A dirty little secret? Import quotas: evidence from Mexico using an applied General Equilibrium Model

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Abstract. The main theoretical argument against import quotas (and other trade barriers) is that they result in social welfare loss; hence, the rhetoric for most trade agreements focuses on their elimination so that welfare gains will improve enhancing opportunities. This research designs an applied General Equilibrium Model for Mexico to evaluate welfare loss from simulated intermediate goods import quotas in the manufacturing industry, finding non-significant welfare loss. Results have strong welfare and policy implications; one is that specific import quota policies to protect, support, develop, specific industries, should not be discarded by default, but a sound evaluation of the cases at hand should be carried out.
Key words: import quotas; applied general equilibrium; welfare; policy.

¿Un secretito sucio? Cuotas de importación: evidencia para México utilizando un modelo de equilibrio general aplicado

Resumen. El principal argumento teórico en contra de las cuotas de importación (y otras barreras comerciales) es que provocan una pérdida de bienestar social; por lo tanto, la retórica de la mayoría de los acuerdos comerciales se centra en su eliminación, con el fin de mejorar el bienestar y aumentar las oportunidades. Esta investigación diseña un modelo de equilibrio general aplicado para México con el fin de evaluar la pérdida de bienestar derivada de cuotas de importación simuladas de bienes intermedios en la industria manufacturera, y concluye que la pérdida de bienestar no es significativa. Los resultados tienen importantes implicaciones de política en materia de bienestar; una de ellas es que las políticas específicas de cuotas de importación para proteger, apoyar y desarrollar industrias específicas no deben descartarse por defecto, sino que debe llevarse a cabo una evaluación sólida de los casos en cuestión.

Palabras clave: cuotas de importación; equilibrio general aplicado; bienestar; política.

Clasificación JEL: C68; D58; O21; O47; O54.

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1. Introduction[1]

The main theoretical argument against tariff and non-tariff trade barriers is that they cause social welfare loss; hence, the rhetoric for most trade agreements focuses on their elimination so that welfare gains will improve and enhance opportunities for all people.[2]

On the other hand, recent developments in world trade barriers, mainly driven by the United States of America (USA) –for instance Trump's steel and aluminum tariffs on Canada, Europe and Mexico–,[3] indicate that an era of world trade wars and protectionism could be knocking on the door. While the European Union (EU) can be considered a peer to the USA in a given degree, and retaliation measures might be handled on an eye-for-an-eye basis, the USA-Mexico relationship has clearly being an asymmetrical one and, as a Less Developed Country (LDC) what Mexico needs more than trade wars and/or retaliations, is a committed government to develop the Mexican productive apparatus using, among other things, barriers to protect the construction and development of strategic and/or key sectors.

Another frequent argument in favor of "free trade" is that it would protect consumers from domestic market power, but if a domestic specific industry is too underdeveloped or does not exist, then simply there is no whom to protect the consumers from.

It remains, for a broader research agenda, to estimate something that mainstream free traders seem not to take into account too often: if a quota is imposed to protect and develop a given (sub)sector, to what extent gains from new employment, from integration and development of that (sub)sector (thus from synergies), increases in multiplier effects, scale economies, spillover effects, and others, would countervail welfare losses caused by that quota?

The main purpose of this paper is to carry out an estimation exercise to asses a single non-tariff barrier –an import quota on intermediate goods for a

1 I am very grateful for the comments and suggestions of two anonymous reviewers who contributed to improving this work. Any remaining errors and shortcomings are my sole responsibility.

2 In the case of the North American Free Trade Agreement (NAFTA), it is a well-known fact that, welfare gains have not been substantial; and even if they were, not "all people" has benefited. In fact, the schedules for tariffs elimination show how, powerful interest small groups (*v.g.* automakers) with strong lobbying, were taken care of, while weaker large groups (*v.g.* farmers and peasants) were rapidly exposed to tariffs elimination (*North American Free Trade Agreement, Part Two: Trade in Goods*. https://www.nafta-sec-alena.org/Home/Legal-Texts/North-American-Free-Trade-Agreement).

3 https://www.nytimes.com/reuters/2018/05/31/business/31reuters-usa-trade-metals.html

single (sub)sector–, quantify its welfare effects, and to see whether it would be advisable, on the grounds of an equivalent variation measure, to impose that import quota in the case of the Mexican economy. To that end, we design and implement a full-fledged, but parsimonious, Applied General Equilibrium Model for Mexico (AGEM-Mx12q) using a 2012 Social Accounting Matrix (SAM-Mx12).[4]

This paper advances the literature, we believe, by clearly showing that a quota on imported inputs of a given key/strategic (sub)sector does not necessarily generate a significant welfare loss and would stimulate its development and consolidation.

The paper is organized as follows. In section 2, the literature on import quotas and welfare is reviewed. In section 3, we describe the data, the model and discuss macro-closures. In section 4, simulations are explained and implemented, and results are analyzed. Section 5 concludes with some final comments.

2. BRIEF LITERATURE REVIEW ON IMPORT QUOTAS

The Great (World) Depression (1929), among other changes, marked a new era in world trade practices and, as early as 1933, a paper by Dietrich analyses the system of import quotas in France, noting that "Though import quotas are a hindrance to the free flow of international trade, there is the question whether they are not an instrument of economic control which may be of value in economic planning" (Dietrich, 1933, p. 661). Dietrich's main conclusion is that "There can be no question but that France instituted her quota system as a first-aid measure to safeguard the domestic market for French producers, agricultural and industrial, and to reinforce her protective tariff system, crippled by consolidated tariffs in commercial treaties. As such they can be considered a qualified success […] [it] would seem to indicate that France is beginning to look upon the quota system as a permanent instrument of her trade policy". Dietrich finishes stating: "If, in truth, we have reached 'the end of *laissez faire*', the corollary of which has always been free trade, it would seem as if import quotas merit consideration, not as a weapon but as an instrument of economic control" (1933, p. 674).

[4] The 2012 is one of the most recent years for which an IOT has been published by the INEGI (Mexican Statistics Institute). We believe that the structure of the Mexican economy has not significantly changed.

Import quotas in the USA were analyzed in a 1937 paper by Whittlesey. Since then, research on import quotas has covered a wide spectrum, reaching sometimes well-stablished conclusions, but not always. In what follows we mention some of the issues just to illustrate that wide spectrum, showing the importance of import quotas, and how they might have diverse effects.

With respect to effects on quality, it is well-known theoretically and empirically that import quotas lead to higher quality products being exported (Feenstra, 1988; Harrigan and Barrows, 2009; Khandelwal *et al.*, 2013; Upward and Wang, 2016).

With respect to effects at the firm level, Upward and Wang (2016, p. 71) assert: "We study how Chinese textile and clothing firms adjusted the product structure of their exports to the US, as triggered by the termination of Multifiber Arrangement (MFA) quotas. We find that the removal of MFA quotas induced firms to expand their product scope while reducing the concentration on their core product".

Sievers and Schaffer (2016, p. 497) analyze "the impacts of the German biofuel quota on sectoral domestic production and imports of the German economy. […] The results indicate a clear increase of domestic production and a decline of net imports in the first case. In the second case gains in domestic production are smaller and net imports are, in contrast to the first case, increasing".

Equivalence among several taxes, volume quotas and share quotas, has also been studied at large (Okumura, 2015; Francois and Woerz, 2009). Effects on exports of the incumbent country (Ülengin *et al.*, 2015). Effects on domestic firms' market power (Blonigen *et al.*, 2013). Best import quota policy (Teimoury *et al.*, 2013), etc.

