21^{st} Century Trade Wars

Edward J. Balistreri
Colorado School of Mines

Russell H. Hillberry
Purdue University

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Abstract

We use the GTAP data in a GTAP-in-GAMS framework to calculate the economic effects of trade policies proposed by candidate Donald Trump in his successful campaign to become President of the United States. We calibrate a multi-sector multi-regional equilibrium with Melitz (2003) technologies in the manufacturing and business services sectors. We calculate optimal bilateral tariffs against China and Mexico and consider their optimal responses. In a more detailed look at Mexico we consider the 35 percent U.S. tariff on Mexican imports that Trump proposed during the campaign, and the 20 percent tariff on Mexican imports that was suggested shortly after he took office. We model optimal Mexican responses as well as responses that would be consistent with its World Trade Organization disciplines.

Key words: Optimal tariffs, Donald Trump, Computable General Equilibrium
JEL codes: F13, F17, F53

1 Introduction

One of the central challenges for applied general equilibrium (AGE) policy modeling has always been obtaining adequate data to do the task. Reputable policy modeling of international-trade policy requires consistent data on production, consumption, input-output relationships, international trade as well as the levels of benchmark distortions and policy instruments. Collecting and consolidating these data for one country is difficult enough. But trade policy analysis typically involves at least two countries and usually many more. Among Tom Hertel's many contributions to the study of trade policy, one of his most important has been the production, through GTAP, of a globally consistent dataset that collects all the necessary information for most countries in the globe. These data are a critical input to quantitative trade policy analysis, and we are confident that we speak for many others when we express our gratitude to Tom and the team at GTAP for collecting and publishing these data. In this paper we take advantage of these data to generate a set of simulations that inform the current rhetoric around U.S. trade policy as it relates to new tariff threats.

When we were employed at the U.S. International Trade Commission in the early 2000s, it seemed that the usefulness of applied general equilibrium models for trade policy analysis (at least as it pertained to the United States) had diminished somewhat. In our time at the Commission we participated in the analyses of a series of the bilateral agreements negotiated under George W. Bush. For the most part these agreements contained rather modest tariff cuts, if any, and instead focused on bilateral commitments in other areas. Identifying and measuring the actual policy instruments in these agreements that affected trade was challenging. It was difficult, if not impossible, to provide credible policy impacts for policy makers that could be traced back to price wedges.[1] The most controversial aspects of

[1] The U.S.–Australia agreement, for example, established working groups that would "consider ... procedures for fostering the development of mutual recognition arrangements between their relevant professional bodies" in its chapter on trade in services.

modern trade agreements (e.g. investor state dispute settlement) are also extremely difficult to quantify in a transparent and credible way. We were asked to comment on fuzzy policy instruments and their uncertain implications.

The recent election of President Trump promises to put quantitative modelers back on firm ground. We are back to talking about a real policy instrument—tariffs.[2] Throughout his campaign, candidate Trump promised to apply tariffs on a number of trade partners who had manipulated their way into *stealing American jobs* and contributing to our malaise. This reawakened protectionist agenda is something AGE modelers can really sink their teeth into. Tariffs are precisely the trade policy instruments for which AGE analysis is most credible. We are suddenly back in a policy environment where we can apply transparent techniques to answer policy-relevant quantitative questions.

The return of old-fashioned protectionist policy instruments offers an opportunity to explore realistic trade policy scenarios using new trade theories. In this paper we calculate optimal bilateral U.S. tariffs vis-a-vis Mexico and China and consider optimal retaliation. We conduct these exercises in a multi-sector multi-region general equilibrium model with a Melitz (2003) formulation of trade in the manufacturing and business services sectors. We use the model to calculate optimal U.S. tariff rates vis-a-vis Mexico and China assuming these countries respond optimally. We explore the situation with Mexico in greater detail, imposing higher-than-optimal tariff rates proposed by candidate Trump. We model Mexico's optimal unconstrained responses as well as responses constrained by World Trade Organization (WTO) disciplines.

