of figures, Figure A14 shows the schedule of reciprocal tariffs between China and the rest of the world with intermediate goods in the left panel, and the welfare effects of reciprocal tariffs in right. The left panel in Figure A15 displays the actual tariff applied by China to the rest of the world by 2007 compared with the reciprocal tariff schedule. The right panel of the figure shows 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 over reciprocity.

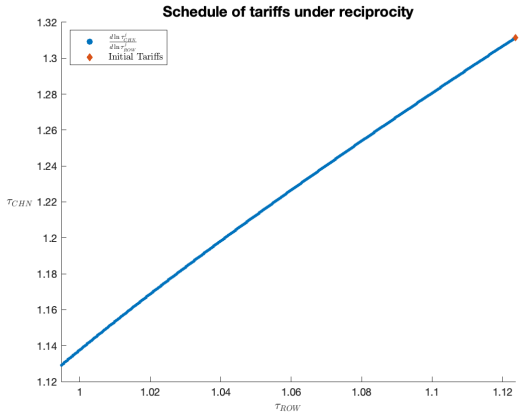


Figure A14a: Tariff schedule under reciprocity with intermediate goods

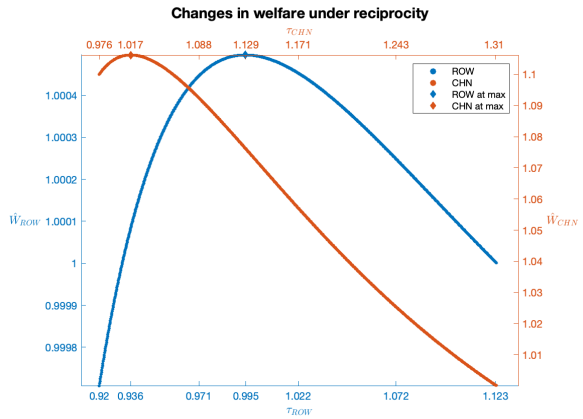


Figure A14b: Welfare effects of reciprocity

Note: The left panel presents the schedule of reciprocal tariff schedule applied between China and the rest of the world starting from the initial equilibrium in 1995. The axes show the reciprocal 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 figures for China.

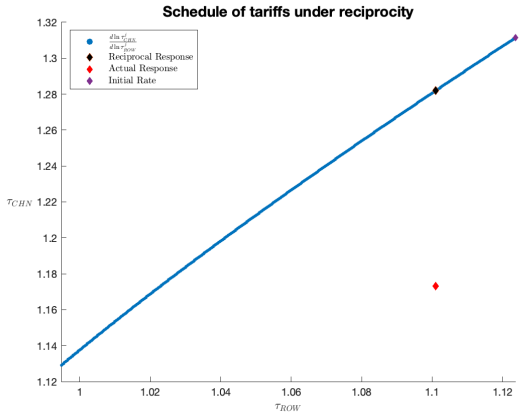


Figure A15a: Reciprocal and actual tariff changes

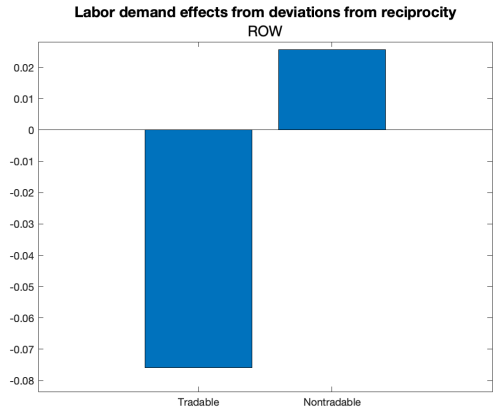


Figure A15b: Employment effects across sectors in the rest of the world

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 1995, 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 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 1995-2007.

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