Studying the economy wide impacts of South African quotas on the imports of clothing and textile products from China, Naudé and Rossouw (2008, p. 737) find that "contrary to the motivations apparently underlying the quota implementation, the macro-economic, sectoral and household effects are negative and result in greater inequality between poorer and richer households. […] The policy implications are the imposition of these quotas could come to be seen as a policy mistake, and that South Africa may benefit more from considering a free trade agreement with China".

Another alternative to import quotas are "voluntary restrictions". According to Johnston and Parajuli (2017, p. 135), while studying the share of Canadian lumber in the U.S. lumber market, in order to protect its domestic industry: "Alternatively, Canada could voluntary limit its share of the U.S.

market through voluntary exports restrictions, and capture rents that more than offset any losses to its domestic producers".

The fact is then that import quotas continue to be of interest, and they are in place for several reasons in several countries. For Mexico, the "Trump Era" has several implications related to the NAFTA and other issues, such as Foreign Direct Investment (FDI).

This paper is mainly concerned with the effects of quotas on welfare following the line of works such as Naudé and Rossouw (2008), and with the quantitative effects of an import quota following the line of Krugman (1995, p. 31):

> Economists have […] long preached the virtues of free markets […] free trade in particular. The logic that says that tariffs and import quotas almost always reduce real income is deep and has survived a century and a half of often vitriolic criticism nearly intact. […] Yet there is a dirty little secret in international trade analysis. The measurable costs of protectionist policies –the reduction in real income that can be attributed to tariffs and import quotas– are not all that large. […] These costs are very real, but when you try to add them up, they are usually smaller than the rhetoric of free trade would suggest. For example, most estimates of the cost of protection in the United States put it well under one percent of GDP. […] That is, the standard estimates suggest that a highly protectionist developing country, by moving to completely free trade, would get a one-time economic boost equal to the growth China achieves every five or six months.

Chao *et al*. (1990, p. 160) stated that "Despite the fact that there has been a rich literature on the issue of the equivalence between tariffs and quotas, very little has been written on the welfare effect of quotas", and in their paper they show that "[…] a tightening of import quotas generally reduces welfare. Quotas can improve welfare of a small economy under a stringent set of conditions".

Schweinberger (2003, p. 696) studied import quotas on intermediate goods in relation to special economic zones, and under a set of assumptions,[5] he concludes: "It is proven that there generally exist allocations of binding quotas to the domestic and special economic zones which improve welfare.

[5] Assumptions are: *i)* Small open economy. All goods are traded in world markets. *ii)* Tariff revenue is transferred as a lump sum to the households. *iii)* The special economic zone is a production special economic zone. All domestic consumption takes place in the domestic zone. *iv)* Perfect competition rules in all goods and factor markets. *v)* Immobile and mobile domestically owned factors are used in the special economic zone. *vi)* The quotas on the imports of the intermediate goods are assumed to be binding unless stated otherwise.

Then it is shown that the abolition of the quotas on imports into the special economic zone may reduce welfare".

On the other hand, under international oligopoly, Furusawa *et al.* (2003, p. 31), analyze welfare-enhancing policies, concluding: "We show that even if policy makers have no idea about costs and demand, they can raise welfare by introducing a small production subsidy. If the government knows that demand is not very convex, a small tariff can be used to enhance welfare. With strategic complements, a small import reduction by an import quota deteriorates welfare".

Kreickemeier (2005, p. 194) analyses the welfare effects of tariffs and quotas in the presence of involuntary unemployment, concluding that "[…] employment effects constitute only one part of the welfare effects triggered by a change in the trade policy. It is clear from the analysis that reforms that yield negative employment effects can nevertheless increase overall welfare".

Also, Fan and Fan (2005, p. 1), found that "[…] there are substantial differences in the welfare effects of an equivalent tariff and quota designed to achieve identical import restrictions. When there is an increase in demand, the deadweight loss from an import quota will be greater than that of a tariff".

In a more recent paper, Winchester (2009, p. 820) stated that "A growing literature focusing on welfare implications following the removal of [non-tariff barriers] NTBs has emerged. We contribute to this research by estimating ad valorem tariff equivalents (TEs) of NTBs and simulating reductions in tariffs and NTBs in a computable general equilibrium (CGE) model". Winchester (2009, p. 820) found that "Our simulations reveal that bilateral negotiations between New Zealand and four possible FTA partners (China, Japan, Korea, and the ASEAN block) will increase New Zealand's welfare by 1.5% when tariffs are eliminated and 16.3% when tariffs and NTBs are abolished". Therefore, the study concludes "[…] we find trade economists do not have a dirty little secret".

Even assuming Winchester's calculations are correct,[6] that conclusive remark does not seem very fair, since Krugman (1995) was talking only about quotas, while Winchester considered tariffs and NTB's together.[7]

[6] From caveats in last paragraph of Winchester's paper, but perhaps more importantly, from the fact that the author does not seem to take into account any negative effects caused by removal of all NTB's (which for some reason were imposed, *v.g.* removal of health and safety regulations). This is not conclusive. See, also, caveats from Fugazza and Maur (2008).

[7] "[…] health and safety regulations, competition laws, technical standards (*e.g.*, licensing and certification regimes) and customs clearance procedures" (Winchester, 2009, p. 820).

Then, Chen *et al.* (2011, p. 549) found that "[…] quotas can result in a welfare advantage over tariffs for an importing country despite that its government does not capture any quota rents. Specifically, the conditions under which an equivalent quota yields higher expected welfare than a tariff are shown to depend on a set of economic variables".

3. Data, model, and macro-closures

Based on Input-Output Table (IOT) published by INEGI (2018a) for 2012 and additional data from national accounts, we build a SAM in order to design and calibrate an AGEM.[8]

The Social Accounting Matrix of the Mexican Economy for 2012 (SAM-Mx12), was built following the North American Industry Classification System (NAICS), this SAM has two versions, the first one with 19 productive Activities and the second one with 47 Activities.

This SAM-Mx12 provides a transparent dataset built using official data from the Mexican institute of statistics, and a clear, parsimonious methodology. It can be extended to include more detailed data on energy, environment or any other data disaggregation of interest. It can also be modified, corrected, and/or extended by other researchers to perform diverse experiments trough structural analysis, applied general equilibrium, or other methodologies.

The SAM-Mx12 provides information on the structure of the Mexican economy as of 2012 at the 19 and 47 productive Activities level of disaggregation. It comprises the whole set of elements constituting the yearly circular flow of the economy, specifying levels of income and expenses for every agent: Households, Government, Firms, and the Rest of the World.

The SAM-Mx12 was entirely elaborated using official data from the INEGI. To begin with, we took the IOT published by INEGI (2018a) and rearrange its data into a social accounting matrix format (see table 1).

To get rid of the statistical discrepancies we divide them, proportionally, among the elements of final demand. Then we add accounts for Income tax and Private consumption and use data from the Mexican System of National Accounts (INEGI, 2014 y 2018b), to fill in the gaps and balance the matrix presented in Appendix 1.

[8] http://www.inegi.org.mx/est/contenidos/proyectos/cn/mip12/default.aspx (January/12th/2018). SAM available from the author upon request.