Relative to standard structures our novel formulation of industrial organization in the trade intensive manufacturing sectors indicates relatively modest optimal tariffs. Our model has strong similarities to that of Ossa (2011), where a country imposing a tariff on imports

[2]Although Trump's tariffs might increase the demand for our services as economists, it is disappointing to realize that we failed to communicate the virtues of cooperative trade policy. Maybe we thought that battle was won?

of a monopolistically competitive industry can cause some of the foreign manufacturing activity to relocate to the country imposing the tariff.[3] By reneging on its commitments to cooperative trade policy, the U.S. can leverage its larger market to relocate manufacturing activity from Mexico to the U.S. Mexico suffers substantial damages from U.S. tariffs, even under a policy of optimal retaliation. Mexico's smaller size and heavy dependence on the U.S. market indicates substantially lower tariffs in the Nash equilibrium. We find that the constraint on the maximum level of WTO consistent Mexican retaliation is not binding relative to Mexico's optimal response. That is, we find that Mexico's optimal retaliation is far below WTO disciplines, therefore Mexico is better off not fully utilizing the WTO consistent retaliation.

We also consider hostile bilateral tariffs between the U.S. and China. Interestingly, under our new-trade market structure, China's benchmark tariffs are above its optimum. This means that the Nash equilibrium for a U.S.-China trade war involves China reducing its tariffs against U.S. goods. The U.S. again (coming from an initial rate of protection that is substantially below its optimum) extracts considerable rents from China at the Nash.

The organization of the paper is as follows. Section 2 briefly reviews the literature on optimal tariffs and Nash equilibrium trade wars. In section 3 we characterize the trade policy scenarios we consider, referencing both the trade policies proposed by candidate Trump and a representation of WTO consistent retaliation by Mexico. Section 4 describes the general equilibrium trade model and describes the data and the aggregation that we employ in our analysis. Section 5 reports results and section 6 concludes.

[3] The operative mechanism in Ossa (2011) is not so far removed from what the president seems to imagine.

2 Literature

The literature on optimal trade policy dates back to Johnson (1953), who demonstrated that, in a one-shot game two large countries would generate a Nash solution with tariff rates above their social optimum. In this context, a theory about the purpose and structure of trade negotiations and agreements is useful. Until recently, the theory proposed by Bagwell and Staiger (1999) was the primary lens through which economists' viewed these issues. More recently Ossa (2011) offered a new theory of trade negotiations and the framework that guides them. Ossa (2014) takes this theory to the data, calculating optimal tariffs. Ossa (2016) conducts a more general exercise, incorporating an additional theory, Grossman and Helpman (1994), which highlights the role of domestic political economy concerns in tariff-setting.

Ossa (2016) provides a useful review of both the theoretical and quantitative literatures. While there is quite a bit of theoretical work on Nash tariffs, he finds only a few efforts to quantify optimal trade policy in a general equilibrium setting. Hamilton and Whalley (1983) conducts a numerical study of a model with two regions and one import good, calculating optimal tariffs well above observed tariff levels. In a calibrated Computable General Equilibrium model, Markusen and Wigle (1989) calculate Nash tariffs for the United States and Canada, as well as welfare effects of a trade war between them on those countries and on six other regions. Perroni and Whalley (2000) calculate Nash tariffs in a seven-region global economy, and consider the benefits of bilateral trade agreements as constraints on possible trade wars. Ossa (2011) and Ossa (2012) calculate Nash optimal tariffs using the theory proposed in Ossa (2011).

The theories of trade wars and trade negotiations posited by Bagwell and Staiger (1999) and Ossa (2011) are quite similar at a macro level. Trade negotiations and agreements allow countries to address an externality. But the two theories differ in the nature of the externality, and this has quantitative consequences for their results. In Bagwell and Staiger (1999) the externality involves the terms of trade — countries with some form of international market power can influence world prices to their advantage. In Ossa (2011) the externality involves the relocation of firms that produce with increasing returns to scale. This effect is consistent with the substantial adjustments in the pattern of trade found by Balistreri et al. (forthcoming) under their monopolistic-competition heterogeneous-firms treatment. Balistreri and Markusen (2009) show that the traditional terms-of-trade channel is muted in models of monopolistic competition, because the firms (facing downward sloping demand) internalize terms-of-trade effects in their pricing decision.[4]

In this paper we adopt a Melitz production technology in a computable general equilibrium model of the global economy. The model is closely related to those that we applied to other trade and climate policy issues: Balistreri et al. (forthcoming), Balistreri and Rutherford (2013), Balistreri and Rutherford (2012), and Balistreri et al. (2011). In this application we aggregate the world economy into 7 regions and into 8 sectors. We consider Nash tariffs but also conduct a scenario under WTO disciplines, which we formalize with a constraint outlined in Bown and Ruta (2010).

3 Trade policy scenarios

International trade policy is once again relevant. Tariffs and trade agreements were central to the 2016 U.S. presidential campaign — even more so than is typical. During the campaign the winner, Donald Trump, proposed to renegotiate the North American Free Trade Agreement (NAFTA) and to pursue trade policies that "put America first." He made a point of singling out Mexico and China, threatening higher tariffs against these trading partners. In light

[4] Balistreri and Markusen (2009) demonstrate that the optimal tariff approaches zero as a country's share of the global endowment approaches zero in a model with both firm-level (a la Krugman) and country-level (a la Armington) differentiated products when the degree of differentiation at the firm and country levels is similar.

of these events, it seems useful to calculate possible implications of actions along these dimensions and possible responses by Mexico and China.

In our first exercises we calculate optimal unilateral U.S. tariffs on Mexico, and optimal unilateral Mexican tariffs on the U.S. We then consider Mexico's potential responses to the proposed 20 and 35 percent Trump tariffs.[5] We proceed to compute the U.S.-Mexico set of bilateral Nash tariffs (a trade war), and we also consider the U.S.-China Nash tariffs.

In each of our scenarios, we model a uniform ad valorem tariff increase that is added to any existing tariffs. True optimality would imply different tariffs across sectors for both the U.S. and the responding countries. A uniform average tariff is transparent and more useful for communication and for comparing results across scenarios. Given the lack of specifics in Trump's proposals we feel that a uniform additional tariff is a reasonable first cut at what he has in mind.

As a caveat it is important to consider that our exercises take the GTAP data as given, and these do not specifically account for bilateral processing trade between the U.S. and China or Mexico. Both countries have sizable processing sectors, and assemble goods with U.S. components, which are often exported back to the U.S. This means that our estimates may overstate optimal U.S. tariffs and/or bilateral responses.

4 Model Description

The model is based on the canonical GTAP-in-GAMS structure presented by Lanz and Rutherford (2016). For this application we adopt the structural extensions made by Balistreri et al. (forthcoming) to treat some goods using the heterogeneous-firms structure suggested by Melitz (2003), while the remaining goods retain an Armington (1969) treatment. The actual equations for the alternative trade structures are presented in Balistreri et al. (forthcoming),

[5]The 35 percent proposal is documented in Applebaum (2016). The 20 percent tariff was floated as a possible means to fund *the border wall*, and is documented in Diamond (2017).

while we refer the reader to the GTAP-in-GAMS documentation (Lanz and Rutherford, 2016) for the overall general equilibrium structure and its formulation as a Mixed Complementary Problem (MCP) in the GAMS software system.[6]

The model structure used in this exercise is relatively transparent as we err on the side of transparency given our goal of getting a rough idea of what trade wars might look like and how costly they may be. A representative household in each region is assumed to have a single level Cobb-Douglas utility function over commodities. Investment and Government spending are Leontief aggregates where the overall levels of investment and government spending are held fixed (in real terms) at their benchmark levels. Therefore, any new (or diminished) tariff revenues accrue to the household through adjustments in the direct lump-sum transfer payments between the household and the government. The households' incomes include gross payments to primary factors (capital and labor), less net transfers and direct taxes to the government, and net capital flows. Capital flows indicate benchmark trade imbalances that are not readily explained in a static trade model. We make the simplest assumption possible concerning capital flows: they are held fixed across all experiments.

Production in the model is given by a nested Constant-Elasticity-of-Substitution (CES) structure. At the top-level nest, intermediate inputs combine with one another and a value-added composite with a low elasticity of substitution (0.2). The value-added composite is a Cobb-Douglas mix of labor and capital inputs.

Under Armington trade, the output of each sector is assumed to be a region-specific variety. Consumer and intermediate goods are a CES composite of domestic and trade-partner varieties. In contrast, under the Melitz trade formulation goods are differentiated at the firm level. Thus, consumers and producers demand a Dixit-Stiglitz composite that is made up of varieties from domestic and foreign firms. The Melitz structure relies on a large-group monopolistic competition heterogeneous-firms industrial organization. Firms

[6] GAMS Development Corporation, Washington D.C., USA.

select into specific bilateral markets based on the fixed cost of operating in each market and their firm-specific productivity draw. In addition, in the multi-sector model the overall profitability of the industry may induce entry or exit such that the mass of firms available for competitive selection changes.[7] The indication is that under the Melitz structure there will be endogenous productivity impacts related to export selection, as well as endogenous Dixit-Stiglitz variety impacts. For more details on the implementation and implications of the Melitz structure in a AGE context see Balistreri and Rutherford (2013).[8]

The multi-region general equilibrium is calibrated to GTAP9 data (Aguiar et al., 2016). Table 1 indicates the aggregate regions, sectors, and primary factors of production used in this analysis. As well as the trade treatments of each of the sectors. The Melitz structure seems appropriate in the manufacturing and business services sectors, but perhaps less so for up-stream agricultural production, resource extraction, and other sectors where there is not a clear case for firm-level increasing returns to scale and firm-level product differentiation. Ultimately, the appropriate trade treatment is an empirical question that is beyond the scope of this study. We do feel, however, that the structural treatment will depend on the sector, and we recognize that the quantifications that we are interested in will be sensitive to these choices.