Table 1. Input-Output Table, 2012 data, rearranged into a SAM format.
Millions of current pesos (basic prices)

SAM-Mx12	*Households*	*Societies*	*Government*	*Net taxes on goods*	*Net taxes on production*	*Investment*	*Capital*	*Labor*	*Activities*	*RoW*	*Statistical discrepancy*	**RoW total**	*Column total*	**Difference RoW-Col**
Households								4 216 575				**4 216 575**	10 501 620	**- 6 285 045**
Societies							10 805 152					**10 805 152**	-	**10 805 152**
Government				482 027	84 631							**566 658**	1 839 067	**- 1 272 408**
Net tax on goods	616 929					18 265			- 153 166			**482 027**	482 027	-
Net tax on production									84 631			**84 631**	84 631	-
Investment												-	3 610 919	**-3 610 919**
Capital									10 805 152			**10 805 152**	10 805 152	-
Labor									4 216 575			**4 216 575**	4 216 575	-
Activities	9 290 542		1 837 535			3 016 560			7 594 193	4 933 065	- 362 230	**26 309 665**	26 309 665	-
Rest of World	594 149		1 531			576 095			3 762 280	167 501	174 613	**5 276 169**	5 100 566	**175 603**
Statistical Discrepancy												-	- 187 616	**187 616**
TOTAL	**10 501 620**	-	**1 839 067**	**482 027**	**84 631**	**3 610 919**	**10 805 152**	**4 216 575**	**26 309 665**	**5 100 566**	**- 187 616**			

Source: own elaboration based on IOT. https://www.inegi.org.mx/programas/mip12/2008/

According to the SAM, the AGEM is specified as follows: we design a neoclassical model (Barro and Sala-i-Martin, 2004), where the economy has a fixed endowment of non-differentiated capital and labor. Under full employment, total demands of factors always equal total endowments. This also implies full-factor mobility among activities and, therefore, a long-term horizon since, eventually, capital can be transformed and allocated to other sectors. The same applies to labor.

Aggregated households are the first account of our SAM, obtaining income from capital, wages, government transfers, and transfers (remittances) from the Rest of the World (RoW). On the other hand, households pay taxes, save, and buy goods for present consumption, which comprise one aggregated domestic good and one imported good.

The government collects revenues from income tax, from products and production taxes, and from capital imports. Then the government makes transfers to households (mainly poverty alleviation programs), saves, and consumes domestic goods and an aggregated imported good.

Savings come from households, activities, the government, and the RoW. Total savings are invested in domestically produced capital goods and one aggregated capital good from the RoW.

Production of total supply (gross product) is carried out as follows: in the first place, value added (VA) is produced combining capital and labor (*composite factor*), then VA is combined with domestic inputs to obtain the domestic product, and finally, foreign inputs are added to get the total gross product.

The RoW obtains income from imports: inputs, capital goods, final consumption of households and government, and capital payments. Then spends on transfers (remittances), documented labor, exports, and savings.

Following Lofgren *et al*. (2002, p. 16), we specify a modified *Johansen closure* to avoid "[…] the misleading welfare effects that appear when foreign savings and real investment change in simulations with a single-period model".

Therefore, we fix real investment so that households' marginal propensity to save will adjust to meet any changes in prices. As for the RoW, we fix the exchange rate (ER) and foreign savings, and, also, transfers to households and payments to labor, assuming that non-documented and documented labor will remain constant, leaving exports as the adjustment variable. Government expenditures are fixed in real terms, including savings, in such a way that when a quota is imposed, the rent generated will accrue to government revenues so that a surplus will be generated. In turn, this surplus will be used to reduce taxes on production and products.

Following Hosoe *et al.* (2010), we model quotas through a complementarity condition in order to obtain quota rents, which in turn will accrue to government revenue and used to implement a revenue neutral decrease in production taxes (Appendix 2, equations 34-36).

The usual caveats apply along with the results from Fugazza and Maur (2008, p. 475): "We find that serious estimation and modeling efforts remain to be undertaken in order to make CGE modelling a useful policy tool to analyze NTBs. Casual policy inferences from loose specifications may, indeed, lead to analytical mistakes".

Appendix 2 contains the mathematical formulation.

4. SIMULATION AND RESULTS

Assume that the government decides to protect and foster the development of a given productive sector. The main simulation we implement is the imposition of a quota on intermediate consumption imported by the *Manufacturing industry*, while at the same time, the rents generated by this quota are used to reduce taxes paid by the *Manufacturing industry* itself. To this end, we use the SAM-Mx12 with 19 productive sectors (Activities), where Activity 5 (*Manufacturing industries*) amounts to 34.3% of total gross product, and its imports to 76.6% of total input imports. Since our focus is on welfare, after solving for the new equilibrium, we compute Hick's Equivalent Variation (HEV). See table 2.[9]

Indeed, according to theory, households' welfare diminishes, but if we observe the present consumption of domestic goods, it barely decreases by 0.43% (not even half a percentage point). Present consumption of imported goods shows an increase, although very small.

Let's assume that stronger protectionism is enforced and the quota goes to 50%, instead (see table 3). As expected, subsidies to the *Manufacturing industry* increase up to 9.7% since quota rents will increase when lowering the quota. On the other hand, as one would expect, households' welfare decreases, since a greater distortion is introduced into the economic system, but even in this case, it only amounts to about 2.6% in terms of domestic present consumption. But on the other hand, consumption of imported good increases by 0.5% and, most importantly, Household's savings increase by 3.8%.

[9] To test our model robustness we run all simulations for several sets of constant elasticities of substitution, results do not show any significant change.

Table 2. Simulation of quota on manufacturing input imports: 80% of benchmark

Variable	*Benchmark*	*Simulation*	*Change (%)*
Households' CES utility	720.2525	717.3594	
Hick's Equivalent Variation (HEV)		-4.1979	
Households' marginal propensity to save	0.1042	0.1049	0.64
Households' savings	122.6377	123.3849	0.61
Households' consumption of aggregated good	932.8931	928.8772	-0.43
Households' real consumption of imported good	59.4149	59.4454	0.05
Price of private consumption of aggregated good	1.000	1.0032	0.32
Taxes paid by manufacturing (%)	0.60	-3.82	

Note: values in the "Benchmark" and "Simulation" columns must be multiplied by 10^10 to convert them to 2012 Mexican pesos.

Source: own elaboration.

Table 3. Quota on manufacturing import inputs: 50% of benchmark

Variable	*Benchmark*	*Simulation*	*Change (%)*
Households' CES utility	720.2525	702.4586	
Hick's Equivalent Variation (HEV)		-26.0392	
Households' marginal propensity to save	0.1042	0.1083	3.87
Households' savings	122.6377	127.3518	3.84
Households' consumption of aggregated good	932.8931	908.0811	-2.66
Households' real consumption of imported good	59.4149	59.7310	0.53
Price of private consumption of aggregated good	1.0000	1.0217	2.17
Taxes paid by manufacturing (%)	0.60	-9.68	

Note: values in the "Benchmark" and "Simulation" columns must be multiplied by 10^10 to convert them to 2012 Mexican pesos.

Source: own elaboration based on IOT. https://www.inegi.org.mx/programas/mip12/2008/

However, quotas are generally imposed on much smaller subsectors. Assume then, that the government desires to protect and develop the Chemicals industry, which was chosen mainly because it is a key subsector[10] in most

[10] In the sense of Rasmussen's backward and forward indexes.

major economies of the world, which is to say that, the Chemical industry is a strategic upstream (downstream) sector that supplies (demands) a wide range of intermediate inputs to manufacturing activities, amplifying its potential spillover effects throughout the economy, and therefore it is a good candidate to protect through a quota. Besides, international experience identifies the chemical sector as a core component of industrial policy in both developed and emerging economies, due to its role in innovation and value-chain integration. Although the Automotive industry or other subsectors could also be considered, especially those with strong import reliance, such extensions are left for future research.