Another set of critical choices involve the assumed trade elasticities. As a part of the GTAP-in-GAMS aggregation, trade-weighted averages of the original GTAP elasticities are reported. We adopt these as the Armington substitution elasticities between regional varieties in the constant-returns sectors. Under our formulation we have a single nest that combines imports from various sources and the domestic variety. The elasticity that we assume is the import-import elasticity.[9] For the Melitz sectors we adopt a firm-level elasticity

[7] Entry is a key margin of adjustment that indicates different welfare impacts across structures (Balistreri et al., 2010).

[8] Other good sources on AGE Melitz formulations include Dixon et al. (2016) and Akgul et al. (2016).

[9] The GTAP data also reports a different elasticity of substitution that applies between the domestic variety and the import-import composite under the often used two-level nesting.

Table 1: Regions, goods, and factors in the model

Regions:		**Goods:**		**Factors:**	
USA	United States	**Armington Structure**		LAB	Labor
MEX	Mexico	AGR	Agricultural	CAP	Capital
CAN	Canada	RES	Primary Resources		
CHN	China and Hong Kong	TRN	Transport Services		
EUR	EU27 plus EFTA	OSV	Other Services		
OCD	Rest of OECD	AOG	All Other Goods		
ROW	Rest of World	**Melitz Structure**			
		FOO	Manufactured Food Products		
		MAN	Manufacturing		
		BSV	Business Services		

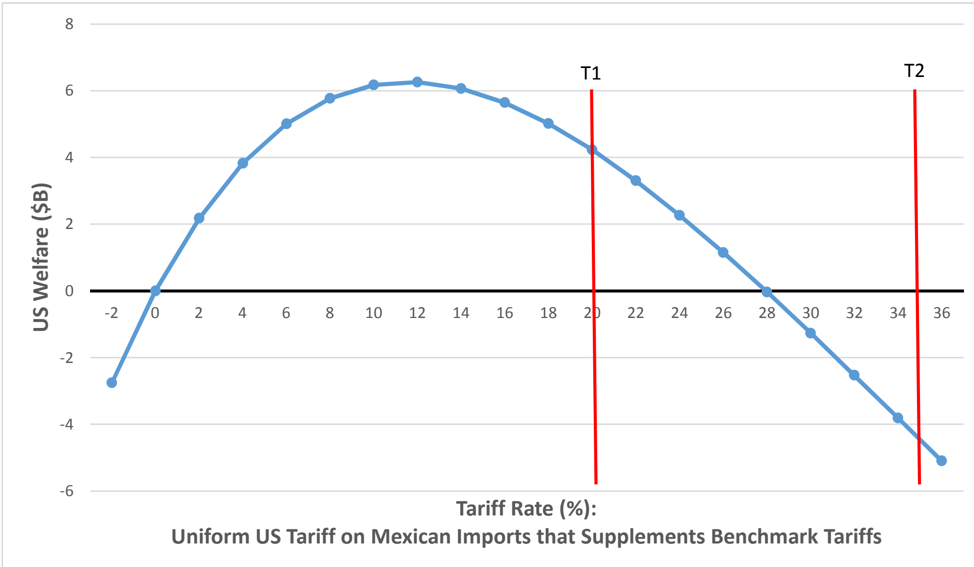
of substitution of 3.8 based on the plant-level analysis of Bernard et al. (2003), and we adopt a Pareto shape parameter (on the firm-level productivity distribution) equal to 4.6, which is our preferred estimate in Balistreri et al. (2011).

5 Results

In this section we present a set of scenario results that characterize the strategic value of tariffs. First, we consider the incentives for the U.S. to unilaterally impose tariffs on Mexico. Then we consider Mexico's potential responses under a set of publically announced threats made by President Trump. In particular, we consider Mexico's optimal responses to a 20% and a 35% U.S. tariff. We then consider the Nash tariffs, where each country imposes its optimal tariff conditional on the tariff set by the other country.

Figure 1 shows the U.S.'s unilateral incentive to impose tariffs on Mexico. The optimal tariff is around 12%, which reflects the U.S.'s large relative size and substantial market power. The U.S. gains $6.3 billion (Equivalent Variation) by pursuing its optimal uniform supplemental tariff (assuming no retaliation). This is a very small gain relative to overall private consumption. The percentage gain is less than 0.06%. We also see in Figure 1 that

Figure 1: U.S. Welfare Impacts of an Additional Uniform Tariff on Mexico Imports

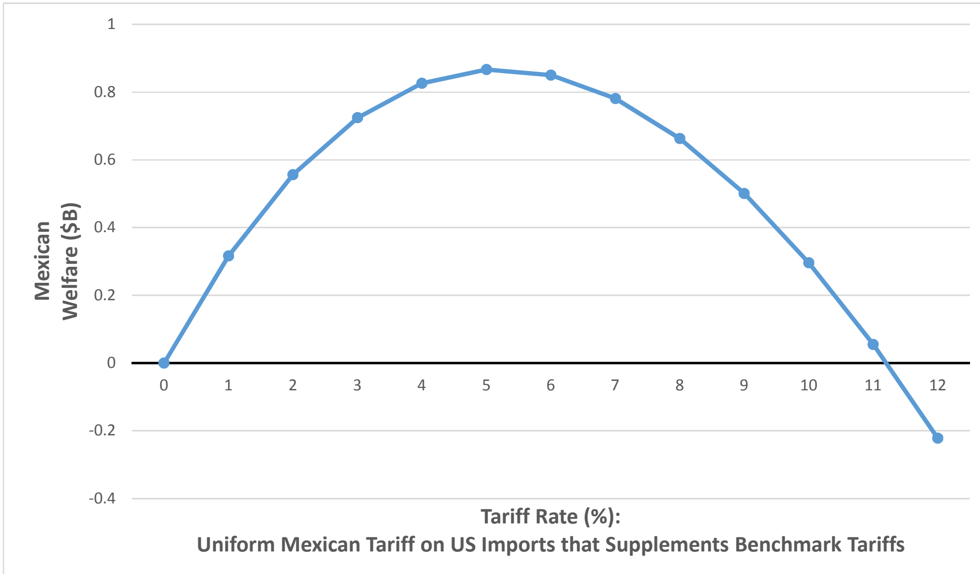


the Trump proposals of a 20% and 35% tariff on Mexican imports (labeled 'T1' and 'T2' in the figure) are well beyond the optimal tariff. In fact, a 35% tariff on Mexico actually costs the U.S. around $5 billion.

It is important to note that our conclusions are sensitive to the assumed Melitz trade structure for the manufacturing and business services sectors. Ossa (2011), citing Venables (1987), explains that models with a monopolistically competitive manufacturing sector and non-manufacturing sectors with constant returns to scale in production contain a production relocation externality that generates positive optimal tariffs. In the more standard Armington framework, the externality addressed by trade policy is a terms-of-trade externality. In that framework, trade quantities are relatively stable with respect to tariff changes, and welfare changes are driven by changes in relative prices. This can mean higher optimal tariffs in the Armington structure than in the Melitz structure.

This is, in fact, what we find. Using the base elasticities but assuming that the Melitz sectors are constant-returns Armington sectors, we find that the optimal unilateral U.S.