This time we look directly at a quota of 50% on intermediate inputs imported by this subsector, using the same SAM but now disaggregated to 47 subsectors, where the Chemical industry (Activity 19 in the 47 subsectors SAM) accounts for only 3% of gross product (see table 4).

Table 4. Simulation of quota on chemical industry imported inputs: 50% of benchmark

Variable	*Benchmark*	*Simulation*	*Change (%)*
Households' CES utility	720.2525	718.6986	
Hick's Equivalent Variation (HEV)		-2.2740	
Households' marginal propensity to save	0.1042	0.1044	0.18
Households' savings	122.6377	122.9171	0.23
Households' consumption of aggregated good	932.8930	930.660	-0.24
Households' real consumption of imported good	59.4149	59.5075	0.16
Price of private consumption of aggregated good	1.0000	1.0026	0.26
Taxes paid by manufacturing (%)	0.90	-7.76	

Note: values in the "Benchmark" and "Simulation" columns must be multiplied by 10^10 to convert them to 2012 Mexican pesos.

Source: own elaboration.

Not surprisingly, welfare loss is dramatically smaller, and present consumption of domestic good decreases in only 0.24% (not even one fourth of a percentage point), while at the same time consumption of imported good increases by 0.16% and, more importantly, Households savings increase by 0.23%.

Although welfare losses remain negative across all simulations, which is theoretically correct, we consider their magnitude is modest in the sense stated by Krugman (1995, p, 31):

> These costs are very real, but when you try to add them up, they are usually smaller than the rhetoric of free trade would suggest. For example, most estimates of the cost of protection in the United States put it well under one percent of GDP. […] That is, the standard estimates suggest that a highly protectionist developing country, by moving to completely free trade, would get a one-time economic boost equal to the growth China achieves every five or six months.[11]

The finding that welfare losses are modest can be explained by the model's transmission mechanisms. In the AGEM-Mx12q, quota rents are fully transferred to the government and recycled as production tax reductions, partially offsetting the initial distortion generated by the import restriction. Moreover, the assumptions of full employment and perfect factor mobility allow capital and labor to be efficiently reallocated toward sectors with higher domestic demand, which mitigates welfare losses at the aggregate level. The overall negative impact stems mainly from a mild increase in domestic goods' prices; however, this is counterbalanced by a slight expansion in imported consumption and a fiscal stimulus to the protected sector. As a result, the economy experiences only a limited decline in real welfare. The simulations thus highlight that the welfare impact of import quotas depends crucially on their fiscal recycling mechanism and the structural features of the economy. When quota rents are reinvested to reduce production taxes and factor markets adjust flexibly, welfare costs become minimal.

5. FINAL COMMENTS

In this paper we build a SAM and design an AGEM for Mexico to analyze the welfare effects from quotas on imports of intermediate goods.

[11] It is worth adding that one of the anonymous reviewers specified the following: Regarding the methodology, the model specification and its calibration with the 2012 SAM are adequate and conform to standard practices in this type of exercise. Although certain assumptions–such as full employment and perfect factor mobility–could limit the realism of the analysis in the Mexican context, it is important to note that such assumptions tend to work against protectionism; therefore, the fact that the estimated costs are minimal even under these conditions suggests that, in a scenario with unemployment or structural rigidities, the results could further reinforce the central thesis of the paper.

Contrary to some authors (*v.g.* Winchester, 2009), we find that import quotas do not generate significant welfare losses, hence, the "dirty little secret" stated by Krugman (1995) might be in place.

Policy implications in terms of international trade and the development of Mexico's productive apparatus are of the greatest importance: protection and development of specific industries through import quotas on intermediate goods, should not be discarded by default on the grounds of "The logic that says that tariffs and import quotas almost always reduce real income" (Krugman, 1995, p. 31). Rather, a sound evaluation of the case at hand should be carried out.

It remains the fact, of course, that other negative effects might unfold (retaliation among them), but also, other positive effects should be considered (employment, wages, development and integration of the productive apparatus), and then again, "[…] serious estimation and modeling efforts remain to be undertaken in order to make CGE modelling a useful policy tool to analyze NTBs" (Fugazza and Maur, 2008, p. 475).

At any rate, development requires a decided impulse from committed governments to protect and foster specific key (sub)sectors if an efficient and sufficient national productive apparatus is to be developed.

The point is not that small gains are not worth obtaining, but that an import quota could be a helpful tool in fostering and developing specific productive activities. At the end of the day, the question of whether restrictions would be beneficial in practice, even though they can be in theory, is an empirical question.

Summarizing, the essential point is that an import quota, *per se*, does not necessarily imply a significant loss of welfare (if any at all), and it can be a useful policy tool to foster economic development, particularly in LDCs where some key productive activities are far from a sensible state of development.

Consequently, the central finding of this analysis is not that import quotas are devoid of costs, but rather that under a framework where the resulting rents are strategically recycled–as simulated through a revenue-neutral reduction in production taxes, which could be effectively implemented through import permit auctions–these static welfare costs could be so modest that they could effectively be offset by the prospective dynamic benefits of industrial development. While this model does not capture long-term gains such as employment generation, knowledge spillovers, enhanced sectoral linkages, and innovation, it is precisely these dynamic advantages that constitute the core rationale for such industrial policy.

APPENDIX 1

Table A1. SAM-Mx12 (10 000 000 000 current pesos) (part 1)

SAM-Mx12	*Households*	*Government*	*IncTax*	*ProdTax*	*SavInv*	*CAPITAL*	*LABOR*
Households	0.0000	30.2278	0.0000	0.0000	0.0000	707.8773	422.6356
Government	0.0000	0.0000	92.3748	157.4986	0.0000	0.0000	0.0000
Income Tax	45.6515	0.0000	0.0000	0.0000	0.0000	46.7233	0.0000
Production & products tax	61.6929	0.0000	0.0000	0.0000	1.8265	0.0000	0.0000
Save-invest	104.2867	35.4106	0.0000	0.0000	0.0000	206.2207	0.0000
CAPITAL	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
LABOR	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ACTIVITY1	0.0000	0.0000	0.0000	0.0000	4.0737	0.0000	0.0000
ACTIVITY2	0.0000	0.0000	0.0000	0.0000	17.0530	0.0000	0.0000
ACTIVITY3	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ACTIVITY4	0.0000	0.0035	0.0000	0.0000	207.7976	0.0000	0.0000
ACTIVITY5	0.0000	0.2122	0.0000	0.0000	26.0504	0.0000	0.0000
ACTIVITY6	0.0000	0.0000	0.0000	0.0000	27.3475	0.0000	0.0000
ACTIVITY7	0.0000	0.0000	0.0000	0.0000	10.6202	0.0000	0.0000
ACTIVITY8	0.0000	0.0099	0.0000	0.0000	0.5257	0.0000	0.0000
ACTIVITY9	0.0000	0.3955	0.0000	0.0000	0.0000	0.0000	0.0000
ACTIVITY10	0.0000	0.0023	0.0000	0.0000	4.3989	0.0000	0.0000
ACTIVITY11	0.0000	1.9164	0.0000	0.0000	0.0484	0.0000	0.0000
ACTIVITY12	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ACTIVITY13	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ACTIVITY14	0.0000	55.0159	0.0000	0.0000	0.0000	0.0000	0.0000
ACTIVITY15	0.0000	33.9638	0.0000	0.0000	0.0000	0.0000	0.0000
ACTIVITY16	0.0000	0.9405	0.0000	0.0000	0.0000	0.0000	0.0000
ACTIVITY17	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ACTIVITY18	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ACTIVITY19	0.0000	91.6220	0.0000	0.0000	0.0000	0.0000	0.0000
Private consumption	918.1382	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Rest of the World (RoW)	59.4149	0.1531	0.0000	0.0000	57.6095	18.8611	0.0000