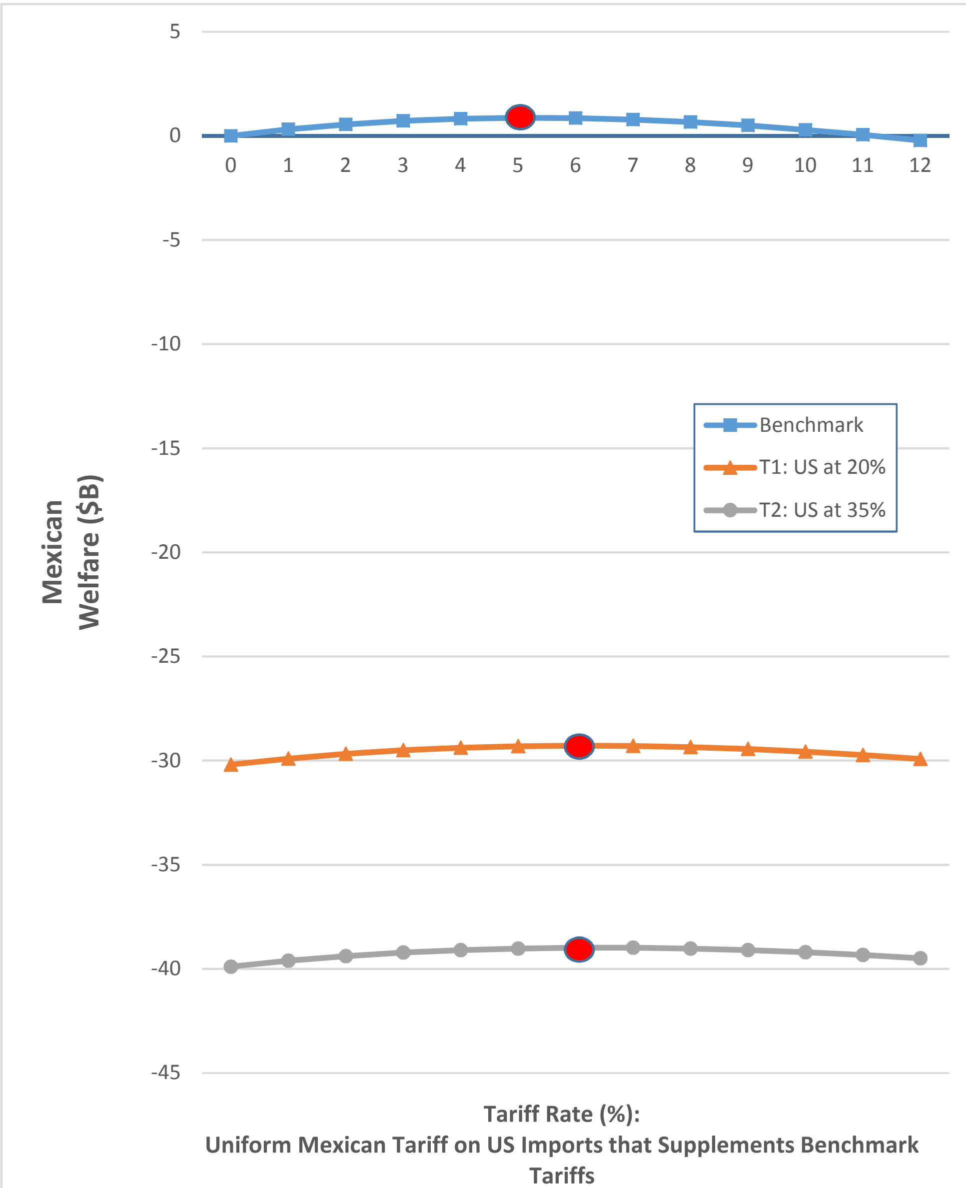
Figure 2: Mexico Welfare Impacts of an Additional Uniform Tariff on U.S. Imports



tariff is 22% with U.S. welfare gains of $15.9 billion. Exploring the structural sensitivity further we find that under the unilateral 20% U.S. tariff scenario we would need Armington elasticities some 57% higher in manufacturing and services to generate the same real output responses in Mexico that we see in the central Melitz case. Even with these elevated elasticities the optimal unilateral U.S. tariff is 14% with welfare gains of $10.7 billion. This is a substantially different outcome than under the Melitz formulation with central elasticities where the optimal tariff is 12% and the welfare gain is only $6.3 billion.

In Figure 2 we consider Mexico's unilateral incentive to impose tariffs on U.S. imports. The optimal tariff for Mexico is significantly lower at 5%, and the available gains are low at $0.87 billion. This is a welfare gain of 0.1%. We generate the same set of responses in Figure 3, but now include the cases of the proposed Trump tariffs. The harm to Mexico of the Trump tariffs would be substantial. Under the 20% tariff proposal welfare in Mexico falls by about $30 billion regardless of Mexico's response. This is nearly a 4% welfare loss,

Figure 3: Mexico Welfare Under Responses to Proposed Trump Tariffs



and the losses are even more extreme under the proposed 35% tariff.[10] In each case Mexico's optimal response recoups little of the overall losses.

It is also important to note that the optimal response in terms of tariff rates is insensitive to the U.S.'s policy. While the optimal tariff rises with the U.S. tariff rate the changes are small. This is a robust finding for all countries throughout our analysis: the reaction functions are relatively insensitive to partner country policy. In a very similar framework that is simplified to produce cleaner analytical results, Ossa (2011) also calculates reaction functions that are insensitive to the tariff imposed by the other country.[11] At a fundamental level a country's optimal tariff against a given partner is dependent on traditional terms-of-trade leverage and (for monopolistic-competition sectors) the production relocation externality as identified by Venables (1987). For models with product differentiation, either at the firm or country levels, these effects are not heavily impacted by partner-country tariffs. Thus, in models with product differentiation we find relatively insensitive reaction functions.

With a relatively good guess at where the reaction functions meet we enumerate the set of tariff combinations local to the Nash. Table 2 reports these results. A trade war between the U.S. and Mexico harms both countries. The optimal U.S. tariff rate is 12% over the range of reported Mexican tariffs, and the optimal Mexican tariff is 6% over the range of reported U.S. tariffs. At the Nash equilibrium the U.S. loses about $1 billion whereas Mexico loses $20.4 billion.

We now consider the legality of Mexico's retaliation under WTO disciplines. As outlined in Bown and Ruta (2010) in a trade dispute the parties are generally bound by reciprocity. Formalizing the reciprocity constraint in this context indicates that Mexico could only impose a tariff up to the point that the tariff reduces the value of exports from the U.S. to Mexico

[10]The large losses imposed on Mexico can be explained by the fact that the tariffs are discriminatory and Mexican firms face significant competition in the U.S. market from firms from other regions. Exports to the U.S. contribute to about 30% of Mexico's GDP so it is not surprising that we see substantial welfare losses in Mexico.

[11]See in particular Figure 2.

Table 2: Nash-equilibrium trade war between the U.S. and Mexico

US Tariff Change (%): Uniform Change Relative to Benchmark		Mexican Tariff Change (%): Uniform Change Relative to Benchmark								
		2	3	4	5	6	7	8	9	10
8	US EV ($B):	3.16	1.91	0.72	-0.44	-1.56	-2.63	-3.67	-4.67	-5.63
	Mex EV ($B):	-14.89	-14.72	-14.61	-14.56	-14.55	-14.59	-14.68	-14.81	-14.97
9		3.40	2.16	0.97	-0.19	-1.30	-2.37	-3.41	-4.40	-5.37
		-16.47	-16.29	-16.18	-16.12	-16.12	-16.16	-16.24	-16.36	-16.52
10		3.57	2.33	1.14	-0.01	-1.12	-2.19	-3.22	-4.22	-5.17
		-17.97	-17.79	-17.68	-17.62	-17.61	-17.65	-17.73	-17.85	-18.01
11		3.65	2.42	1.23	0.08	-1.02	-2.09	-3.12	-4.10	-5.06
		-19.40	-19.23	-19.11	-19.05	-19.04	-19.08	-19.15	-19.27	-19.42
12		3.67	2.44	1.25	0.11	**-0.99**	-2.05	-3.08	-4.06	-5.01
		-20.77	-20.60	-20.48	-20.42	**-20.41**	-20.44	-20.51	-20.63	-20.77
13		3.61	2.39	1.21	0.07	-1.03	-2.08	-3.10	-4.08	-5.02
		-22.07	-21.90	-21.79	-21.72	-21.71	-21.74	-21.81	-21.92	-22.06
14		3.50	2.28	1.10	-0.03	-1.12	-2.17	-3.18	-4.16	-5.10
		-23.32	-23.15	-23.03	-22.97	-22.95	-22.98	-23.05	-23.15	-23.30
15		3.32	2.11	0.94	-0.19	-1.27	-2.32	-3.32	-4.29	-5.22
		-24.51	-24.34	-24.22	-24.15	-24.13	-24.16	-24.23	-24.33	-24.47
16		3.09	1.89	0.73	-0.39	-1.47	-2.51	-3.51	-4.48	-5.40
		-25.64	-25.47	-25.35	-25.28	-25.26	-25.29	-25.35	-25.46	-25.59

by an amount equivalent to the value of reduced Mexican exports to the U.S. Under scenario T1 where the U.S. unilaterally imposes a 20% tariff, Mexican exports to the U.S. fall by $125 billion. The retaliatory Mexican tariff that reduces U.S. exports by an equivalent $125 billion is 31.2%! This is significantly above the optimal (6%) and further degrades Mexican welfare. Under the full WTO retaliation welfare in Mexico falls by $36 billion (or 4.7%). The WTO disciplines are even less binding under the proposed 35% U.S. tariff on Mexico. We can ask how low the U.S. tariff would have to be in order for the WTO restriction to become binding. That threshold is around 6%. Mexico is better off pursuing optimal retaliation as opposed to using WTO-consistent reciprocity tariffs if the U.S. chooses tariffs above 6%. An important lesson here is that normal WTO-consistent retaliation is not likely to be a credible deterrent against a large rogue country intent on extracting rents from specific trade partners.