Source: own elaboration based on IOT. https://www.inegi.org.mx/programas/mip12/2008/

Table A1. SAM-Mx12 (10 000 000 000 current pesos) (part 2)

SAM-Mx12	*ACTIV1*	*ACTIV2*	*ACTIV3*	*ACTIV4*	*ACTIV5*	*ACTIV6*	*ACTIV7*
Households	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Government	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Income Tax	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Production & products tax	-0.1961	91.6831	-1.6779	-0.0400	3.1518	2.3169	-8.1270
Save-invest	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CAPITAL	39.5775	33.2385	19.7029	74.9290	206.4500	196.8671	65.1378
LABOR	8.1767	7.0090	4.8729	51.3563	55.3095	41.3373	28.4138
ACTIVITY1	6.7495	0.0000	0.0022	0.0508	38.8546	0.0001	0.0000
ACTIVITY2	0.0802	3.2984	0.6123	2.3088	73.6689	0.0036	0.0147
ACTIVITY3	1.1318	1.0086	0.3244	0.6829	9.7838	4.5999	0.8993
ACTIVITY4	0.0002	0.6036	0.1541	16.4322	0.3994	0.4460	0.3057
ACTIVITY5	10.9963	7.7979	12.3216	36.0246	123.8654	15.4294	34.5548
ACTIVITY6	2.8325	2.3325	2.8258	9.4287	51.4713	3.8219	4.9726
ACTIVITY7	0.5899	0.6105	0.9265	2.0258	14.2331	2.4640	3.8982
ACTIVITY8	0.0127	0.1487	0.0919	1.0189	1.2417	1.5153	0.6919
ACTIVITY9	0.4009	0.8667	0.1197	3.6520	3.3888	1.5490	1.0290
ACTIVITY10	0.2775	0.7738	0.0551	1.2340	5.0619	8.4776	1.6958
ACTIVITY11	0.0881	1.7570	0.4588	2.0487	7.4763	3.4092	3.1788
ACTIVITY12	0.0059	1.3676	0.0923	0.0130	1.8018	1.4462	0.8956
ACTIVITY13	0.0732	1.2267	0.1859	2.4221	15.7597	14.6509	2.5426
ACTIVITY14	0.0001	0.0000	0.0156	0.0003	0.0148	0.0086	0.1096
ACTIVITY15	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ACTIVITY16	0.0000	0.0000	0.0000	0.0000	0.0000	0.0003	0.0008
ACTIVITY17	0.0215	0.2210	0.0833	0.4737	1.0401	0.6399	0.6675
ACTIVITY18	0.0713	0.1455	0.0727	0.8592	1.4434	1.0178	1.0136
ACTIVITY19	0.0000	0.0000	0.0000	0.0000	0.0000	0.0335	0.0000
Private consumption	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Rest of the World (RoW)	5.3992	4.1536	4.9829	23.5954	288.1060	10.2780	14.3319

Source: own elaboration based on IOT. https://www.inegi.org.mx/programas/mip12/2008/

Table A1. SAM-Mx12 (10 000 000 000 current pesos) (part 3)

SAM-Mx12	*ACTIV8*	*ACTIV9*	*ACTIV10*	*ACTIV11*	*ACTIV12*	*ACTIV13*	*ACTIV14*
Households	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Government	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Income Tax	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Production & products tax	0.4284	3.2256	0.7007	0.1047	0.6673	0.4232	0.3672
Save-invest	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
CAPITAL	26.6865	31.7742	174.4155	24.9054	6.1331	17.8417	5.8949
LABOR	6.8270	12.1395	2.6222	9.1935	1.1744	30.2447	56.1210
ACTIVITY1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ACTIVITY2	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
ACTIVITY3	0.5131	0.4149	1.8117	0.5265	0.0169	0.6597	1.3779
ACTIVITY4	0.0004	0.0000	0.0574	0.0026	0.0009	0.0038	0.6284
ACTIVITY5	2.2016	1.5971	4.8621	1.1246	0.1375	1.6205	0.8222
ACTIVITY6	1.4649	0.5957	0.6748	0.3568	0.0182	0.4366	0.2842
ACTIVITY7	0.7946	1.2453	0.3199	0.3814	0.0241	0.3371	0.2723
ACTIVITY8	2.2996	5.9985	0.6801	0.6169	0.0508	0.4930	0.7790
ACTIVITY9	1.1843	7.2050	1.2138	0.8128	0.0701	0.5273	0.2858
ACTIVITY10	1.3843	1.5870	2.8045	1.0786	0.1883	0.5900	0.7394
ACTIVITY11	1.5313	3.1506	2.2178	2.8808	0.5140	1.5414	1.0361
ACTIVITY12	0.7678	2.0801	0.2072	0.0694	0.6634	0.1727	0.0741
ACTIVITY13	2.2154	2.5181	0.8998	2.4266	0.2960	1.7078	0.7739
ACTIVITY14	0.0042	0.0786	0.0024	0.0390	0.0000	0.0000	0.0269
ACTIVITY15	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
ACTIVITY16	0.0703	0.0030	0.0018	0.0000	0.0000	0.0003	0.0000
ACTIVITY17	0.2331	0.3485	0.0832	0.0938	0.0322	0.3594	0.3280
ACTIVITY18	0.0906	0.7727	0.3083	0.2314	0.0083	0.1122	0.1994
ACTIVITY19	0.0000	0.0000	0.0001	0.0000	0.0000	0.0000	0.0000
Private consumption	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Rest of the World (RoW)	6.6600	3.5053	1.5691	0.9853	0.0509	0.9808	0.8613

Source: own elaboration based on IOT. https://www.inegi.org.mx/programas/mip12/2008/

Table A1. SAM-Mx12 (10 000 000 000 current pesos) (part 4)

SAM-Mx12	*ACTIV15*	*ACTIV16*	*ACTIV17*	*ACTIV18*	*ACTIV19*	*PrivCons*	*RoW*
Households	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	28.4436
Government	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Income Tax	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Production & products tax	0.1396	0.0572	0.2168	-0.0283	0.5660	0.0000	0.0000
Save-invest	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	11.4334
CAPITAL	7.5697	5.0135	24.2805	19.2646	0.0001	0.0000	0.0000
LABOR	25.3889	1.5430	6.9273	11.1935	61.8072	0.0000	0.9780
ACTIVITY1	0.0037	0.0000	0.0005	0.0006	0.0000	15.5924	10.9608
ACTIVITY2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	61.2027
ACTIVITY3	1.2299	0.3072	2.0750	0.8361	1.8952	15.6487	0.4795
ACTIVITY4	1.0580	0.0146	0.0498	0.0525	0.5058	0.0000	0.0000
ACTIVITY5	2.8713	0.5253	5.0717	2.7177	6.2478	267.4069	338.0637
ACTIVITY6	1.8420	0.0974	1.0531	0.8778	2.2682	153.0242	42.2858
ACTIVITY7	0.5989	0.0635	0.1898	0.2937	2.1790	99.9246	14.2346
ACTIVITY8	0.3621	0.0975	0.2057	0.3440	1.8188	35.9402	0.4144
ACTIVITY9	0.1174	0.0820	0.3230	0.0645	2.5555	49.6036	2.7931
ACTIVITY10	0.4955	0.1651	0.3878	1.8063	0.9967	161.2516	0.0005
ACTIVITY11	2.1114	0.1950	0.6152	0.7970	2.7095	5.1718	0.9765
ACTIVITY12	0.0619	0.0246	0.1837	0.0699	0.0491	0.0000	0.0000
ACTIVITY13	1.0216	0.3893	2.8233	1.1281	1.3773	3.6139	0.0000
ACTIVITY14	0.0007	0.0106	0.0000	0.0001	0.0071	15.5376	0.0000
ACTIVITY15	0.0000	0.0000	0.0000	0.0000	0.0000	14.6489	0.0000
ACTIVITY16	0.0000	0.0068	0.0001	0.0000	0.0941	7.8533	0.0000
ACTIVITY17	0.3072	0.0298	0.0415	0.1089	2.6399	38.6899	0.0000
ACTIVITY18	0.6704	0.1164	0.3906	0.5500	0.7969	33.9613	0.0000
ACTIVITY19	0.0000	0.0000	0.0000	0.0000	0.0000	0.2692	0.0000
Private consumption	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Rest of the World (RoW)	2.7625	0.2325	1.6071	2.7551	3.4109	0.0000	0.0000

Source: own elaboration based on IOT. https://www.inegi.org.mx/programas/mip12/2008/

APPENDIX 2
THE MATHEMATICAL MODEL: AGEM-MX12Q

According to the SAM-Mx12, we specify the mathematical model as follows: in table A3 and table A4 we describe parameters and variables of the model, then the formulae follows.

Table A3. Parameters AGEM-Mx12

Parameter	*Description*	*Parameter*	*Description*
Factors		**Production**	CES Value added (Composite factor)
$Captot$	Total capital endowment	σva_j	Constant elasticity of substitution
$Labtot$	Total labor endowment	δva_j	Capital-Labor shares
Households		ϕva_j	Scale parameter
τ^{caphh}	Households' share of captot		**Leontief domestic production**
$MPSHH$	Households' marginal propensity to save	$ruva_j$	Per unit value added (composite factor)
σpc	Private consumption CES	$ruii_{i,j}$	Per unit input *i*
δpc	Preference parameter		**CES Total supply (Gross product)**
Government		σgp_j	Constant elasticity of substitution
$\tau^{inctaxHH}$	Income tax on Households	δgp_j	Domestic-Imported shares
$\tau^{inctaxcap}$	Income tax on Activities	ϕgp_j	Scale parameter
τ^{hhDOM}	Tax on domestic good		**Private consumption aggregated good**
τ^{hhRdM}	Tax on imported good	$rucp_i$	Unit requirements (Leontief aggregation)
τ_j^{tp}	Tax on production and products	**RoW**	
τ^{impinv}	Tax on imported capital goods	τ^{caprow}	Share of RoW in captot
$\alpha_{trgovhh}$	Share of transfers in public spending	α_{labRoW}	Share of labor in RoW spending
α_{savgov}	Share of savings in public spending	α_{TRRoW}	Share of remittances in RoW spending
$\alpha_{importgov}$	Share of imports in public spending	α_{savRoW}	Share of savings in RoW spending
$\alpha_{govcons}$	Share of domestic goods in public spending	α_{EXP}	Share of exports in RoW spending
$\beta_{govconsi}$	Share of each good in public spending	β_{EXPi}	Share of each good in exportations

Continue

Table A3 Parameters AGEM-Mx12 (*continuation*)

Parameter	*Description*	*Parameter*	*Description*
Investment		**Investment**	
τ^{depr}	Depreciation rate	α_{INVint}	Share of domestic capital in total investment
τ^{reinv}	Reposition rate	β_{INVi}	Share of each good in domestic investment
$\tau_{invimport}$	Share of imported capital goods in total investment.	$PondIPI_i$	Weight for each good in investment price index
Mc_j	Non-binding quota on imported inputs.		

Source: own elaboration.

Table A4. Endogenous variables in the model

Variable	*Description*	*Variable*	*Description*
	HOUSEHOLDS		**GOVERNMENT**
DISPINC	Households' disposable income	*REVINCTAX*	Revenue from income taxes
SAVHH	Households' savings	*REVtaxPROD*	Revenue from products and production taxes
MPSHH	Households' marginal propensity to save	*REVIMPINV*	Revenue from taxes on imported capital good
CONSHH	Households' domestic consumption	*INCGOV*	Total Government revenues
IMPORTHH	Households' imported consumption	*TAUINCTAXHH*	Rate of income tax on households
IPCES	CES denominator	*TRgovHH*	Transfers from government
		SAVGOV	Government savings
	SAVINGS-INVESTMENT	*CONSGOVi*	Government consumption
INVIMPORT	Investment in imported capital	*IMPORTGOV*	Government imports
INVi	Investment in domestic capital	*SRPLgov*	Government surplus
SAVTOT	Total savings		
	PRODUCTION		**PRICES**
DEMCAPj	Capital demand	*Pcap*	Price of capital
DEMLABj	Labor demand	*Plab*	Price of labor
IPCESVAj	CES denominator	*Pvaj*	Price of value added

Continue

Table A4. Endogenous variables in the model (*continuation*)

Variable	*Description*	*Variable*	*Description*
VAj	Value added	*Pdpi*	Price of domestic production
DEMINPi,j	Domestic input demand	*Pgpi*	Price of gross product
DOMPRODj	Domestic production	*Ppc*	Price of aggregated good
DEMIMPORTi,j	Imported demand	*IPinv*	Price index for investment
IPCESgp	CES denominator	*ER*	Exchange rate
GROSSPRODi	Gross product	*Prow*	Price of goods from RoW
	REST OF THE WORLD		
INCRoW	RoW total income		QUOTAS
TRRoWHH	Remittances	*RQj*	Rent from quota
SAVRoW	RoW savings	*TRQj*	Quota rate of rent
LABRoW	Labor hired by RoW		
EXPORTi	Exports		

Source: own elaboration.

Factors

This is a neoclassical model (Barro and Sala-i-Martin, 2004, p. 27), where the economy has a fixed endowment of non-differentiated capital and labor. Full employment equilibrium implies that total demand of factors always equals total endowments, and full factor mobility among activities, therefore a long-term horizon since eventually, capital can be transformed and allocated to any sector. The same applies to labor.

Households behavior

Aggregated households are the first account of the SAM, obtaining income from capital, wages, government transfers and transfers (remittances) from the Rest of the World (RoW). On the other hand, households pay taxes, save (future consumption), and buy goods (present consumption). Present consumption comprises one aggregated domestic good and one imported good.