Given that China has also been the target of Trump's tariff threats we consider a bilateral trade war between the U.S. and China. Table 3 shows tariff combinations and welfare impacts local to the Nash equilibrium. Interestingly China's optimal tariff adjustment is negative.

China gains from unilaterally lowering its tariffs against the U.S. This is due (in part) to China's relatively high benchmark tariff regime and our adoption of the Melitz structure for manufacturing. The calculated average benchmark tariff on U.S. manufactured goods and services (Melitz sectors) shipped to China is 5.6%, whereas the U.S. benchmark tariff on the same goods from China is only 2.9%.[12]

Balistreri and Rutherford (2013) also find that China has a unilateral incentive to lower its tariffs relative to the benchmark. They find that under a Melitz treatment that China is beyond its optimal tariff in the benchmark, but China is below its optimal tariff under a standard Armington structure. The same pattern emerges in the model used for the analysis in this paper. Under the Armington structure China would appear to benefit from tariff increases. The optimal unilateral change in the tariff on U.S. imports to China, conditional on maintaining benchmark U.S. tariffs, under our Melitz treatment is -6%. At the same elasticities — but adopting a pure Armington structure — the optimal change in the tariff is +10%. This highlights the dramatic structural sensitivity of any optimal tariff analysis. In our analysis China has roughly a zero average tariff against the U.S. at the Nash. Recent analysis suggest that negative tariffs should not be surprising under a Melitz treatment. Caliendo et al. (2017) find that negative optimal tariffs are consistent with the theory and common in their calibrated model.

6 Conclusion

The election of President Trump elevates the need for quantitative analysis of the economic consequences of protectionist U.S. trade policies and of retaliatory responses by affected U.S. trading partners. Comprehensive and balanced data on production, trade flows and trade

[12] Across all goods and services the benchmark average tariff on U.S. shipments to China is 4.3%. The components are as follows: 8.3% on `FOO`, 5.1% on `MAN`, 3.1% on `AGR`, and 0.2% on `RES`. The remaining goods and services have no benchmark tariffs.

Table 3: Nash-equilibrium trade war between the U.S. and China

US Tariff Change (%): Uniform Change Relative to Benchmark		China Tariff Change (%): Uniform Change Relative to Benchmark: -6	-5	-4
10	US EV ($B):	16.33	14.92	13.58
	Chn EV ($B):	-42.38	-42.35	-42.42
11		16.37	14.96	13.63
		-45.83	-45.79	-45.85
12		16.30	14.89	13.57
		-49.12	-49.07	-49.13

policies from GTAP are a critical input for exercises like these. We use the GTAP data to calibrate a multi-sector multi-country general equilibrium model in which manufacturing and business services sectors have a Melitz (2003) technology. We apply the calibrated model to quantify the effects of protectionist U.S. tariff policies towards Mexico and China, as well as best responses by those countries.

Assuming no retaliation, both the U.S. and Mexico can slightly improve their own welfare with a uniform unilateral increase in their respective bilateral tariffs. President Trump's proposed tariff increases on imports from Mexico lie well above the optimal U.S. tariffs vis-a-vis Mexico. Mexico suffers substantial welfare losses from either the optimal U.S. tariff or from one of President Trump's proposals.

We also calculate Nash equilibria in which each country imposes its optimum bilateral tariff, taking the other country's optimum as given. Both the U.S. and Mexico suffer welfare losses in this scenario, though the U.S. losses are quite small. Optimal Mexican responses are similar in the case of an optimal U.S. tariff and in cases where the U.S. follows through on President Trump's proposals to raise tariffs well beyond the optimum.

We conduct a similar exercise with China. We calculate that China's benchmark tariffs lie above its optimum, and that China's best response to optimal U.S. tariffs is to reduce their own tariffs. In this situation the Nash equilibrium produces modest U.S. welfare gains and Chinese welfare losses.

One contribution of the paper is to demonstrate a challenge that aggressive U.S. protectionism applies for the world trading system. Retaliatory tariffs by relatively smaller economies like Mexico are limited by economic fundamentals, which means that WTO-authorized retaliation is not incentive compatible. Countries like China, which have relatively high benchmark tariffs, may also be limited in their retaliatory capabilities because higher Chinese tariffs would compound Chinese losses from increased U.S. tariffs.

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