We define disposable income as:

$$DISPINC = \begin{bmatrix} \tau^{caphh} * \left[captot * \left(1 - \tau^{cap} - \tau^{depr}\right)\right] \\ * Pcap + (labtot - LABRoW) * Plab \end{bmatrix} * (1 - \tau^{HH}) + LABRoW * Prow * ER + TRGOVHH + TRRoWHH * ER \quad (1)$$

Assuming households maximize a Constant Elasticity of Substitution (CES) utility function, the optimal consumption is:

$$HHCONSDOM = \frac{(DISPINC - HHSAV) * \delta_{PC}^{\sigma^{PC}} * \left[Ppc * \left(1 + \sigma^{hhDOM}\right)\right]^{-\sigma^{CP}}}{IPCES} \quad (2)$$

$$HHCONSRoW = \frac{(DISPINC - HHSAV) * (1 - \delta_{PC})^{\sigma^{PC}} * \left[ProwFC * ER * \left(1 + \sigma^{hhDOM}\right)\right]^{-\sigma^{PC}}}{IPCES} \quad (3)$$

$$IPCES = \delta_{PC}^{\sigma^{PC}} * \left[Ppc * \left(1 + \sigma^{hhDOM}\right)\right]^{1-\delta_{PC}} + (1 - \delta_{CP})^{\sigma^{CP}} * \left[PrdmCF * TC * \left(1 + \sigma^{IDhogNAL}\right)\right]^{1-\delta_{CP}} \quad (4)$$

$$AHRHOG = PMAHOG * INGDISP \quad (5)$$

Government behavior

The government collects revenues from income taxes:

$$REVINCTAX = \tau^{capHH} * captot * \left(1 - \tau^{inctaxcap} - \tau^{depr}\right) * Pcap * \tau^{inctaxHH} + (labtot - LABRoW) * Plab * \tau^{inctaxHH} + \tau^{inctaxcap} * captot * Pcap \quad (6)$$

From products and production taxes:

$$REVTAXPRO = \tau^{PCdom} * HHCONSDOM * Pcp + \tau^{PCrow} * HHCONSRoW * Prow * ER + \sum_j \left[VA_j * Pva_j + \sum_i DEMINP_{i,j} * Pgp_i\right] * \tau_j^{TP} \quad (7)$$

From taxes on capital imports:

$$REVIMPINV = \tau^{impinv} * (INVRdM * Prow * ER) \quad (8)$$

So that total government income is:

$$INCGOV = REVINCTAX + REVTAXPROD + RECIMPINV \quad (9)$$

Then the government makes transfers to households (poverty alleviation programs):

$$TRGOVHH = \alpha^{trgovhh} * INCGOV \quad (10)$$

Saves:

$$SAVGOV = \alpha^{savgov} * INCGOV \quad (11)$$

And consumes:

$$CONSGOVDOM_i = \frac{\beta_i^{consgov} * \alpha^{consgovdom} * INCGOV}{Pgp_i} \quad (12)$$

$$CONSGOBRoW = \frac{\alpha^{consgovrow} * INCGOV}{Prow * ER} \quad (13)$$

We define government surplus as:

$$SRPLGOV = INCGOV - TRGOVHH - SAVGOV - CONSGOVRoW * P_{RoW} * ER - \sum_i CONSGOVDOM_i * Pgp_i \quad (14)$$

Savings-investment

Savings come from households, firms, government and RoW, so that total investment is:

$$SAVTOT = SAVHH + SAVGOV + SAVRoW * ER + \tau^{depr} * CAPTOT * Pcap \quad (15)$$

Investment in capital goods from the RoW is given by:

$$INVRoW = \frac{\alpha^{invrow} * SAVTOT}{PrOW * ER * (1+\tau^{invrow})} \tag{16}$$

We also specify a price index for investment in domestic capital goods:

$$IPINV = \sum_i Pgp_i * pondipi_i \tag{17}$$

Domestic capital goods investment is discussed in the Macro-closures section.

Production

Production of total supply (gross product) is carried out as follows: in the first place, value added (VA) is produced, combining capital and labor (composite factor), then VA is combined with domestic inputs to obtain domestic product. Finally, foreign inputs are added to get the total gross product. Equations for optimal –cost minimizing– demands of factors and inputs follow.

CES production of value added is:

$$DEMCAP_j = \frac{VA_j}{fiva_j} \frac{\delta va_j^{\sigma va_j} * Pcap^{-\sigma va_j}}{\left[\delta va_j^{\sigma va_j} * Pcap^{1-\sigma va_j} + (1-\delta va_j)^{\sigma va_j} * Plab^{1-\sigma va_j}\right]^{\sigma va_j/(\sigma va_j - 1)}} \tag{18}$$

$$DEMLAB_j = \frac{VA_j}{fiva_j} \frac{(1-\delta va_j)^{\sigma va_j} * Plab^{-\sigma va_j}}{\left[\delta va_j^{\sigma va_j} * Pcap^{1-\sigma va_j} + (1-\delta va_j)^{\sigma va_j} * Plab^{1-\sigma va_j}\right]^{\sigma va_j/(\sigma va_j - 1)}} \tag{19}$$

And from the assumption of perfect competition we have:

$$Pva_j = \frac{1}{fiva_j}\left[\delta va\middle|j^{\sigma va_j} * Pcap^{1-\sigma va_j} + (1-\delta va_j)^{\sigma va_j} * Plab^{1-\sigma va_j}\right] 1/(1-\sigma va_j) \tag{20}$$

Leontief domestic production is:

$$DEMINP_{i,j} = DOMPROD_j * ruii_{i,j} \tag{21}$$

$$DEMVA_j = DOMPROD_j * ruva_{i,j} \tag{22}$$

And from the assumption of perfect competition we have:

$$Pdp_j * DOMPROD_j = \left[Pva_j * VA_j + \sum_i DEMINP_{i,j} * Pgp_i\right] * \left(1 + \tau_j^{tp}\right) \tag{23}$$

CES production of total supply (gross product) is:

$$DOMPROD_j = \frac{GROSSPROD_j}{figp_j} *$$

$$\frac{\delta gp_j^{\sigma gp_j} * Pdp_j^{-\sigma gp_j}}{\left[\delta gp_j^{\sigma gp_j} * Pdp_j^{1-\sigma gp_j} + (1-\delta gp_j)^{\sigma gp_j} * \left(Prow * ER * (1+TRQ_j)\right)^{1-\sigma gp_j}\right]^{\sigma gp_j/(\sigma gp_j - 1)}} \tag{24}$$

$$DEMIMPORT_j = \frac{GROSSPROD_j}{figp_j} *$$

$$\frac{[1-\delta gp_j]^{\sigma gp_j} * [Prow * ER * (1+TRQ_j)]^{-\sigma gp_j}}{\left[\delta gp_j^{\sigma gp_j} * Pdp_j^{1-\sigma gp_j} + (1-\delta gp_j)^{\sigma gp_j} * \left(Prow * ER * (1+TRQ_j)\right)^{1-\sigma gp_j}\right]^{\sigma gp_j/(\sigma gp_j - 1)}} \tag{25}$$

And from the assumption of perfect competition we get:

$$Pgp_j = \frac{1}{figp_j}\left[\delta gp_j^{\sigma gp_j} * Pdp_j^{1-\sigma gp_j} + (1-\delta gp_j)^{\sigma gp_j} * \left(Prow * ER * (1+TRQ_j)\right)^{1-\sigma gp_j}\right]^{1/(1-\sigma gp_j)} \tag{26}$$

Aggregated good for private final consumption is:

$$Ppc = \sum_i Pgp_i * rucp_i \tag{27}$$

Rest of the World (RoW)

The RoW obtains income from our economy imports: inputs, capital goods, final consumption of households and government, and capital payments. At RoW prices:

$$INCRoW = [IMPORTHH + IMPORTgov + INVIMPORT + \sum_i DEMIMPORT_i] * Prow + \tau^{CAPRoW} * captot * (1 - \tau^{ITC} - \tau^{DEPR}) * Pcap/ER \quad (28)$$

Also at RoW prices, expenditures are given by:

$$TRRoWHH = \alpha^{trRoW} * INCRoW \quad (29)$$

$$SAVRoW = \alpha^{savRoW} * INCRoW \quad (30)$$

$$LABRoW = \alpha^{labRoW} * INCRoW/Prow \quad (31)$$

$$EXPORT_i = \beta_i^{exp} * \alpha^{exp} * INCRoW/[Pgp_i/ER] \quad (32)$$

Small country assumption is:

$$Prow = 1 \quad (33)$$

Rents from quotas, and complementarity condition

$$RQ_j = TRQ_j * Prow * ER * DEMIMP_j \quad (34)$$

$$TRQ_j * \lfloor Mc_j - DEMIMP_j \rfloor = 0 \quad (35)$$

$$Mc_j - DEMIMP_j \geq 0 \quad (36)$$

Macroeconomic closures

From the full employment assumption, we have:

$$\sum_j DEMCAP_j = captot \tag{37}$$

$$\sum_j DEMLAB_j = labtot \text{ - LABRoW} \tag{38}$$

Fixed marginal propensity to save: flexible investment.

$$\left[SAV - INVIMP * Prow * ER * \left(1 + \tau^{impinv}\right)\right] * \beta_i^{inv} = INV_i * Pgp_i \tag{39a}$$

Alternatively: fixed investment with flexible marginal propensity to save:

$$\begin{aligned} SAVHH = {} & \sum_i INV_i * Pgp_i + INVIMP * Prow * ER * \left(1 + \tau^{impinv}\right) \\ & - SAVGOV - \tau^{depr} * captot * Pcap - SAVRoW * ER \end{aligned} \tag{39b}$$

Finally, goods and services markets also clear:

$$\begin{aligned} GROSSPROD_i = {} & \sum_j DEMINP_{i,j} + CONSHH * rucp_i + CONSGOV_i \\ & + INV_i + exp_i \end{aligned} \tag{40}$$

This mathematical model was implemented using the General Algebraic Modeling System (GAMS Release 24.8).

References

Barro, R. and Sala-i-Martin, X. (2004). *Economic Growth*. The MIT Press.

Blonigen, B., Liebman, B., Pierce, J. and Wilson, W. (2013). Are all trade protection policies created equal? Empirical evidence for nonequivalent market power effects of tariffs and quotas. *Journal of International Economics 89*. https://doi.org/10.3386/w16391.

Chao, C., Hwang, H. and Yu, E. (1990). Welfare of quotas under variable returns to scale. *Southern Economic Journal, 57(1)*. https://doi.org/10.2307/1060486.

Chen, H., Chang, Y. and Chiou, J. (2011). A welfare analysis of tariffs and equivalent quotas under demand uncertainty: Implications for tariffi-

cation. *International Review of Economics and Finance 20*. https://doi.org/10.1016/j.iref.2010.10.002.

Dietrich, E. (1933). French import quotas. *The American Economic Review, 23(4).*

Fan, L. and Fan, C. (2005). On the welfare effect of an equivalent tariff and quota. *Economic Issues, 10, Part 1*. https://www.economicissues.org.uk/Vol10.html#a1

Francois, J. and Woerz, J. (2009). Non-linear panel estimation of import quotas: The evolution of quota premiums under the ATC. *Journal of International Economics 78*. https://doi.org/10.1016/j.jinteco.2009.01.017

Feenstra, R. (1988). Quality change under trade restraints in Japanese autos. *The Quarterly Journal of Economics, 103(1)*. https://doi.org/10.2307/1882645

Fugazza, M. and Maur, J. (2008). Non-tariff barriers in CGE models: How useful for policy? *Journal of Policy Modeling, 30*. https://doi.org/10.1016/j.jpolmod.2007.10.001.

Furusawa, T., Higashida, K. and Ishikawa, J. (2003). What information is needed for welfare-enhancing policies under international oligopoly? *Japan and the World Economy, 15*. https://doi.org/10.1016/S0922-1425(02)00035-X

Harrigan, J. and Barrows, G. (2009). Testing the theory of trade policy: evidence from the abrupt end of the multifiber arrangement. *The Review of Economics and Statistics, 91(2)*. https://doi.org/10.1162/rest.91.2.282

Hosoe, N., Gasawa, K. and Hashimoto, H. (2010). *Textbook of computable general equilibrium modelling. Programing and simulation*. Palgrave Macmillan.

INEGI (2014). Cuentas por Sectores Institucionales (2003-2013). Base 2008. https://www.inegi.org.mx/contenidos/productos/prod_serv/contenidos/espanol/bvinegi/productos/metodologias/SCNM/702825068479.pdf

_____(2018a). Matriz Insumo Producto 2012. http://www.inegi.org.mx/est/contenidos/proyectos/cn/mip12/default.aspx

_____ (2018b). Banco de Información Económica (BIE). http://www.inegi.org.mx/sistemas/bie/

Johnston, M. and Parajuli, R. (2017). What's next in the U.S.-Canada softwood lumber dispute? An economic analysis of restrictive trade policy measures. *Forest Policy and Economics, 85.* https://doi.org/10.1016/j.forpol.2017.09.011.

Khandelwal, A., Schott, P. and Shang-Jin, W. (2013). Trade liberalization and embedded institutional reform: evidence from Chinese exporters. *American Economic Review, 103(6)*. https://doi.org/10.1257/aer.103.6.2169.

Kreickemeier, U. (2005). Unemployment and the welfare effects of trade policy. *The Canadian Journal of Economics, 38(1).* https://doi.org/10.1111/j.0008-4085.2005.00275.x.

Krugman, P. (1995). Dutch tulips and emerging markets. *Foreign Affairs, 74(4).* https://doi.org/10.2307/20047206.

Lofgren, H., Harris, R. and Robinson, S. (2002). *A standard Computable General Equilibrium (CGE) Model in GAMS*. International Food Policy Research Institute.

Naudé, W. and Rossouw, R. (2008). South African quotas on textile imports from China: a policy error? *Journal of Policy Modeling 30*. https://doi.org/10.1016/j.jpolmod.2007.12.006.

Okumura, Y. (2015). Volume and share quotas in Cournot competition. *Economic Modelling 47*. https://doi.org/10.1016/j.econmod.2015.02.026.

Schweinberger, A. (2003). Special economic zones and quotas on imported intermediate goods: a policy proposal. *Oxford Economic Papers 55*. https://doi.org/10.1093/oep/55.4.696.

Sievers, L. and Schaffer, A. (2016). The impacts of the German biofuel quota on sectoral domestic production and imports of the German economy. *Renewable and Sustainable Energy Reviews 63*. https://doi.org/10.1016/j.rser.2016.05.058.

Teimoury, E., Nedaei, H., Ansari, S. and Sabbaghi, M. (2013). A multi-objective analysis for import quota policy making in a perishable fruit and vegetable supply chain: a system dynamics approach. *Computers and Electronics in Agriculture 93*. https://doi.org/10.1016/j.compag.2013.01.010.

Ülengin, F., Cekyay, B., Palut, P., Ülengin, B., Kabak, Ö., Özaydin, Ö. and Ekici, S. (2015). Effects of quotas on Turkish foreign trade: a gravity model. *Transport Policy 38*. https://doi.org/10.1016/j.tranpol.2014.09.006

Upward, R. and Wang, Z. (2016). Quota restrictions and intra-firm reallocations: evidence from Chinese exports to the US. *Economics Letters 144*. https://doi.org/10.1016/j.econlet.2016.04.025

Whittlesey, C. (1937). Import quotas in the United States. *TheQuarterly Journal of Economics, 52(1)*. https://doi.org/10.2307/1884499

Winchester, N. (2009). Is there a dirty little secret? Non-tariff barriers and the gains from trade. *Journal of Policy Modeling, 31(6).* https://doi.org/10.1016/j.jpolmod.2009.08.004